



China Semiconductors

Localizing the next generation of long-term winners

After two decades of infrastructure build in plants, automation and logistics, China has entered another stage of technology migration – upstream semiconductors. As Chinese companies localize their supply chains, new leaders across China's semiconductor ecosystem are being cultivated. Our deep dive reveals that while technology development is still in the early stages, revenue opportunities in entry-to-mid level segments are compelling. We initiate with Buy ratings on 11 companies averaging a 2020-25E EPS CAGR of 67% as they capture a rising share of a growing pie.

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Please see page 447 for a **glossary** of technical terms

Actionable Ideas: 11 New Buys

- **Acco Test** (SPE, Testing Equipment; TP Rmb469, target P/E 22x 25E): 61% earnings CAGR driven by expanding product portfolio (from analog testing to power semis, SoC testing) and rising market share. *Pg263*
- **ACM Research** CL-Buy (SPE, Cleaning Tools; TP US\$150, target P/E 14x 25E): 64% earnings CAGR driven by share gains in local SPE market and expanding product portfolio (from cleaning tools to copper plating, furnace). *Pg274*
- **AMEC** (SPE & Etcher; TP Rmb382, target P/E 30x 25E): 95% earnings CAGR driven by increasing share allocation at local wafer fabs (30% share in etch segment by 2025E vs. 8% in 2020E, GSe) and expanding product line. *Pg286*
- **Anji Micro** (CMP Slurry; TP Rmb647, target P/E 30x 25E): 74% earnings CAGR driven by expanding product portfolio (from copper slurry to tungsten slurry for local memory) and increasing order allocation from local wafer fabs. *Pg296*
- **CR Micro** (MOSFET; TP Rmb88, target P/E 33x 25E): 55% earnings CAGR driven by product upgrades (IGBT, power IC) and expanding end markets (industrial and automotive). *Pg306*
- **Montage** (Memory Interface IC; TP Rmb161, target P/E 32x 25E): 43% earnings CAGR driven by product upgrade (DDR5) and market expansion (server platforms). *Pg330*
- **NSIG** (silicon wafer; TP Rmb60, 80x 25E P/E): 2021-25E 138% earnings CAGR driven by ramp up of 12" wafer production, with domestic demand to quintuple vs. 2019 as local fabs expand capacity. *Pg347*
- **Sanan** (Power Amplifier; TP Rmb40, target P/E 29x 25E): 38% earnings CAGR driven by technology migration (GaAs, GaN PA) and market expansion (PA). *Pg360*
- **Silan** (MOSFET & IGBT; TP Rmb21.5, target P/E 30x 25E): 87% earnings CAGR driven by product upgrades (high-voltage power semi) and expanding end markets (industrial and automotive). *Pg382*
- **StarPower** CL-Buy (IGBT; TP Rmb402, target P/E 40x 25E): 65% earnings CAGR in 2020-25E driven by product upgrades (Gen 7, 3300V+ IGBT) and growing end market applications (EVs, green home appliances). *Pg394*
- **Wingtech** (MOSFET; TP Rmb189, target P/E 33x 25E): 22% earnings CAGR driven by market share gains and expanding product portfolio (GaN FET, SiC, PMIC). *Pg420*

Why read this report?

- We size the TAMs and revenue opportunities across the China semiconductor ecosystem: SPE capex (US\$36bn by 2025, +31% CAGR 2020-25E), IGBT and MOSFET (US\$21bn combined, +6% CAGR); PA/WiFi/Bluetooth (US\$7bn by 2025, +5% CAGR).
- We analyze the competitive dynamics between Chinese semiconductor companies and their global peers in terms of technology roadmap, product portfolios, SKUs, customer base, end market exposure and financial data.
- We expand our China semiconductor coverage to include IGBT, MOSFET, SPE, PA, Wafers, CMP slurry, and Memory Interface IC.
- Our SUSTAIN team highlights what they see as key environmental and social issues for Chinese semiconductor companies.

How are we different from the market?

- For the 11 companies we initiate on we are 32%/64% above Bloomberg consensus earnings for 2021E/22E and forecast an average 2020-25E EPS CAGR of 67%.
- Our investment framework applies a top-down (TAM) and bottom-up approach (pricing, units, customers, competitors, products) across seven sub-sectors (IGBT, MOSFET, SPE, PA, Wafers, CMP slurry, and Memory Interface IC).
- Our regression analysis shows China semiconductor stocks with high multiples are rewarded because of the strength and duration of their earnings growth.
- Within our Greater China technology coverage, we reiterate our preference for semiconductors over smartphone components and telecom equipment.

What are the best investment opportunities?

- The long-term winners in China semiconductors are leaders in technology, scale and SKUs and are best placed to benefit from the localization of supply chains. A cycle of accelerated tech migration, expanding product lines and rising market share will drive outsized earnings growth over the next five years.
- We initiate on 11 companies, all with Buy ratings: StarPower (CL-Buy), ACM Research (CL-Buy), CR Micro, Silan, Wingtech, Sanan, Montage, AMEC, AccoTest, Anji Micro, and NSIG.

China Semiconductors in numbers



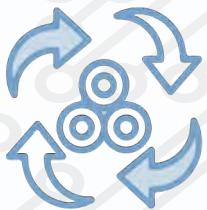
How big is the market now, and how big could it be?

- China semiconductor revenues: **US\$109bn in 2019**, comprising 39% fabless, 28% from foundry/IDM, and 33% from OSAT
- China SPE capex: **US\$10bn in 2020E**; +31% CAGR in 2020-25E
- China IGBT & MOSFET **US\$3bn in 2020E**; +6% CAGR in 2020-25E
- China PA/WiFi/Bluetooth **US\$2bn in 2020E**; +5% CAGR in 2020-25E



EPS CAGR in 2020-25E

- +67% on average for our 11 initiations, driven by market share gains, product mix upgrades, and product line expansion
- +57% on average for our 4 Power semiconductor stocks (Starpower, CR Micro, Silan, Wingtech)
- +72% on average for our 3 SPE stocks (AMEC, ACMR, AccoTest)
- +106% on average for our 2 Semiconductor Materials stocks (Anji, NSIG)
- +43% for Montage (Memory interface IC); +38% for Sanan (PA foundry)



Local suppliers to grow in the local market

- Well established Chinese brands cultivating local supply chains
- Chinese brands account for 90% of the domestic market in smartphones, 70-80% in surveillance, 50-60% in home appliances, and ~40% in vehicles
- Local semiconductor suppliers still have small market share in China (2019): Starpower 4% (IGBT), CR Micro 8% (MOSFET), Wingtech 7% (MOSFET), Silan 3% (MOSFET)



Technology gap between local suppliers and global peers

- 1958: First IC invented globally
- 1965: China's first silicon-based digital IC; 1995: China's first 8-inch wafer processing
- Chinese semis catching up to global leaders in technology, especially in lower-end products such as power semi: Starpower (local leader in IGBT) has narrowed its IGBT generation gap with Infineon (the global leader) to under 5 years despite entering this segment 14 years later

PM Summary: Buy Local Leaders

China's semiconductor ecosystem is being retooled for long-term sustainable growth and self-sufficiency. The geopolitical backdrop has prompted domestic brands to localize their supply chains and in the process, cultivate the next generation of long-term winners. As a cycle of accelerated technology migration, expanding product lines and market share gains takes hold, we expect our 11 Buy-rated names (all leaders in their respective industries) to generate outsized earnings growth over the next five years (67% CAGR).

China semiconductors: the right place to invest

(1) **right sector:** The semiconductor industry as a whole is still benefiting from tech migration driven by 5G, green / energy-saving, and high speed computing. China's semiconductors will enjoy significant upside from a low base as they are still in the early stages of this process relative to global leaders.

(2) **right market:** China has seen the emergence of many leading local brands (e.g. in smartphones, 90% of the domestic market belongs to domestic brands), which have played a key role in developing local supply chains. Supported by these customers and the government, local semiconductor companies are set to capture a rising share of a growing pie.

(3) **right timing:** macro uncertainty and supply chain disruptions in tech since 2018 have prompted Chinese brands across a variety of industries to diversify their product sourcing, offering significant revenue opportunities to local suppliers. Even if the geopolitical backdrop improves, we believe this trend is irreversible.

China semiconductors deep dive

In this report we provide a comprehensive analysis of China's semiconductor ecosystem:

- **We introduce detailed TAM** (Total Addressable Market) models based on capex/capacity, shipments, ASPs, dollar content per device and end market applications in order to **size the revenue opportunity for seven semi sub-sectors: IGBT, MOSFET, PA, Wifi / Bluetooth IC, SPE, silicon wafers, and CMP slurry.**
- **Outsized growth:** We forecast China's SPE market to grow by 63%/31% in 2021-22E (31% CAGR in 2020-25E) and semiconductor devices to grow 5-17% YoY in 2021-22E (6% CAGR in 2020-25E) driven by 5G migration and uptake of green / energy efficiency requirements across EVs, home appliances and industrial equipment.
- **Closing the gap:** We analyze the bridge between domestic players and global leaders in terms of technology, product portfolios, SKUs, customer base, end market exposure and key financial data. In many sub-sectors Chinese semis are significantly lagging global leaders in technology, scale and financial wherewithal but that gap is steadily narrowing. **StarPower (the domestic leader in IGBT) has narrowed its technology gap with global leader Infineon to under 5 years despite entering**

this segment 14 years later - we expect this to be replicated in other parts of China's semiconductor ecosystem.

- **The next generation of winners:** We initiate on 11 Buy ideas (2 on the Conviction List), each a leader in their respective sub-sector. They enjoy greater scale, more comprehensive SKUs / product portfolios, and more resources devoted to R&D, recruitment, and potential M&A, increasing the likelihood of design wins and market share gains. **We expect our Buy-rated names to outpace the market with earnings growth of 40-319% YoY in 2021-22E and a 22-138% earnings CAGR over the next five years.**

Semiconductors a new stage of technology migration in China

Following two decades of infrastructure build in plants, automation and logistics, China has entered another stage of technology migration – upstream semiconductors. After enduring tech supply chain disruptions since 2018, Chinese manufacturers are localizing their semiconductor supply chains – from foundries to IC design, IDM, SPE, Silicon Wafers as well as IGBT and MOSFET – creating multi-year growth opportunities across the ecosystem.

- **Geopolitical backdrop has seen Chinese companies actively diversify their supply chains, especially in tech,** creating compelling revenue opportunities for new domestic suppliers.
- The sheer scale of many Chinese brands, in some cases dominating market share, means **gaining inroads into the domestic client base will drive tremendous growth for China semis off a low base,** and enable a **rapid move up the learning curve.** Across consumer electronics, vehicles, home appliances and industrials, Chinese brands are significantly increasing their presence, commanding 90% of the domestic market in smartphones, 70-80% in surveillance, 50-60% in home appliances, and ~40% in vehicles.
- **In the process of localizing supply chains, new leaders in the semi space are being cultivated:** Chinese customers have been willing to work closely with local semi suppliers to help them raise their product quality and performance, enabling access to new and growing markets. By securing products from a domestic base of suppliers Chinese customers are able to shore up their own supply chains amid macro uncertainty.
- **Better understanding of local customer needs:** Local semiconductor suppliers can also provide superior service to domestic customers by providing in time product revisions and customized products within budgets.
- **Semiconductors on the national agenda:** The Chinese government has prioritized the development of the local semiconductor industry by establishing national funds (China IC Funds) to invest in leading domestic semiconductor companies, providing subsidies to companies that source from domestic semiconductor companies as well as providing subsidies and lower tax rates to semiconductor companies to develop their technology, product lines or to expand capacity.

China semiconductors in the early stages of development, with significant upside in technology, product lines and market share

- **Technology migration / product specification upgrades from a low base:** China semiconductors are at the early stages of tech migration relative to global leaders, meaning they will see outsized upside as they narrow the gap and move up the curve. The China semiconductor industry started in 1965, when silicon-based digital IC was first developed, and in 1995 China established its first 8-inch chip production line. The global semiconductor industry dates back to 1958, when the first IC was invented, and by 1968, annual sales of global IC has already surpassed US\$1bn, when China's semiconductor industry was in its infancy.
- **Market share gains from a low base:** We expect meaningful market share gains to start from products with lower entry barriers, such as power semiconductors (e.g. MOSFET, IGBT), analog IC and discrete RF, as their much narrower technology gap between Chinese suppliers and global peers means domestic customers are more likely to try new local suppliers. Local semi companies are also positioned to capture design wins as they are better placed to understand local customer needs.
- **Product line expansion from a low base:** There is significant long-term revenue and earnings upside as product lines grow from a low base relative to global peers. For example, in power semiconductors, Wingtech (China's largest supplier of power semis) has around 16K SKUs (even after merging with Nexperia, a global leader in power semiconductors), less than one-third of Infineon (60K SKUs) while other Chinese suppliers are yet to reach 10K SKUs.

SEMICONDUCTOR DEVICES

PRODUCT POWER SEMICONDUCTORS

	IGBT	MOSFET	POWER IC	DIODE AND OTHERS	TOTAL
Market size (US\$ bn, 2019, global)	6.2	8.9	21.0	4.9	41.0
Market size (% , 2019, global)	15%	22%	51%	12%	100%

RF FRONT END

PA MODULE	DISCRETE FILTER, DUPLEXER, ETC.	DISCRETE SWITCH, LNA	RECEIVE MODULE, TUNER, OTHERS	TOTAL
6.7	3.5	1.0	5.7	17.0
40%	21%	6%	33%	100%

MEMORY INTERFACE IC WIFI, BLUETOOTH

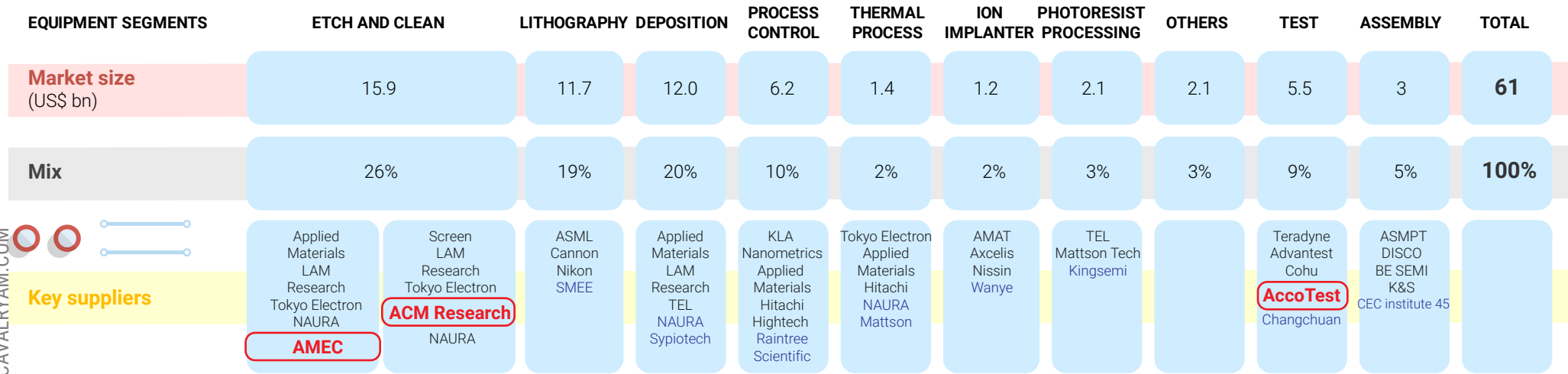
0.6	7.8

Supplier by type

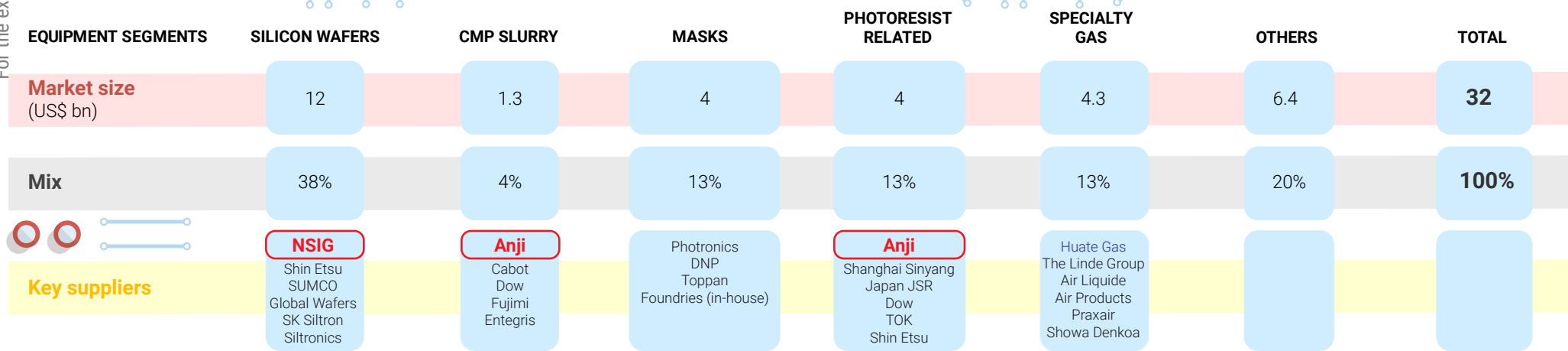
	StarPower	NCE Power SinoPower Niko Semi Excelliance Mos	SG Micro Silergy		Vanchip RDA Lansus OnMicro Smarter Micro	Maxscend Microgate Shoulder	Maxscend Will Semi Unisoc Vanchip Lansus		Montage Rambus	Maxscend Beken Espressif Rockchip MediaTek Nordic Marvel
Fabless										
Foundry	Hua Hong SMIC	Hua Hong SMIC CR Micro	Hua Hong SMIC CR Micro	CR Micro	Sanan Win semi	SMIC Hua Hong TowerJazz TSMC ST Micro UMC	SMIC Hua Hong TowerJazz TSMC ST Micro UMC			SMIC TSMC UMC
IDM	CR Micro Silan Wingtech Infineon Mitsubishi On Semi Fuji Electric Semikron	CR Micro Silan Wingtech Infineon On Semi ST Micro Renesas	CR Micro Silan TI Infineon ADI ST Micro On Semi	CR Micro Silan Wingtech Infineon On Semi Rohm Diodes	Skyworks Qorvo Broadcom Murata	Murata TDK Taiyo Yuden Skyworks Qorvo Broadcom On Semi Infineon NXP TI	Murata TDK Taiyo Yuden Skyworks Qorvo Broadcom On Semi Infineon NXP TI	Murata TDK Taiyo Yuden Skyworks Qorvo Broadcom On Semi Infineon NXP TI	Renesas	Broadcom

Chinese suppliers we are initiating on
Other local (Chinese) suppliers
Foreign suppliers

SEMICONDUCTOR EQUIPMENT



SEMICONDUCTOR WAFER FABRICATION MATERIAL



Chinese suppliers we are initiating on
Other local (Chinese) suppliers
Foreign suppliers

We initiate on 11 new Buy ideas (2 of which are on the Conviction List)

Buy the leaders: We initiate on 11 new Buy ideas (2 on the CL): market leaders in their respective sub-sector that we expect will generate outsized bottom line growth over the next five years from a cycle of tech migration, expanded product lines and market share gains.

IGBT: Insulated-Gate
Bipolar Transistor

SPE: Semiconductor
Production Equipment

MOSFET:
Metal-Oxide-Semiconductor
or Field-Effect Transistor

1. **StarPower CL-Buy (IGBT; TP Rmb402, target P/E 40x 25E):** 65% earnings CAGR in 2020-25E driven by product upgrades (Gen 7, 3300V+ IGBT) and growing end market applications (EVs, green home appliances).
2. **ACM Research CL-Buy (SPE, Cleaning Tools; TP US\$150, target P/E 14x 25E):** 64% earnings CAGR driven by share gains in the local SPE market, expanding product portfolio (from cleaning tools to copper plating, furnace), driving a burgeoning SAM (from US\$1.5bn up to US\$5bn).
3. **CR Micro (MOSFET; TP Rmb88, target P/E 33x 25E):** 55% earnings CAGR driven by product upgrades (IGBT, power IC) and expanding end markets (industrial and automotive).
4. **Silan (MOSFET & IGBT; TP Rmb21.5, target P/E 30x 25E):** 87% earnings CAGR driven by product upgrades (high-voltage power semi) and expanding end markets (industrial and automotive).
5. **Wingtech (MOSFET; TP Rmb189, target P/E 33x 25E):** 22% earnings CAGR driven by market share gains and expanding product portfolio (GaN FET, SiC, PMIC).
6. **Sanan (Power Amplifier; TP Rmb40, target P/E 29x 25E):** 38% earnings CAGR driven by technology migration (GaAs, GaN PA) and market expansion (PA).
7. **Montage (Memory Interface IC; TP Rmb161, target P/E 32x 25E):** 43% earnings CAGR driven by product upgrade (DDR5) and market expansion (server platforms).
8. **AMEC (SPE & Etcher; TP Rmb382, target P/E 30x 25E):** 95% earnings CAGR driven by increasing share allocation at local wafer fabs (30% share in etch by 2025E vs. 8% in 2020E) and expanding product line (e.g. high-aspect ratio etching for 128-layer 3D NAND, dual damascene etching) increasing its serviceable available market.
9. **AccoTest (SPE, Testing Equipment; TP Rmb469, target P/E 22x 25E):** 61% earnings CAGR driven by an expanding product portfolio (from analog testing to power semis, SoC testing) and rising demand from local customers (e.g. Hisilicon, SG Micro, China local OSATs). The SoC testing market is c.30x the scale of analog testing.
10. **Anji Micro (CMP Slurry; TP Rmb647, target P/E 30x 25E):** 74% earnings CAGR driven by an expanding product portfolio (from copper slurry to tungsten slurry for local memory players) and increasing order allocation from local wafer fabs that are looking for local substitutes to mitigate supply chain risks.
11. **NSIG (Silicon Wafer; TP Rmb60, 80x 25E P/E):** 2021-25E 138% earnings CAGR (2020 will be loss making) driven by a ramp in 12" wafer production, with domestic demand to quintuple vs. 2019 as local fabs expand capacity.

CMP Slurry: Chemical
Mechanical Planarization
Slurry

Exhibit 1: 11 New Buy ideas in China semiconductors

Initiation snapshot: Drivers, earnings growth, valuation

Company	Ticker	Segment	Rating	Target Price (RMB)	Valuation (2025E P/E)	Implied P/E (2022E)	EPS CAGR (2020-25E)	Key product	Key product rev % in 2019A	Key product rev % in 2025E	Earnings drivers
Star Power	603290.SS	IGBT	Buy*	402	40x	130x	65%	600-1200V IGBT for EV 600V IPM for green home appliances ≥3300V IGBT	21% 4% 0%	28% 18% 16%	a. Product upgrade to Gen 7 and ≥ 3300 voltage b. Expanding end markets from industrial to EV and green home appliances
CR Micro	688396.SS	MOSFET	Buy	88	33x	80x	55%	MOSFET for auto/industrial IGBT Power IC	10% 1% 5%	21% 7% 16%	a. Product upgrade to IGBT and power IC b. Expanding end markets from consumer electronics to industrial and auto
Silan	600460.SS	MOSFET, IGBT	Buy	21.5	30x	71x	87%	MOSFET IGBT	22% 8%	26% 22%	a. Product upgrade to high-voltage b. Expanding end markets from consumer electronics to EV and industrial
Wingtech	600745.SS	MOSFET	Buy	189	33x	39x	22%	MOSFET	1%	28%	a. Market share gains b. Expanding product line (GaN FET, SiC, PMIC)
Sanan	600703.SS	PA	Buy	40	29x	55x	38%	PA/Compound Semi Mini/Micro-LED	3% 3%	28% 21%	a. Tech upgrade to GaAs and GaN PA b. Expanding end markets from LED to PA and compound semis
Montage	688008.SS	Memory interface IC	Buy	161	32x	68x	43%	DDR4 interface IC DDR5 interface IC	99% 0%	7% 67%	a. Product upgrade to DDR5 interface IC b. Expanding end markets from server DRAM to server platform
AMEC	688012.SS	SPE, etcher	Buy	382	30x	186x	95%	Etcher	46%	91%	a. Expanding product line to 128-L 3D NAND and 5nm logic b. Top tier customer base including TSMC 5nm fab
ACM Research	ACMR	SPE, cleaning tool	Buy*	150	14x	36x	64%	Cleaning tool	85%	96%	a. Expanding from single wafer cleaning to copper plating and furnace b. Leading local cleaning tool maker with key customers SK Hynix, YMTTC, Huali, and SMIC
AccoTest	688200.SS	SPE, testing equipment	Buy	469	22x	60x	56%	Analog testing SoC testing	92% 0%	53% 30%	a. Expanding product line (analog testing to power semi and SoC testing) b. SoC testing market c.30x the scale of analog testing
Anji Micro	688019.SS	CMP slurry	Buy	647	30x	91x	74%	Copper slurry Tungsten slurry	49% 4%	24% 47%	a. Expanding into Tungsten slurry, capturing demand from local memory b. Top tier customers TSMC, SMIC, and YMTTC
NSIG	688126.SS	Silicon wafer	Buy	60	80x	475x	138%	12" wafer 8" wafer	14% 73%	51% 47%	a. Ramping up 12" wafer production from a low base b. Local 12" wafer demand to quintuple vs. 2019 as local fabs expand capacity

Note: (1) *StarPower and ACM Research are on the Conviction List. (2) For NISG we use a 2021-25E earnings CAGR as we expect 2020E will be loss making.
ACM Research TP in US\$

Source: Bloomberg, Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Within China semiconductors we prefer stocks with the following attributes:

- **Leaders in their sub-sector:** This increases the likelihood of becoming a qualified supplier for large Chinese companies, thereby growing their product lines. A larger scale, more cutting edge technology and greater resources to allocate to R&D, recruiting talent and potentially undertaking M&A are also key competitive advantages. Each of the 11 stocks we initiate on are domestic leaders in their fields: **StarPower** (IGBT), **CR Micro** (MOSFET), **Silan** (MOSFET and power IC), **Wingtech** (automotive MOSFET after acquiring Nexperia), **Montage** (memory interface IC), **Sanan** (PA foundry), **Anji** (CMP slurry), **NSIG** (wafer), **AMEC** (etcher), **ACMR** (cleaning equipment), and **Acco Test** (testing equipment).
- **Operating in lower-end markets that have a smaller tech gap vs. global peers:** In lower-end markets such as low-voltage IGBT and MOSFET, a narrower product performance gap vs. global leaders is likely to see large domestic brands more willing to try new suppliers. Among our 11 leaders, we expect four to become the earliest beneficiaries of supply chain localization: **StarPower**, **CR Micro**, **Silan** and **Wingtech**.

Sizing the market opportunities for IGBT, MOSFET, PA, Wifi / Bluetooth IC and SPE

We have sized the global and China Total Addressable Market (TAM) for five sub-sectors in China semis (IGBT, MOSFET, PA, Wifi / Bluetooth IC, and SPE) using our proprietary model based on shipments, ASPs, units per device and end product exposure.

Exhibit 2: Summary of our TAM estimates and growth

Market	2020E TAM (US\$ mn)	2025E TAM (US\$ mn)	2020E-25E CAGR
Global			
IGBT	7,142	10,349	8%
MOSFET	8,844	11,009	4%
Power amplifier	6,759	11,557	11%
Wi-Fi	4,321	5,088	3%
Bluetooth	3,243	3,710	3%
China			
IGBT	2,514	3,601	7%
MOSFET	2,884	3,730	5%
Power amplifier	3,004	3,932	6%
Wi-Fi	1,246	1,510	4%
Bluetooth	857	1,093	5%
SPE capex	9,927	37,742	31%

Source: Goldman Sachs Global Investment Research, Gao Hua Securities Research

- For example, to derive a TAM for IGBT we divided the market by application: (1) industrial control, (2) automotive, (3) EV charging pile, (4) consumer electronics, (5) power generation and grid, and (6) railway or train. In each application we estimated IGBT unit growth using growth of the end market and units per device (also factoring in price declines; for IGBT ASP estimates we estimated the dollar content by applications and assumed a 2-3% YoY annual price decline).

Exhibit 3: We size market opportunities (globally and in China) for IGBT, MOSFET, PA, Wifi / Bluetooth and SPE**IGBT TAM (Global and China)**

Global TAM by applications	2020E TAM (US\$ bn)	2023E TAM (US\$ bn)	CAGR	% of Total	Key drivers
Industrial control	1,784	2,090	5%	25%	Industrial Robots; Segment closely ties to macro growth
Automotive	1,352	2,431	22%	19%	Rising Electric Vehicles penetration; IGBT content growth in EV vs. ICE (US\$269-308 vs. c.US\$0)
EV charging pile	102	122	6%	1%	Volume growth: DC EV charging infrastructure ramps up as EV demand increases
Consumer electronics	1,674	1,985	6%	23%	Content growth: invertization in home appliances drives incremental demand for IGBT
Power generation and grid	1,582	2,049	9%	22%	Renewable energy (wind/solar) capacity addition
Railway/train	648	709	3%	9%	Steady growth as China's train demand off the peak
Total	7,142	8,857	7%	100%	EV/EV infrastructure, power generation

China TAM by applications	2020 TAM (US\$ mn)	2023E TAM (US\$ mn)	CAGR	% of Total	Key drivers
Industrial control	515	618	6%	21%	Industrial Robots; Increase in automation, higher demand for inverters
Automotive	362	640	21%	14%	EV growth: EV / HEV/ PHEV penetration in automotive shipment: 6% in 2019 vs. 11% in 2022E
EV charging pile	70	83	6%	3%	EV charging infrastructure growth;
Consumer electronics	600	743	7%	24%	Home appliance invertization to drive up IGBT content per box
Power generation	576	598	1%	23%	Renewable energy capacity addition
Railway/Train	390	428	3%	16%	Stable growth in train purchases by China
Total	2,514	3,110	7%	100%	EV growth, EV infrastructure, home appliance

Source: Goldman Sachs Global Investment Research, Gao Hua Securities Research

- To estimate future SPE spending in China, we took a comprehensive look at each new 12" wafer fab's capacity expansion plans, key timing (e.g. equipment move-in and production start), and then based on their capacity expansion plans, we forecasted the equipment needed by category (e.g. etcher, lithography, deposition, cleaning tools, etc.) and the dollar amount required to achieve the capacity targets each year. **We believe this is by far the most granular analysis of China's SPE demand.**

Exhibit 4: We expect China's WFE capex to reach c.US\$10bn in 2020E and grow by 31% p.a. to US\$38bn by 2025E

China WFE capex	2018	2019	2020E	2021E	2022E	2023E	2024E	2025E	2026E
Foundries		3,063	5,578	6,851	7,445	7,634	8,243	8,592	9,110
SMIC (overall)		1,363	3,428	3,841	4,355	4,332	4,786	4,780	5,142
Hua Hong		700	760	710	730	802	807	812	818
Other Chinese foundries		1,000	1,390	2,300	2,360	2,500	2,650	3,000	3,150
Memory		2,625	3,750	5,250	7,875	11,625	17,250	27,750	22,750
NAND		1,125	2,250	3,750	4,875	7,125	11,250	18,000	15,250
DRAM		1,500	1,500	1,500	3,000	4,500	6,000	9,750	7,500
Other smaller 12" IDM projects		300	400	500	800	800	1,000	1,000	1,000
8" projects		100	199	364	400	400	400	400	400
China SPE capex (US\$ mn)	4,500	6,088	9,927	12,965	16,520	20,459	26,893	37,742	33,260

Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 5: We break down SPE demand into specific equipment category by each technology generation (more details in the SPE section of this report)

12" matured nodes	2019	2020E	2021E	2022E	2023E	2024E	2025E	2026E
Capacity addition (k wpm)								
Total	32	63	84	84	114	89	93	101
Equipment demand (# units)								
Furnaces	71	139	185	185	252	197	205	222
Etcher	80	158	210	210	286	224	233	252
Photoresist coater	23	45	59	59	80	63	66	71
Lithography	26	51	68	68	92	72	75	81
Photoresist remover	26	51	68	68	92	72	75	81
CVD	135	265	353	353	480	376	391	423
PVD	77	152	202	202	274	215	224	242
Ion implanter	42	82	110	110	149	117	121	131
CMP	39	76	101	101	137	108	112	121
Cleaning tool	55	108	143	143	195	152	159	171

Source: Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 6: We look at capex budgets by each project and their capacity targets to arrive at their annual SPE demand

New 12-inch projects capex total US\$160bn

Company / project name	Ticker	Type	Capex (USD)	Products	Construction start	Equipment move in	Production start
SMIC	981.HK	Foundry	10.5bn	14nm and above advanced nodes	-	Aug-2019	3Q19
Hua Hong (Wuxi)	1347.HK	Foundry	10bn (Phase 1: 2.5bn)	90nm, 65/55nm	Mar-2018	May-2019	3Q19
Huall (Fab 6)	Private	Foundry	5.5bn	28nm/14nm	Dec-2016	May-2018	Oct-2018
GTA Semiconductors	Private	Foundry	4bn (Phase 2)	Power discretes, PMIC, CIS	Aug-2018	-	-
Wuxi HSMC*	Private	Foundry	20bn	14nm/7nm logic	Mar-2019	Nov-2019	2H20
Silan Microelectronics (Xiamen)	600480.SS	IDM	2.3bn (Phase 1: 1bn)	MEMS, power discretes	Oct-2018	4Q19	4Q19/1Q20
Jiangsu AMS	Private	IDM	1.8bn	EEPROM	Aug-2017	Mar-2018	Apr-2018
CR Microelectronics	688396.SS	IDM	1.4bn	Power discretes, PMIC	2019	2021	2021
Cansemi	Private	IDM	1bn	MCU, PMIC, analog, power discretes	Mar-2018	Mar-2019	Sep-2019
Yangtze Memory (YMTC)	Private	Memory	24bn (12bn spent)	3D NAND Flash	Dec-2016	Apr-2018	Dec-2018
Changxin Memory (CXMT)	Private	Memory	22bn	DRAM	Jul-2017	1Q18	Sep-2019
Unigroup (Nanjing)	Private	Memory	30bn (Phase 1: 10bn)	3D NAND Flash/DRAM	Sep 2018	1H20	Likely in 2022
Unigroup (Chengdu)	Private	Memory	24bn (Phase 1: 10bn)	3D NAND Flash	Aug 2018	1Q21	Not disclosed
Unigroup (Chongqing)	Private	Memory	10bn	DRAM	4Q19	2021	2021

Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Technology, product comparison between China and global peers

We analyze the bridge between Chinese semis and their global peers in terms of (1) technology, (2) SKUs and product portfolio, and (3) key financial data, such as size of revenues, R&D spending, and ROE.

Chinese semis are currently operating at the lower-end of products and market segments compared to global peers, however with gradual technology migration and product portfolio expansion **we expect the gap to narrow, in some cases meaningfully:**

- **StarPower (China's leader in IGBT) has narrowed its technology gap with global leader Infineon to under 5 years despite entering this segment 14 years after Infineon.** By 2025 we expect this technology gap to have narrowed even further given its continued efforts to expand its product offerings and develop higher-end products such as higher voltage (3300V and above) IGBTs for power generation and traction markets. StarPower is also developing next generation IGBT6/7 to catch up with global peers, which launched IGBT6/7 in 2017-18.

- **Local SPEs - AMEC and NAURA:** China's SPE makers already cover most equipment segments, including thermal process, deposition, wafer cleaning, and etching but most local SPEs can only cover up to 14nm process node (vs. global leaders at 5nm production and preparing for 3nm), a lag of at least two generations. In addition, even in a legacy technology node, some of the equipment used for critical processes are still dominated by global players. However, **China semi leaders have made accelerated technology breakthroughs over the past year:** AMEC's dielectric etcher has been delivered to TSMC's 5nm production line (the leading edge process node), and NAURA's deposition tool for copper barrier and seed layer (primarily dominated by foreign suppliers) has been accepted by YMTC.

Exhibit 7: Technology / Product comparison between China & Global peers; each sub sector we initiate coverage on has a detailed comparison

IGBT: technology / product comparison between China and Global peers

Company	450v and less	600/700v	900/1000v	1200/1300v /1350v	1500/1600v	1700/1800v	2400/2500v	3300v	4500v	6500v
Market mix	3%	30%	30%		25%		7%		5%	
Microchip		✓								
Vishay		✓	✓							
ST Micro	✓	✓		✓						
Renesas		✓	✓							
Rohm	✓	✓				✓				
CR Micro		✓		✓						
Silan		✓		✓						
BYDE		✓		✓						
On Semi	✓	✓	✓	✓	✓	✓				
StarPower		✓	✓	✓		✓				
Toshiba	✓	✓	✓	✓		✓				
SiEn		✓	✓	✓	✓	✓				
Infineon	✓	✓	✓	✓	✓	✓		✓	✓	✓
Fuji Electric		✓	✓	✓		✓		✓	✓	✓
Littelfuse (incl. IXYS)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
ABB		✓	✓	✓		✓	✓	✓	✓	✓
Mitsubishi	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
CRRC		✓	✓	✓	✓	✓	✓	✓	✓	✓

Discrete	✓
Module	✓

Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 8: Local SPE makers now collectively cover most equipment segments

Product offerings and foreign peers in each equipment segment

Equipment segments	Sub-categories	Equipment by local SPE makers	Commercial status	Global leaders	NAURA 北方华创	AMEC 中微半导体	ACM Research 盛美半导体	SREE 上海微电子装备	PNC 至纯科技	Kingsemi 沈阳芯源微	Wanye 万业企业	Jingce 精测电子	AccoTest 华峰测控	Changchuan 长川科技	Raintree 上海睿励	Mattson 屹唐半导体	Hwatsing 华海清科	Piotech 沈阳拓荆
Thermal process	Oxidation	✓	HVM	TEL	✓													
	Diffusion	✓	HVM	AMAT	✓													
	Annealing	✓	HVM	ASM Hitachi	✓													
Lithography	DUV/EUV	✓		ASML				✓										
	Silicon etch	✓	HVM	LAM	✓													
	Dielectric etch	✓	HVM	TEL		✓												
Etcher	Metal etch	✓	HVM	AMAT	✓													
	Coater	✓	HVM	TEL						✓								
	Remover	✓	HVM	Mattson														
Photoresist	LPCVD	✓	Initial orders	AMAT	✓													
	PECVD	✓	Initial orders	TEL														
	ALD	✓	Initial orders	LAM														
	MOCVD	✓	HVM	ASM Int'l	✓							✓	✓	✓				✓
PVD	Al-pad	✓	HVM	AMEC		✓												
	Hard mask	✓	HVM	AMAT	✓													
	CuBS	✓	Initial orders	Evatec	✓													
Ion implanter	High energy	✓	Qualification	AMAT							✓							
	High current	✓	Qualification	Axcelis							✓							
	Low ion current	✗																
CMP		✓	Repeat orders	AMAT/ Ebara														✓
Cleaning tool	Single wafer	✓	HVM	SCREEN			✓		✓									
	Batch	✓	HVM	LAM TEL	✓		✓		✓									
Testing	Analog	✓	HVM	Teradyne									✓	✓				
	SoC	✓	R&D	Advantest														
	Memory	✓	Initial orders	Cohu														
Metrology		✓	Initial orders	KLA/AMAT								✓			✓			

Source: Company data

Exhibit 9: AMEC is catching up with global technology migration, which is at the 5nm node

	1995	1998	1999	2000	2002	2005	2006	2007	2008	2009	2010	2011	2012	2014	2015	2017	2018	2019	2020
Global	0.35um	0.25um	0.18um	0.13um	90nm		65nm		45nm		32nm	28nm	22nm	16/14nm		10nm	7nm		5nm
SMIC								90nm		65nm		55nm	40nm			28nm		14nm	
NAURA equipment						100nm			90nm			65nm-40nm			28nm			14nm	
AMEC equipment									65-16nm				45-7nm				7-5nm		

Source: Company data

Exhibit 10: Technology / Product comparison between China & Global peers; detailed comparison for all sub-sectors we initiate

SPE: financial comparison between China & Global peers

2020E	AMEC	ACMR	AccoTest	NAURA	China avg	AMAT	LAM Research	SCREEN	Tokyo Electron	KLA	Global avg	China vs global
1) Scale												
Revenue (US\$m)	381	157	50	738	332	16,183	10,299	3,011	10,421	5,855	9,154	-96%
Net income (US\$m)	45	23	22	72	40	3,271	2,239	77	1,627	1,327	1,708	-98%
Market cap (US\$m)	20,573	1,545	2,773	15,657	10,137	58,187	48,740	2,507	43,599	31,566	36,920	-73%
Global market share	<1%	<1%	<1%	<1%		21%	15%	3%	15%	7%		
2) Growth (2020-22E CAGR)												
Revenue	56%	51%	60%	54%	55%	10%	13%	3%	10%	4%	8%	47 ppt
OP income	105%	88%	77%	105%	94%	15%	20%	57%	18%	3%	23%	71 ppt
Net income	87%	82%	77%	102%	87%	18%	22%	59%	19%	15%	27%	61 ppt
3) Profitability												
GM	37%	43%	82%	41%	51%	45%	45%	24%	40%	61%	42%	9 ppt
OPM	11%	15%	47%	12%	21%	25%	26%	4%	21%	35%	20%	1 ppt
NM	12%	15%	44%	10%	20%	20%	22%	2%	16%	23%	14%	6 ppt
4) R&D												
R&D to revenue	13%	11%	13%	11%	12%	14%	13%	7%	11%	11%	9%	3 ppt
5) Return												
ROE	8%	21%	13%	8%	12%	9%	11%	3%	22%	16%	13%	-1 ppt
CROCI	8%	15%	14%	15%	13%	7%	8%	7%	29%	7%	14%	-2 ppt

Market cap as of July 10, 2020

Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Valuation: The market rewards high earnings growth; discounted P/E the best way to value China semis

Our regression analysis of China semis shows that the market values stocks based on earnings growth; i.e. **those stocks with stronger earnings growth enjoy a higher P/E multiple**. We therefore derive our target P/E multiples based on each company's future earnings growth. Our investment framework applies a top-down (TAM, SAM) and bottom-up approach (pricing, units, customers, competitors, products) across six sub-sectors within China semis.

Discounted P/E captures long-term opportunities: Given China semiconductors are at an early stage of development — with upside in technology migration, market share gains, and expanded product lines — we use a discounted P/E as our primary valuation methodology to better capture their long-term opportunities.

- We forecast six years of earnings with growth in the first three years (2020-22E) mainly driven by expanding market share within core existing products and growth in the later three years (2023-25E) mainly driven by technology migration, improved product mix, additional product lines and increased end market applications.
- Our target P/E multiples are derived from each subsector's correlation (including global peers) between earnings growth and P/E. To derive our target prices we apply this target P/E multiple to 2025E EPS and discount it back to 2022E at the company's cost of equity, which differs according to each company's beta.
- For Wingtech, we also add a SOTP using different target P/E multiple for its semiconductor and ODM business to reflect its different business structure and earnings growth.

Ultimately, we believe the market will reward China semis with higher valuation given their strong earnings growth. The 11 stocks we initiate are currently trading at 0.4x - 4.3x PEG based on 2021E P/E and 2022-23E average EPS YoY.

Our 11 Buy-rated names that we initiate coverage on in this report:

- **Have an average target P/E multiple on 2025E EPS of 34x (ranging from 14-80x).** ACMR has the lowest target multiple in the group (14x) as its shares are domiciled in the US (all other stocks are A-shares). NSIG has the highest target P/E multiple (80x) as it has the strongest earnings growth (117% YoY in 2025E) as we expect it to enjoy significant market share gains off a low base and improve its product mix from technology migration (from 8-inch to 12-inch wafers).
- **Have an average implied P/E multiple on 2022E EPS of 82x (excluding outlier NSIG) ranging from 36-475x, or an implied average 2022E PEG of 1.6x (excluding NSIG) ranging from 0.7x-5.4x.** ACMR has the lowest implied P/E multiple (36x) as its shares are domiciled in the US (all other stocks are A-shares). NSIG has the highest implied 2022E P/E (475x) for the reasons described above.
- **Currently trade at an average 57x 2022E EPS (excluding NSIG) ranging from 21-381x, or an average 2022E PEG of 1.0x (excluding NSIG), ranging from 0.4x-4.3x.** ACMR currently trades at the lowest P/E in the group (21x) as its shares

are domiciled in the US. NSIG currently trades at the highest P/E (381x) for the reasons described above.

DCF values in-line with discounted P/E values: We also use a 10-year DCF to cross-check our target prices where appropriate, with second stage FCF until 2030E and 3% terminal growth discounted back to 2022E via a WACC ranging between 8-9%. These six DCF cross-checks provide valuations pretty much in line with our primary valuation methodology.

Exhibit 11: China semis new coverage valuation snapshot: 11 new Buy ideas (2 on the Conviction List)

Company	Ticker	Rating	12M TP (Rmb)	Upside / Downside	Discount PE assumption	2025E EPS YoY	Implied 2022E PE	Avg. EPS YoY in 2023E & 2024E	Current trades at x 2022E PE	DCF valuation per share	DCF assumption	DCF implied 2022E PE
ACM Research	ACMR	B*	150	84%	14x 25E COE: 11%	53%	36x	51%	20x	-	-	-
CR Micro	688396.SS	B	88	57%	33x 25E COE: 9% □	39%	80x	45%	51x	89.7	WACC: 8.8% Terminal GR: 3%	81x
Sanan	600703.SS	B	40	41%	29x 25E COE: 9%	32%	55x	36%	39x	40.9	WACC: 8.6% Terminal GR: 3%	56x
Starpower	603290.SS	B*	402	52%	40x 25E COE: 9%	56%	130x	58%	85x	405	WACC: 9.0% Terminal GR: 3%	131x
AccoTest	688200.SS	B	469	48%	22x 25E COE: 8%	37%	60x	60%	40x	-	-	-
Anji	688019.SS	B	647	42%	30x 25E COE: 12%	49%	91x	69%	64x	-	-	-
AMEC	688012.SS	B	382	42%	30x 25E COE: 9%	99%	186x	102%	131x	-	-	-
Wingtech	600745.SS	B	189	18%	33x 25E COE: 9%	49% semi	39x	44% semi	33x	190	WACC: 8.2% Terminal GR: 3%	39x
Montage	688008.SS	B	161	37%	32x 25E COE: 9%	38%	68x	39%	50x	166	WACC: 9.0% Terminal GR: 3%	70x
NSIG	688126.SS	B	60	25%	80x 25E COE: 9%	117%	475x	88%	381x	-	-	-
Silan	600460.SS	B	21.5	26%	30x 25E COE: 9%	31%	71x	50%	57x	22.2	WACC: 8.1% Terminal GR: 3%	74x

*On the Conviction List. Pricing as of Jul 10, 2020. ACM Research TP in US\$.

Source: Bloomberg, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 12: China semis new coverage earnings growth and valuation summary

Segment	Company	2017	2018	2019	2020E	2021E	2022E	2023E	2024E	2025E	Target multiple	Rating	TP (RMB)	Upside	Implied 2022E PE
Power semi	Starpower	146%	84%	40%	27%	59%	82%	71%	58%	56%	40x (2025E)	Buy*	402	52%	130x
	CR Micro	nm	511%	-7%	17%	74%	65%	55%	45%	39%	33x (2025E)	Buy	88	57%	80x
	Silan	77%	1%	-91%	269%	292%	88%	58%	50%	31%	30x (2025E)	Buy	21.5	26%	71x
	Wingtech	586%	-81%	1954%	143%	54%	18%	18%	14%	13%	33x (2025E)	Buy	189	18%	39x
	Wingtech - semi				13%	57%	44%	48%	39%	49%	38x (2025E)				
Memory interface chip	Montage	274%	112%	27%	33%	43%	51%	43%	39%	38%	32x (2025E)	Buy	161	37%	68x
PA	Sanan	46%	-11%	-54%	15%	40%	42%	38%	36%	32%	29x (2025E)	Buy	40	41%	55x
CMP slurry	Anji	7%	13%	46%	53%	101%	86%	66%	72%	49%	30x (2025E)	Buy	647	42%	91x
Wafer	NSIG	nm	-95%	nm	nm	nm	319%	88%	87%	117%	80x (2025E)	Buy	60	25%	475x
SPE	AMEC	nm	204%	108%	66%	97%	78%	105%	99%	99%	30x (2025E)	Buy	382	42%	186x
	ACM Research	nm	nm	187%	21%	111%	57%	53%	48%	53%	14x (2025E)	Buy*	150	84%	36x
	AccoTest	28%	72%	12%	52%	74%	79%	82%	38%	37%	22x (2025E)	Buy	469	48%	60x

Upside as of Jul 10, 2020. ACM Research TP in US\$.

Source: Bloomberg, Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

We are 32%/64% above Bloomberg consensus net income for 2021E/22E

We expect China semis to expand their product portfolios and capture market share off a low base (reflected in revenues that are +13/+25% higher than consensus). We are slightly below consensus (-0.3/-0.3ppts in 2021E/22E) on gross margin, suggesting upside to our forecasts should consensus estimates be met.

Exhibit 13: We are 32% above consensus earnings in 2021E...

GS estimates vs. Bloomberg consensus (2021E)

2021E	Revenue			Net income			GM			Opex ratio		
	GS	BBG	GS vs. BBG	GS	BBG	GS vs. BBG	GS	BBG	GS vs. BBG	GS	BBG	GS vs. BBG
Star Power	1,239	1,246	-1%	273	244	12%	32%	31%	0.7ppts	10%	10%	-0.3ppts
Wingtech	91,522	91,553	0%	4,674	4,507	4%	13%	13%	0ppts	6%	7%	-0.3ppts
Sanan	9,874	10,320	-4%	2,086	2,398	-13%	30%	35%	-4.8ppts	9%	9%	-0.6ppts
Montage	3,148	2,850	10%	1,773	1,493	19%	74%	72%	1.8ppts	20%	14%	6.1ppts
AMEC	4,199	3,434	22%	618	404	53%	38%	38%	-0.1ppts	22%	25%	-3.3ppts
ACM Research	250	184	36%	48	29	65%	44%	44%	0.6ppts	24%	25%	-1.7ppts
AccoTest	526	455	16%	269	204	31%	82%	81%	0.6ppts	29%	36%	-6.4ppts
Anji Micro	755	526	44%	202	125	62%	51%	52%	-0.7ppts	24%	25%	-0.4ppts
NSIG	2,367	2,617	-10%	75	49	52%	20%	21%	-1.1ppts	18%	17%	0.3ppts
Average			13%			32%			-0.3ppts			-0.7ppts

No BBG consensus for CR Micro and Silan

Source: Goldman Sachs Global Investment Research, Bloomberg

Exhibit 14: ...and 64% above consensus earnings in 2022E

2022E	Revenue			Net income			GM			Opex ratio		
	GS	BBG	GS vs. BBG	GS	BBG	GS vs. BBG	GS	BBG	GS vs. BBG	GS	BBG	GS vs. BBG
Star Power	1,988	1,670	19%	495	339	46%	34%	32%	1.3ppts	7%	10%	-2.9ppts
Wingtech	91,389	114,789	-20%	5,515	5,773	-4%	14%	13%	1.1ppts	6%	7%	-0.5ppts
Sanan	12,860	12,051	7%	2,959	3,134	-6%	32%	38%	-5.4ppts	7%	8%	-0.2ppts
Montage	4,644	3,632	28%	2,671	1,924	39%	73%	71%	1.3ppts	16%	14%	2ppts
AMEC	6,500	4,625	41%	1,100	603	82%	39%	39%	-0.2ppts	20%	25%	-4.8ppts
ACM Research	361	240	50%	76	49	54%	45%	45%	-0.5ppts	22%	22%	0.2ppts
AccoTest	896	681	32%	482	309	56%	81%	83%	-1.1ppts	24%	38%	-13.8ppts
Anji Micro	1,188	715	66%	377	167	126%	53%	53%	0ppts	20%	27%	-7.3ppts
NSIG	3,386	3,166	7%	314	110	186%	24%	23%	0.9ppts	14%	18%	-3.5ppts
Average			25%			64%			-0.3ppts			-3.4ppts

Source: Bloomberg, Goldman Sachs Global Investment Research

Risks

- **Delays in technology breakthroughs:** Our positive view on China semis is based on continuous technology migration and expansion of expanding product portfolio and market share. This could be delayed by lack of R&D resources or a shift in strategy that sees some companies remaining in lower-end markets.
We forecast R&D to gradually catch up to global peers over the next five years: (1) Power Semiconductors (**Starpower, CR Micro, Silan, Wingtech**): R&D to grow at a 17% CAGR in 2020-25E; (2) Memory Interface IC (**Montage**): R&D to grow at a 21% CAGR; (3) Power Amplifier (**Sanan**): R&D to grow at an 8% CAGR; (4) SPE (**AMEC, ACM Research, Acco Test**): local suppliers to spend 10%+ of their annual revenue in R&D; and (5) Materials (**Anji** and **NSIG**): R&D to grow at a 20%+ CAGR.
- **More intense competition:** Fierce competition could result from a slowdown in the overall semiconductor market, which would trigger price competition, or more new entrants coming into the market, potentially impacting margins and profitability.
We forecast gross margins over the next five years as follows: (1) Power Semiconductors (**Starpower, CR Micro, Silan, Wingtech**): increase by 6ppts on average in 2020-25E; (2) Memory Interface IC (**Montage**): decline by 6ppts due to product mix, (3) Power Amplifier (**Sanan**): increase by up by 10ppt; (4) SPE (**AMEC, ACM Research, Acco Test**): Remain stable at 40-45% for AMEC and ACM Research and 80%+ for Acco Test; (5) Materials (**Anji, NSIG**): increase by 5ppt for Anji and 16ppt for NSIG.
- **Slower-than-expected progress in sourcing semis from Chinese suppliers:** This could eventuate if Chinese semi suppliers do not satisfy Chinese brand

requirements on product performance or scale production, which would create downside risks to our revenues and earnings growth forecasts as our earnings growth is mainly driven by revenue growth.

We forecast earnings growth over the next five years as follows: (1) +67% on average for the 11 stocks we initiate on, driven by market share gains, product mix upgrade and product line expansion; (2) +57% on average for our four Power Semiconductors stocks (**Starpower, CR Micro, Silan, Wingtech**); (3) +72% on average for our three SPE stocks (**AMEC, ACMR, AccoTest**); (4) +106% on average of our two Semiconductor Materials stocks (**Anji, NSIG**); (5) +43% for **Montage** (Memory Interface IC); and (6) +38% for **Sanan** (Power Amplifier foundry).

- **Decline in performance of Chinese brand customers:** Significant loss of market share in the domestic market for Chinese household brands would create downside risk to our revenue assumptions.

Across consumer electronics, vehicles, home appliances and industrials, Chinese brands have significantly increased their presence, commanding 90% of the domestic market in smartphones, 70-80% in surveillance, 50-60% in home appliances, and ~40% in vehicles.

- **Slower-than-expected investments in R&D or capacity:** Slower-than-expected investments in R&D or capacity could slow a company's market share expansion or product lines expansion, leading to downside risks to our revenues estimates.

Semiconductors our preferred sector within Greater China Tech

As we highlighted in May 2019 ([report link](#)), within our Greater China Tech coverage we prefer semiconductors over smartphone components and telecom equipment as continuous technology migration will underpin market growth and rising dollar content.

We also reiterate our Buy ratings on:

- **SMIC (CL-Buy):** SMIC is enjoying rapid technology migration into more advanced nodes, faster 12/14nm revenue ramp-up than 28nm, and growing demand from domestic IC design customers. Key drivers: (1) Mature nodes will continue to be its main profit drivers, on the back of increasing demand from CIS, NOR flash, connectivity ICs, and consumer SoCs on 40-65nm as well as PMIC and CIS on 8" fabs; and (2) advanced nodes help SMIC expand into smartphone AP, ASIC, FPGA, CPU. Notably, we model zero business from Huawei/HiSilicon from 4Q20E.
- **Hua Hong (Buy):** Key beneficiary of growing IGBT / MOSFET market in China, comprising 43% of 2020E revenues. We remain positive on Hua Hong's power semiconductor business as it has several advantages over emerging local players: 1) leading edge technology, 2) pure-play foundry, 3) first mover in power semis in a 12" wafer fab, 4) largest power semi capacity in China, and 5) a diversified and comprehensive customer base.

CIS: CMOS Image Sensor

PMIC: Power Management IC

AP: Application Processors

ASIC: Application-Specific Integrated Circuit

FPGA: Field Programmable Gate Array

RFFE: Radio Frequency
Front End

LNA: Low-Noise Amplifier

SAW Filter: Surface
Acoustic Wave Filter

MCU: Microcontroller Unit

- **Maxscend (Buy):** Maxscend is a leading RFFE supplier (switch, LNA, SAW filter) that has successfully penetrated into all leading Android smartphone brands (Samsung, Xiaomi, Huawei, OPPO and Vivo), and expanding product lines (Wifi PA, Bluetooth low energy MCU and RFFE for 5G base stations). We forecast a 49% earnings CAGR in 2020-22E on the back of (1) improving product mix as it benefits from 5G migration, (2) rising market share from a low base, (3) growing end markets, and (4) expanding product lines.
- **Naura (Buy):** NAURA is a key beneficiary of China's rising investment in semiconductors and localization of the supply chain. It is a local leader in thermal process / furnaces, physical vapor deposition, and silicon etcher. Among Chinese SPE makers NAURA has by far the largest product offering and its customers consist of local semi manufacturers such as SMIC, Hua Hong, YMTC and GTA Semiconductors.

An ESG Blueprint for China's semiconductor industry

Our SUSTAIN team notes that of the 11 companies we initiate on in this report, only three (Hangzhou Silan, Wingtech and Sanan) are included in MSCI ACWI, but still have low ESG disclosure rates of 0-4% versus the global Semiconductor average disclosure rate of 57% and 49% in AEJ.

While waste water and air pollution regulations may not seem to put an immediate burden on semiconductor companies, they could create reputational and legal challenges if investments are not made in order to comply over time. Our SUSTAIN team also sees potential talent shortages as a risk which companies and other stakeholders will need to consider as human resource management will be key to driving growth.

Financial Snapshot: Initiating Coverage on China Semiconductors; 11 Buy ratings

This section shows: (1) P&L, Balance sheet, and cash flow, (2) Product mix, and (3) Waterfall chart for the eleven new Buy ideas.

Bottom line: Strong earnings growth ahead driven by technology migration, market share expansion and product lines extension from low base.

AccoTest

Exhibit 15: AccoTest financial table

Income statement (Rmb mn)	12/19	12/20E	12/21E	12/22E	Balance sheet (Rmb mn)	12/19	12/20E	12/21E	12/22E
Total revenue	254.6	352.4	526.0	895.7	Cash & equivalents	227.5	1,484.1	1,192.5	1,202.6
Cost of goods sold	(46.3)	(64.9)	(94.8)	(166.7)	Accounts receivable	132.4	157.3	275.1	461.1
SG&A	(61.0)	(77.3)	(94.4)	(119.5)	Inventory	52.8	78.7	113.5	224.5
R&D	(32.7)	(45.5)	(60.1)	(93.1)	Other current assets	7.0	7.0	7.0	7.0
Other operating profit/(expense)	--	--	--	--	Total current assets	419.7	1,727.0	1,588.1	1,895.3
EBITDA	117.4	177.0	335.1	620.0	Net PP&E	16.8	314.5	621.2	635.6
Depreciation & amortization	(2.8)	(12.2)	(58.4)	(103.6)	Net intangibles	22.3	34.2	40.9	44.6
EBIT	114.6	164.8	276.7	516.4	Total investments	0.0	0.0	0.0	0.0
Interest income	1.9	2.6	14.8	11.9	Other long-term assets	34.8	34.8	34.8	34.8
Interest expense	0.0	0.0	0.0	0.0	Total assets	493.6	2,110.5	2,284.9	2,610.4
Income/(loss) from uncons. subs.	--	--	--	--	Accounts payable	6.1	11.7	14.3	31.4
Others	2.5	9.6	6.8	6.8	Short-term debt	--	--	--	--
Pretax profits	119.0	176.9	298.3	535.1	Other current liabilities	59.4	59.4	59.4	59.4
Income tax	(17.1)	(22.1)	(29.8)	(53.5)	Total current liabilities	65.4	71.1	73.6	90.8
Minorities	--	--	--	--	Long-term debt	--	--	--	--
Net income pre-preferred dividends	102.0	154.8	268.5	481.6	Other long-term liabilities	0.1	0.1	0.1	0.1
Preferred dividends	--	--	--	--	Total long-term liabilities	0.1	0.1	0.1	0.1
Net income (pre-exceptionals)	102.0	154.8	268.5	481.6	Total liabilities	65.6	71.2	73.8	90.9
Post-tax exceptionals	--	--	--	--	Preferred shares	--	--	--	--
Net income	102.0	154.8	268.5	481.6	Total common equity	428.0	2,039.3	2,211.2	2,519.4
EPS (basic, pre-exception) (Rmb)	2.27	2.89	4.39	7.87	Minority interest	--	--	--	--
EPS (basic, post-exception) (Rmb)	2.27	2.89	4.39	7.87	Total liabilities & equity	493.6	2,110.5	2,284.9	2,610.4
EPS (diluted, post-exception) (Rmb)	2.27	2.89	4.39	7.87	BVPS (Rmb)	9.33	33.33	36.14	41.18
DPS (Rmb)	0.60	1.04	1.58	2.83					
Dividend payout ratio (%)	26.4	36.0	36.0	36.0					
Free cash flow yield (%)	NM	(1.2)	(1.0)	0.9					
Growth & margins (%)	12/19	12/20E	12/21E	12/22E	Ratios	12/19	12/20E	12/21E	12/22E
Sales growth	16.4	38.4	49.3	70.3	CROCI (%)	38.7	13.5	14.6	23.3
EBITDA growth	22.6	50.7	89.4	85.0	ROE - common equity (%)	30.7	12.5	12.6	20.4
EBIT growth	22.3	43.7	67.9	86.6	ROE - total shareholders' equity (%)	30.7	12.5	12.6	20.4
Net income growth	12.4	51.7	73.5	79.4	ROA (%)	26.2	11.9	12.2	19.7
EPS growth	5.1	27.3	51.8	79.4	Inventory days	386.1	370.0	370.0	370.0
Gross margin	81.8	81.6	82.0	81.4	Receivables days	150.2	150.0	150.0	150.0
EBITDA margin	46.1	50.2	63.7	69.2	Payable days	46.9	50.0	50.0	50.0
EBIT margin	45.0	46.8	52.6	57.7	Net debt/equity (%)	(53.2)	(72.8)	(53.9)	(47.7)
					Interest cover - EBIT (X)	NM	NM	NM	NM
Cash flow statement (Rmb mn)	12/19	12/20E	12/21E	12/22E	Valuation	12/19	12/20E	12/21E	12/22E
Net income pre-preferred dividends	102.0	154.8	268.5	481.6	P/E (X)	NM	109.7	72.3	40.3
D&A add-back	2.8	12.2	58.4	103.6	P/B (X)	NM	9.5	8.8	7.7
Minorities interests add-back	--	--	--	--	EV/EBITDA (X)	--	87.6	54.3	29.4
Net (inc)/dec working capital	(62.7)	(45.1)	(150.1)	(279.9)	EV/GCI (X)	--	7.6	8.1	6.8
Other operating cash flow	17.5	--	--	--	Dividend yield (%)	NM	0.3	0.5	0.9
Cash flow from operations	59.7	121.8	176.9	305.3					
Capital expenditures	(27.9)	(321.8)	(371.8)	(121.8)					
Acquisitions	--	--	--	--					
Divestitures	--	--	--	--					
Others	(2.9)	--	--	--					
Cash flow from investments	(30.8)	(321.8)	(371.8)	(121.8)					
Dividends paid (common & pref)	(20.0)	(55.7)	(96.7)	(173.4)					
Inc/(dec) in debt	--	--	--	--					
Common stock issuance (repurchase)	110.7	1,512.3	--	--					
Other financing cash flows	(4.0)	--	--	--					
Cash flow from financing	86.7	1,456.5	(96.7)	(173.4)					
Total cash flow	115.5	1,256.6	(291.6)	10.1					

Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

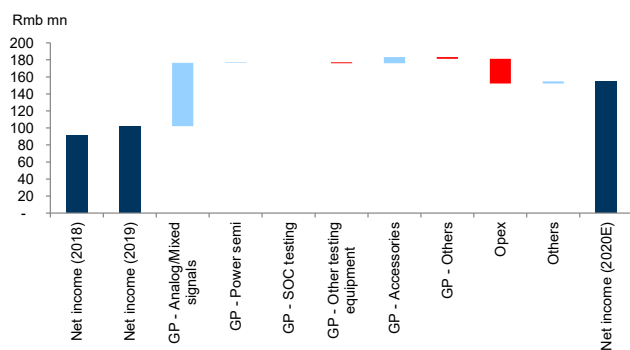
Exhibit 16: AccoTest revenue and GP mix by product

	2019	2020E	2021E	2022E	2023E
Revenue mix	100%	100%	100%	100%	100%
Analog/Mixed signals	92%	90%	89%	77%	55%
Power semi	0%	0%	1%	1%	4%
SOC testing	0%	0%	0%	13%	33%
Other testing equipment	7%	7%	8%	8%	8%
Accessories	1%	3%	2%	1%	1%
Others	0%	0%	0%	0%	0%
GM	81.8%	81.6%	82.0%	81.4%	80.7%
Analog/Mixed signals	80.3%	82.9%	83.0%	83.0%	83.0%
Power semi	0.0%	0.0%	80.0%	80.0%	82.0%
SOC testing	0.0%	0.0%	0.0%	75.0%	77.0%
Other testing equipment	76.6%	77.6%	78.1%	78.1%	78.1%
Accessories	82.9%	84.3%	84.3%	84.3%	84.3%
GP mix	100%	100%	100%	100%	100%
Analog/Mixed signals	91%	92%	91%	79%	56%
Power semi	0%	0%	1%	1%	4%
SOC testing	0%	0%	0%	12%	32%
Other testing equipment	2%	1%	0%	0%	0%
Accessories	7%	7%	8%	8%	8%
Others	1%	0%	0%	0%	0%

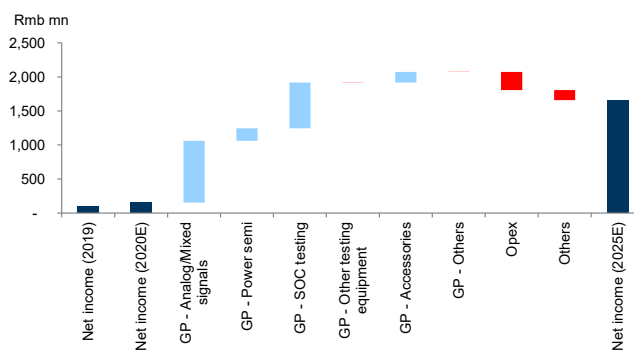
Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 17: AccoTest earnings driven by analog/mixed signal IC in 2020E

Net profit waterfall chart 2019-20E



Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 18: We expect SOC and power semi to have rising revenue contribution till 2025E

Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

ACMR

ACMR financials

Income statement (\$ mn)	12/19	12/20E	12/21E	12/22E	Balance sheet (\$ mn)	12/19	12/20E	12/21E	12/22E
Total revenue	107.5	157.3	250.1	361.0	Cash & equivalents	58.3	62.8	48.6	55.7
Cost of goods sold	(56.9)	(89.0)	(139.4)	(200.2)	Accounts receivable	31.1	46.5	76.8	101.2
SG&A	(20.0)	(27.6)	(29.2)	(35.6)	Inventory	44.8	67.3	93.0	137.3
R&D	(12.9)	(17.5)	(30.1)	(43.2)	Other current assets	64.2	64.2	64.2	64.2
Other operating profit/(expense)	--	--	--	--	Total current assets	198.4	240.9	282.7	358.5
EBITDA	18.6	24.0	52.4	85.7	Net PP&E	3.6	4.9	19.0	45.3
Depreciation & amortization	(0.8)	(0.8)	(1.0)	(3.7)	Net intangibles	0.3	0.2	0.2	0.1
EBIT	17.8	23.2	51.3	82.0	Total investments	5.9	5.9	5.9	5.9
Interest income	0.3	0.6	0.6	0.5	Other long-term assets	9.4	9.4	9.4	9.4
Interest expense	(0.7)	(1.1)	(1.1)	(1.1)	Total assets	217.7	261.4	317.2	419.3
Income/(loss) from uncons. subs.	0.2	0.1	--	--	Accounts payable	13.3	33.1	39.5	64.7
Others	1.4	3.7	4.0	4.0	Short-term debt	13.8	13.8	13.8	13.8
Pretax profits	18.9	26.5	54.9	85.4	Other current liabilities	25.4	26.5	26.5	26.5
Income tax	0.5	(2.6)	(5.5)	(8.5)	Total current liabilities	53.5	73.3	79.7	105.0
Minorities	(0.6)	(1.0)	(1.0)	(1.0)	Long-term debt	--	--	--	--
Net income pre-preferred dividends	18.9	22.9	48.4	75.8	Other long-term liabilities	3.7	6.7	6.7	6.7
Preferred dividends	--	--	--	--	Total long-term liabilities	6.7	6.7	6.7	6.7
Net income (pre-exceptionals)	18.9	22.9	48.4	75.8	Total liabilities	60.2	80.0	86.5	111.7
Post-tax exceptionals	--	--	--	--	Preferred shares	--	--	--	--
Net income	18.9	22.9	48.4	75.8	Total common equity	97.3	120.2	168.6	244.3
EPS (basic, pre-except) (\$)	1.12	1.23	2.67	4.18	Minority interest	60.2	61.2	62.2	63.3
EPS (basic, post-except) (\$)	1.12	1.23	2.67	4.18	Total liabilities & equity	217.7	261.4	317.2	419.3
EPS (diluted, post-except) (\$)	0.99	1.20	2.67	4.18	BVPS (\$)	5.09	6.63	9.29	13.47
DPS (\$)	--	--	--	--					
Dividend payout ratio (%)	0.0	0.0	0.0	0.0					
Free cash flow yield (%)	2.7	0.3	(0.9)	0.4					
Growth & margins (%)	12/19	12/20E	12/21E	12/22E	Ratios	12/19	12/20E	12/21E	12/22E
Sales growth	44.1	46.3	58.9	44.4	CROCI (%)	23.0	14.7	24.4	29.6
EBITDA growth	169.7	29.2	118.1	63.6	ROE - common equity (%)	25.3	21.0	33.5	36.7
EBIT growth	174.9	30.5	121.2	59.6	ROE - total shareholders' equity (%)	18.0	13.5	23.5	28.2
Net income growth	187.4	21.0	111.5	56.7	ROA (%)	11.8	9.5	16.7	20.6
EPS growth	170.1	9.1	117.3	56.7	Inventory days	268.2	230.0	210.0	210.0
Gross margin	47.1	43.4	44.3	44.5	Receivables days	94.5	90.0	90.0	90.0
EBITDA margin	17.3	15.3	20.9	23.7	Payable days	96.1	95.0	95.0	95.0
EBIT margin	16.5	14.8	20.5	22.7	Net debt/equity (%)	(63.5)	(59.9)	(40.9)	(33.0)
					Interest cover - EBIT (X)	43.2	46.2	112.4	137.0
Cash flow statement (\$ mn)	12/19	12/20E	12/21E	12/22E	Valuation	12/19	12/20E	12/21E	12/22E
Net income pre-preferred dividends	18.9	22.9	48.4	75.8	P/E (X)	13.2	70.2	32.3	20.6
D&A add-back	0.8	0.8	1.0	3.7	P/B (X)	2.9	13.0	9.3	6.4
Minorities interests add-back	0.6	1.0	1.0	1.0	EV/EBITDA (X)	11.3	64.9	29.2	17.8
Net (inc)/dec working capital	(15.9)	(18.2)	(49.6)	(43.5)	EV/GCI (X)	1.3	8.5	6.6	4.9
Other operating cash flow	5.1	--	--	--	Dividend yield (%)	0.0	0.0	0.0	0.0
Cash flow from operations	9.4	6.5	0.8	37.0					
Capital expenditures	(1.0)	(2.0)	(15.0)	(30.0)					
Acquisitions	--	--	--	--					
Divestitures	--	--	--	--					
Others	(4.6)	--	--	--					
Cash flow from investments	(5.5)	(2.0)	(15.0)	(30.0)					
Dividends paid (common & pref)	--	--	--	--					
Inc/(dec) in debt	4.3	--	--	--					
Common stock issuance (repurchase)	26.9	--	--	--					
Other financing cash flows	54.8	--	--	--					
Cash flow from financing	86.0	0.0	0.0	0.0					
Total cash flow	89.9	4.5	(14.2)	7.0					

Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

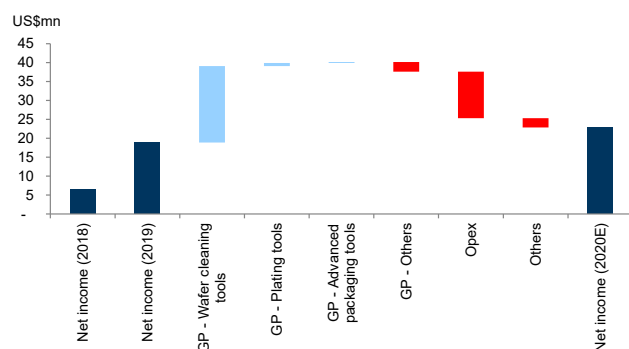
Exhibit 19: ACMR revenue and gross profit mix by product

	2019	2020E	2021E	2022E	2023E
Revenue mix	100%	100%	100%	100%	100%
Wafer cleaning tools	85%	87%	91%	91%	93%
Plating tools	11%	8%	6%	6%	5%
Advanced packaging tools	3%	3%	2%	2%	1%
Others	2%	2%	1%	1%	1%
GM	47.1%	44.3%	44.7%	44.8%	44.9%
Wafer cleaning tools	45.3%	45.0%	45.0%	45.0%	45.0%
Plating tools	39.3%	40.0%	42.5%	45.0%	45.0%
Advanced packaging tools	44.7%	45.0%	45.0%	45.0%	45.0%
Others	0.0%	30.0%	30.0%	30.0%	30.0%
Gross profit	100%	100%	100%	100%	100%
Wafer cleaning tools	81%	89%	92%	91%	94%
Plating tools	9%	8%	6%	6%	5%
Advanced packaging tools	3%	3%	2%	2%	1%
Others	7%	1%	1%	1%	1%

Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 20: ACMR profit driven by wafer cleaning tools in 2020E

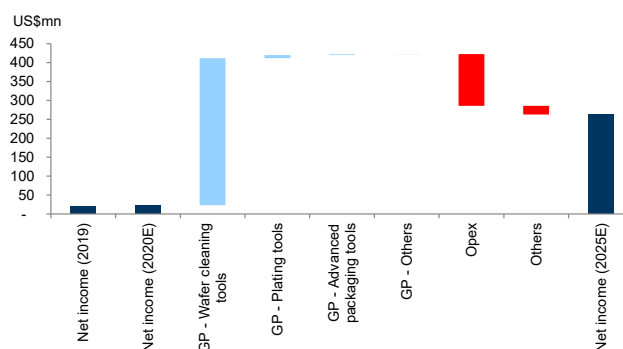
Net profit waterfall chart 2019-20E



Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 21: Wafer cleaning tools remain the major profit driver for ACMR

Net profit waterfall chart 2020-25E



Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

AMEC

AMEC financials

Income statement (Rmb mn)	12/19	12/20E	12/21E	12/22E	Balance sheet (Rmb mn)	12/19	12/20E	12/21E	12/22E
Total revenue	1,946.9	2,678.3	4,199.5	6,500.3	Cash & equivalents	944.8	836.3	676.6	894.1
Cost of goods sold	(1,266.9)	(1,689.5)	(2,593.1)	(3,970.9)	Accounts receivable	366.4	734.3	876.5	1,616.8
SG&A	(308.0)	(346.0)	(433.3)	(556.2)	Inventory	1,088.0	1,504.2	1,905.9	2,445.8
R&D	(233.7)	(344.4)	(483.2)	(724.9)	Other current assets	1,447.1	1,447.1	1,447.1	1,447.1
Other operating profit/(expense)	--	--	--	--	Total current assets	3,846.3	4,521.8	4,906.1	6,403.8
EBITDA	166.1	331.6	733.8	1,313.0	Net PP&E	154.8	155.4	206.9	382.3
Depreciation & amortization	(27.8)	(33.2)	(43.9)	(64.7)	Net intangibles	295.8	508.3	801.8	1,240.2
EBIT	138.3	298.4	689.9	1,248.3	Total investments	168.9	168.9	168.9	168.9
Interest income	14.2	16.6	14.7	11.9	Other long-term assets	308.3	308.3	308.3	308.3
Interest expense	(0.8)	0.0	0.0	0.0	Total assets	4,774.1	5,662.7	6,392.0	8,503.4
Income/(loss) from uncons. subs.	(12.6)	(18.4)	(18.4)	(18.4)	Accounts payable	221.7	796.7	908.4	1,920.2
Others	59.2	55.0	0.0	(20.0)	Short-term debt	--	--	--	--
Pretax profits	198.4	351.6	686.2	1,221.8	Other current liabilities	674.4	674.4	674.4	674.4
Income tax	(9.8)	(38.0)	(68.6)	(122.2)	Total current liabilities	896.1	1,471.1	1,582.8	2,594.6
Minorities	0.0	0.2	0.2	0.2	Long-term debt	--	--	--	--
Net income pre-preferred dividends	188.6	313.8	617.8	1,099.8	Other long-term liabilities	126.7	126.7	126.7	126.7
Preferred dividends	--	--	--	--	Total long-term liabilities	126.7	126.7	126.7	126.7
Net income (pre-exceptionals)	188.6	313.8	617.8	1,099.8	Total liabilities	1,022.8	1,597.8	1,709.5	2,721.4
Post-tax exceptionals	--	--	--	--	Preferred shares	--	--	--	--
Net income	188.6	313.8	617.8	1,099.8	Total common equity	3,751.1	4,064.9	4,682.7	5,782.4
EPS (basic, pre-except) (Rmb)	0.37	0.59	1.16	2.06	Minority interest	0.1	0.0	(0.2)	(0.4)
EPS (basic, post-except) (Rmb)	0.37	0.59	1.16	2.06	Total liabilities & equity	4,774.1	5,662.7	6,392.0	8,503.4
EPS (diluted, post-except) (Rmb)	0.37	0.59	1.16	2.06	BVPS (Rmb)	7.01	7.60	8.75	10.81
DPS (Rmb)	--	--	--	--					
Dividend payout ratio (%)	0.0	0.0	0.0	0.0					
Free cash flow yield (%)	0.2	(0.1)	(0.1)	0.2					
Growth & margins (%)	12/19	12/20E	12/21E	12/22E	Ratios	12/19	12/20E	12/21E	12/22E
Sales growth	18.8	37.6	56.8	54.8	CROCI (%)	0.9	8.0	13.9	20.7
EBITDA growth	27.4	99.6	121.3	78.9	ROE - common equity (%)	6.4	8.0	14.1	21.0
EBIT growth	26.1	115.7	131.2	80.9	ROE - total shareholders' equity (%)	6.4	8.0	14.1	21.0
Net income growth	107.5	66.4	96.9	78.0	ROA (%)	4.5	6.0	10.2	14.8
EPS growth	85.0	58.6	96.9	78.0	Inventory days	336.4	280.0	240.0	200.0
Gross margin	34.9	36.9	38.3	38.9	Receivables days	82.6	75.0	70.0	70.0
EBITDA margin	8.5	12.4	17.5	20.2	Payable days	94.9	110.0	120.0	130.0
EBIT margin	7.1	11.1	16.4	19.2	Net debt/equity (%)	(35.6)	(30.2)	(22.8)	(22.2)
					Interest cover - EBIT (X)	NM	NM	NM	NM
Cash flow statement (Rmb mn)	12/19	12/20E	12/21E	12/22E	Valuation	12/19	12/20E	12/21E	12/22E
Net income pre-preferred dividends	188.6	313.8	617.8	1,099.8	P/E (X)	NM	NM	NM	130.9
D&A add-back	27.8	33.2	43.9	64.7	P/B (X)	10.8	35.4	30.7	24.9
Minorities interests add-back	0.0	(0.2)	(0.2)	(0.2)	EV/EBITDA (X)	NM	NM	NM	108.7
Net (inc)/dec working capital	92.3	(209.0)	(432.2)	(268.3)	EV/GCI (X)	9.3	33.0	28.7	23.2
Other operating cash flow	(175.4)	--	--	--	Dividend yield (%)	0.0	0.0	0.0	0.0
Cash flow from operations	133.3	137.8	229.3	896.0					
Capital expenditures	(44.9)	(246.3)	(388.9)	(678.4)					
Acquisitions	--	--	--	--					
Divestitures	--	--	--	--					
Others	(1,284.0)	--	--	--					
Cash flow from investments	(1,328.9)	(246.3)	(388.9)	(678.4)					
Dividends paid (common & pref)	(0.9)	--	--	--					
Inc/(dec) in debt	(72.1)	--	--	--					
Common stock issuance (repurchase)	1,444.4	--	--	--					
Other financing cash flows	98.7	--	--	--					
Cash flow from financing	1,470.2	0.0	0.0	0.0					
Total cash flow	274.5	(108.5)	(159.6)	217.5					

Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

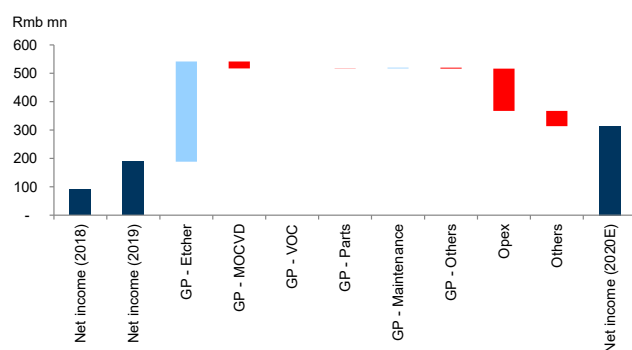
Exhibit 22: AMEC revenue and gross profit mix

	2019	2020E	2021E	2022E	2023E
Revenue mix	100%	100%	100%	100%	100%
Etcher	46%	65%	71%	75%	86%
MOCVD	35%	22%	18%	15%	5%
VOC	0%	0%	0%	0%	0%
Parts	17%	13%	10%	9%	8%
Maintenance	1%	1%	1%	1%	1%
Others	0%	0%	0%	0%	0%
GM	34.9%	36.9%	38.3%	38.9%	40.7%
Etcher	42.0%	42.0%	42.0%	42.0%	42.0%
MOCVD	23.0%	23.0%	23.0%	23.0%	23.0%
VOC	40.0%	40.0%	40.0%	40.0%	40.0%
Parts	38.0%	38.0%	38.0%	38.0%	38.0%
Maintenance	55.0%	55.0%	55.0%	55.0%	55.0%
Others	43.0%	43.0%	43.0%	43.0%	43.0%
Gross profit mix	100%	100%	100%	100%	100%
Etcher	55%	74%	78%	81%	89%
MOCVD	23%	14%	11%	9%	3%
VOC	0%	0%	0%	0%	0%
Parts	19%	13%	10%	9%	8%
Maintenance	2%	1%	1%	1%	1%
Others	1%	-2%	0%	0%	0%

Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 23: Etcher is the main profit driver for AMEC in 2020E

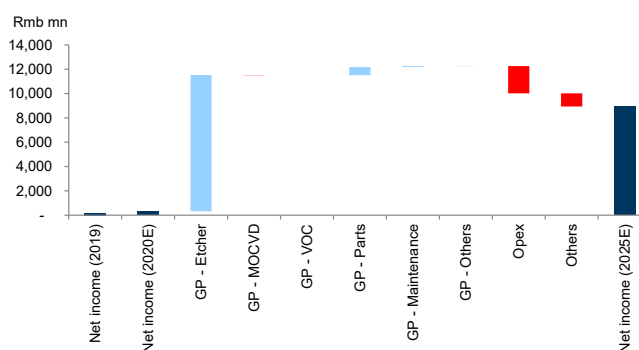
Net profit waterfall chart 2019-20E



Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 24: We expect AMEC's earnings to grow by 28x from low base

Net profit waterfall chart 2020-25E



Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Anji Micro

Anji Micro financials

Income statement (Rmb mn)	12/19	12/20E	12/21E	12/22E	Balance sheet (Rmb mn)	12/19	12/20E	12/21E	12/22E
Total revenue	285.4	455.7	754.8	1,188.3	Cash & equivalents	455.1	423.2	414.6	507.4
Cost of goods sold	(142.0)	(223.7)	(367.8)	(558.6)	Accounts receivable	53.8	108.5	160.3	262.9
SG&A	(49.8)	(63.7)	(80.3)	(98.9)	Inventory	77.0	106.9	135.0	201.7
R&D	(57.5)	(81.0)	(103.8)	(134.1)	Other current assets	287.6	287.6	287.6	287.6
Other operating profit/(expense)	--	--	--	--	Total current assets	873.5	926.1	997.6	1,259.5
EBITDA	44.6	95.9	219.8	427.4	Net PP&E	50.1	101.9	185.2	234.9
Depreciation & amortization	(8.4)	(8.5)	(17.0)	(30.6)	Net intangibles	7.0	7.0	6.9	6.8
EBIT	36.1	87.3	202.8	396.7	Total investments	0.0	0.0	0.0	0.0
Interest income	6.9	10.6	9.8	9.6	Other long-term assets	60.6	60.6	60.6	60.6
Interest expense	0.0	0.0	0.0	0.0	Total assets	991.2	1,095.5	1,250.2	1,561.8
Income/(loss) from uncons. subs.	--	--	--	--	Accounts payable	20.8	55.3	69.8	120.2
Others	30.3	12.2	12.2	12.2	Short-term debt	--	--	--	--
Pretax profits	73.3	110.1	224.8	418.5	Other current liabilities	58.4	58.4	58.4	58.4
Income tax	(7.5)	(9.5)	(22.5)	(41.9)	Total current liabilities	79.2	113.7	128.2	178.6
Minorities	--	--	--	--	Long-term debt	--	--	--	--
Net income pre-preferred dividends	65.8	100.5	202.3	376.7	Other long-term liabilities	24.5	24.5	24.5	24.5
Preferred dividends	--	--	--	--	Total long-term liabilities	24.5	24.5	24.5	24.5
Net income (pre-exceptionals)	65.8	100.5	202.3	376.7	Total liabilities	103.6	138.2	152.6	203.0
Post-tax exceptionals	--	--	--	--	Preferred shares	--	--	--	--
Net income	65.8	100.5	202.3	376.7	Total common equity	887.6	957.3	1,097.6	1,358.8
EPS (basic, pre-except) (Rmb)	1.45	1.89	3.81	7.09	Minority interest	--	--	--	--
EPS (basic, post-except) (Rmb)	1.45	1.89	3.81	7.09					
EPS (diluted, post-except) (Rmb)	1.45	1.89	3.81	7.09	Total liabilities & equity	991.2	1,095.5	1,250.2	1,561.8
DPS (Rmb)	0.38	0.58	1.17	2.17	BVPS (Rmb)	16.71	18.03	20.67	25.59
Dividend payout ratio (%)	26.2	30.6	30.6	30.6					
Free cash flow yield (%)	0.7	0.0	0.2	0.9					
Growth & margins (%)	12/19	12/20E	12/21E	12/22E	Ratios	12/19	12/20E	12/21E	12/22E
Sales growth	15.2	59.7	65.6	57.4	CROCI (%)	13.6	10.5	19.8	30.9
EBITDA growth	1.3	115.2	129.2	94.5	ROE - common equity (%)	10.7	10.9	19.7	30.7
EBIT growth	0.5	141.8	132.2	95.7	ROE - total shareholders' equity (%)	10.7	10.9	19.7	30.7
Net income growth	46.4	52.7	101.2	86.2	ROA (%)	9.2	9.6	17.2	26.8
EPS growth	28.3	30.6	101.2	86.2	Inventory days	188.3	150.0	120.0	110.0
Gross margin	50.3	50.9	51.3	53.0	Receivables days	71.6	65.0	65.0	65.0
EBITDA margin	15.6	21.0	29.1	36.0	Payable days	62.1	62.1	62.1	62.1
EBIT margin	12.7	19.2	26.9	33.4	Net debt/equity (%)	(58.1)	(50.5)	(43.3)	(41.8)
					Interest cover - EBIT (X)	NM	NM	NM	NM
Cash flow statement (Rmb mn)	12/19	12/20E	12/21E	12/22E	Valuation	12/19	12/20E	12/21E	12/22E
Net income pre-preferred dividends	65.8	100.5	202.3	376.7	P/E (X)	96.1	NM	119.5	64.2
D&A add-back	8.4	8.5	17.0	30.6	P/B (X)	8.3	25.2	22.0	17.8
Minorities interests add-back	--	--	--	--	EV/EBITDA (X)	130.5	NM	107.8	55.2
Net (inc)/dec working capital	(9.9)	(50.0)	(65.5)	(118.8)	EV/GCI (X)	6.4	24.0	20.7	16.4
Other operating cash flow	20.3	--	--	--	Dividend yield (%)	0.3	0.1	0.3	0.5
Cash flow from operations	84.7	59.1	153.8	288.5					
Capital expenditures	(42.1)	(60.3)	(100.3)	(80.3)					
Acquisitions	--	--	--	--					
Divestitures	--	--	--	--					
Others	(202.7)	--	--	--					
Cash flow from investments	(244.8)	(60.3)	(100.3)	(80.3)					
Dividends paid (common & pref)	--	(30.8)	(62.0)	(115.4)					
Inc/(dec) in debt	--	--	--	--					
Common stock issuance (repurchase)	474.9	--	--	--					
Other financing cash flows	0.6	--	--	--					
Cash flow from financing	475.5	(30.8)	(62.0)	(115.4)					
Total cash flow	315.3	(32.0)	(8.5)	92.7					

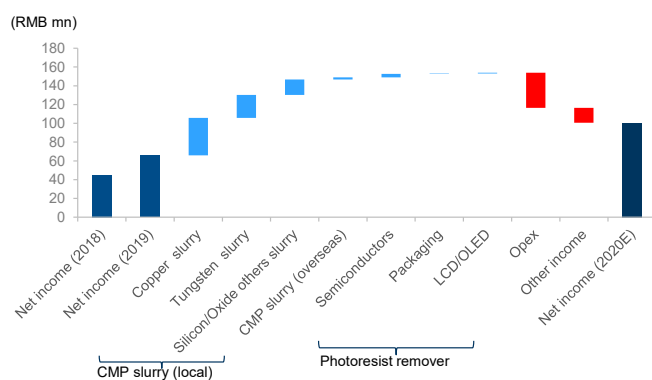
Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 25: Anji micro rev mix / GP mix / GM by products

	2019	2020E	2021E	2022E	2023E	2024E	2025E
Revenue mix	100%	100%	100%	100%	100%	100%	100%
CMP slurry	83%	85%	88%	89%	90%	92%	93%
Photoresist remover	17%	14%	12%	11%	10%	8%	7%
Others	0%	1%	0%	0%	0%	0%	0%
CMP slurry segment							
CMP slurry sales (local) mix	100%	100%	100%	100%	100%	100%	100%
Copper slurry	69%	58%	50%	42%	36%	30%	26%
Tungsten slurry	6%	13%	20%	29%	36%	46%	51%
Silicon/Oxide others	25%	29%	30%	29%	28%	23%	23%
CMP slurry sales (overseas) mix	100%	100%	100%	100%	100%	100%	100%
Photoresist removal segment							
Photoresist removal sales mix	100%	100%	100%	100%	100%	100%	100%
Semiconductors	37%	41%	44%	49%	56%	58%	61%
Packaging	23%	23%	23%	24%	22%	22%	22%
LCD/OLED	41%	36%	34%	28%	22%	19%	16%
Gross margin	50%	51%	51%	53%	54%	56%	56%
CMP slurry	54%	54%	54%	55%	56%	57%	57%
Photoresist remover	32%	32%	31%	36%	37%	37%	37%
Others	15%	15%	15%	15%	15%	15%	15%
CMP slurry segment							
CMP slurry (local)	52%	53%	53%	55%	55%	57%	57%
Copper slurry	58%	58%	58%	58%	58%	58%	58%
Tungsten slurry	80%	78%	76%	74%	72%	70%	68%
Silicon/Oxide others	28%	30%	30%	30%	30%	30%	30%
CMP slurry (overseas)	67%	67%	67%	67%	67%	67%	67%
Photoresist removal segment							
Photoresist remover	32%	32%	31%	36%	37%	37%	37%
Semiconductors	54%	50%	45%	40%	40%	40%	40%
Packaging	29%	25%	25%	35%	35%	35%	35%
LCD/OLED	14%	15%	17%	30%	30%	30%	30%
Gross profit mix	100%	100%	100%	100%	100%	100%	100%
CMP slurry	89%	91%	93%	93%	93%	95%	96%
Photoresist remover	11%	9%	7%	7%	7%	5%	4%
Others	0%	0%	0%	0%	0%	0%	0%
CMP slurry segment							
CMP slurry GP (local) mix	100%	100%	100%	100%	100%	100%	100%
Copper slurry	77%	65%	54%	45%	38%	31%	27%
Tungsten slurry	9%	18%	29%	39%	47%	57%	61%
Silicon/Oxide others	14%	17%	17%	16%	15%	12%	12%
CMP slurry GP (overseas) mix	100%	100%	100%	100%	100%	100%	100%
Photoresist removal segment							
Photoresist removal GP mix	100%	100%	100%	100%	100%	100%	100%
Semiconductors	62%	65%	63%	54%	61%	63%	66%
Packaging	21%	18%	18%	23%	21%	21%	21%
LCD/OLED	17%	17%	19%	23%	18%	16%	13%

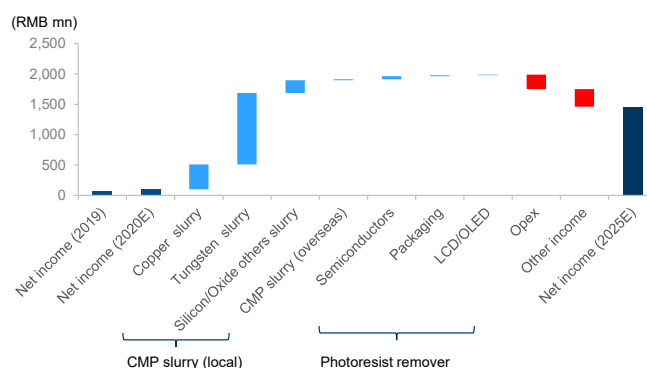
Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 26: Waterfall chart 2019-20E



Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 27: Waterfall chart 2020-25E



Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

CR Micro

Exhibit 28: CR Micro financial table

Income statement (Rmb mn)	12/19	12/20E	12/21E	12/22E	Balance sheet (Rmb mn)	12/19	12/20E	12/21E	12/22E
Total revenue	5,742.8	5,883.6	7,315.1	9,504.7	Cash & equivalents	1,930.7	5,977.7	5,661.4	5,287.0
Cost of goods sold	(4,431.3)	(4,495.7)	(5,470.5)	(6,936.1)	Accounts receivable	1,006.0	1,160.3	1,492.9	1,902.4
SG&A	(555.0)	(545.4)	(596.8)	(667.3)	Inventory	1,054.8	1,213.8	1,516.6	1,907.3
R&D	(482.6)	(495.7)	(557.1)	(640.6)	Other current assets	1,101.1	1,101.1	1,101.1	1,101.1
Other operating profit/(expense)	--	--	--	--	Total current assets	5,092.5	9,452.9	9,772.1	10,197.8
EBITDA	966.5	1,138.2	1,589.4	2,285.9	Net PP&E	3,815.7	4,152.6	4,545.6	5,063.5
Depreciation & amortization	(692.6)	(791.5)	(898.6)	(1,025.1)	Net intangibles	274.9	258.2	243.2	229.7
EBIT	273.8	346.8	690.7	1,260.8	Total investments	81.7	81.7	81.7	81.7
Interest income	37.8	67.5	102.0	96.6	Other long-term assets	830.4	830.4	830.4	830.4
Interest expense	(45.0)	(53.9)	(53.9)	(36.0)	Total assets	10,095.3	14,775.8	15,472.9	16,403.2
Income/(loss) from uncons. subs.	(0.3)	0.8	--	--	Accounts payable	848.5	824.0	1,241.0	1,415.2
Others	239.6	196.7	192.5	181.9	Short-term debt	--	--	--	--
Pretax profits	506.0	557.8	931.4	1,503.3	Other current liabilities	1,130.3	1,130.3	1,130.3	1,130.3
Income tax	6.5	(41.6)	(69.9)	(112.7)	Total current liabilities	1,978.7	1,954.2	2,371.3	2,545.5
Minorities	(111.7)	(47.8)	(47.8)	(47.8)	Long-term debt	1,506.1	1,506.1	1,006.1	506.1
Net income pre-preferred dividends	400.8	468.4	813.7	1,342.7	Other long-term liabilities	219.6	219.6	219.6	219.6
Preferred dividends	--	--	--	--	Total long-term liabilities	1,725.7	1,725.7	1,225.7	725.7
Net income (pre-exceptionals)	400.8	468.4	813.7	1,342.7	Total liabilities	3,704.5	3,680.0	3,597.0	3,271.2
Post-tax exceptionals	--	--	--	--	Preferred shares	--	--	--	--
Net income	400.8	468.4	813.7	1,342.7	Total common equity	5,423.1	10,080.3	10,812.6	12,020.8
EPS (basic, pre-except) (Rmb)	0.46	0.39	0.67	1.10	Minority interest	967.7	1,015.5	1,063.3	1,111.1
EPS (basic, post-except) (Rmb)	0.46	0.39	0.67	1.10	Total liabilities & equity	10,095.3	14,775.8	15,472.9	16,403.2
EPS (diluted, post-except) (Rmb)	0.46	0.39	0.67	1.10	BVPS (Rmb)	6.17	8.29	8.89	9.89
DPS (Rmb)	0.03	0.04	0.07	0.11					
Dividend payout ratio (%)	7.2	10.0	10.0	10.0					
Free cash flow yield (%)	NM	(0.2)	0.4	0.4					
Growth & margins (%)	12/19	12/20E	12/21E	12/22E	Ratios	12/19	12/20E	12/21E	12/22E
Sales growth	(8.4)	2.5	24.3	29.9	CROCI (%)	1.9	6.6	7.4	9.4
EBITDA growth	(35.0)	17.8	39.6	43.8	ROE - common equity (%)	8.4	6.0	7.8	11.8
EBIT growth	(49.9)	26.6	99.2	82.5	ROE - total shareholders' equity (%)	7.0	5.4	7.1	10.7
Net income growth	(6.7)	16.9	73.7	65.0	ROA (%)	4.0	3.8	5.4	8.4
EPS growth	(6.7)	(15.5)	73.7	65.0	Inventory days	92.1	92.1	91.1	90.1
Gross margin	22.8	23.6	25.2	27.0	Receivables days	67.2	67.2	66.2	65.2
EBITDA margin	16.8	19.3	21.7	24.0	Payable days	67.9	67.9	68.9	69.9
EBIT margin	4.8	5.9	9.4	13.3	Net debt/equity (%)	(6.6)	(40.3)	(39.2)	(36.4)
					Interest cover - EBIT (X)	38.0	NM	NM	NM
Cash flow statement (Rmb mn)	12/19	12/20E	12/21E	12/22E	Valuation	12/19	12/20E	12/21E	12/22E
Net income pre-preferred dividends	400.8	468.4	813.7	1,342.7	P/E (X)	NM	145.9	84.0	50.9
D&A add-back	692.6	791.5	898.6	1,025.1	P/B (X)	NM	6.8	6.3	5.7
Minorities interests add-back	111.7	47.8	47.8	47.8	EV/EBITDA (X)	--	57.0	40.7	28.3
Net (inc)/dec working capital	277.4	(337.8)	(218.4)	(625.9)	EV/GCI (X)	--	2.9	2.7	2.5
Other operating cash flow	(906.3)	--	--	--	Dividend yield (%)	NM	0.1	0.1	0.2
Cash flow from operations	576.3	969.9	1,541.7	1,789.7					
Capital expenditures	(612.3)	(1,111.6)	(1,276.6)	(1,529.6)					
Acquisitions	--	--	--	--					
Divestitures	--	--	--	--					
Others	571.6	--	--	--					
Cash flow from investments	(40.7)	(1,111.6)	(1,276.6)	(1,529.6)					
Dividends paid (common & pref)	(155.1)	(46.9)	(81.5)	(134.4)					
Inc/(dec) in debt	(944.7)	--	(500.0)	(500.0)					
Common stock issuance (repurchase)	(571.2)	4,235.7	--	--					
Other financing cash flows	1,528.4	--	--	--					
Cash flow from financing	(142.5)	4,188.8	(581.5)	(634.4)					
Total cash flow	393.0	4,047.0	(316.3)	(374.3)					

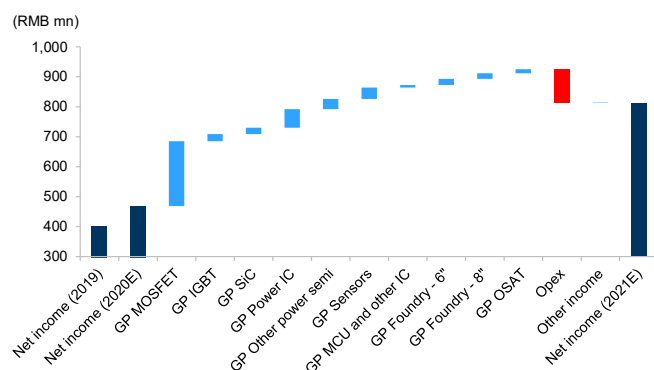
Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 29: CR Micro Rev mix / GP mix / GM by products

	2019	2020E	2021E	2022E	2023E	2024E	2025E
Revenue mix	100%	100%	100%	100%	100%	100%	100%
MOSFET	26%	29%	33%	35%	36%	36%	34%
IGBT	1%	2%	2%	3%	4%	6%	7%
SiC	0%	0%	1%	1%	2%	2%	3%
GaN	0%	0%	0%	1%	1%	2%	2%
Power IC	5%	6%	7%	9%	11%	13%	16%
Other power semi	7%	7%	7%	7%	7%	6%	5%
Sensors	2%	3%	3%	4%	5%	6%	7%
MCU and other IC	2%	2%	2%	2%	2%	2%	2%
Foundry - 6"	17%	16%	14%	12%	10%	9%	8%
Foundry - 8"	23%	21%	18%	15%	13%	12%	10%
OSAT	14%	13%	11%	9%	8%	7%	6%
Others	3%	2%	2%	2%	1%	1%	1%
IDM	44%	48%	55%	62%	67%	72%	76%
Manufacturing service	56%	52%	45%	38%	33%	28%	24%
GM	23%	24%	25%	27%	29%	30%	31%
MOSFET	29%	29%	30%	31%	32%	32%	33%
IGBT	33%	33%	34%	35%	36%	37%	37%
SiC	0%	40%	40%	41%	42%	43%	43%
GaN	0%	0%	0%	0%	40%	41%	41%
Power IC	32%	32%	33%	34%	35%	36%	36%
Other power semi (SBD/FRD)	23%	22%	23%	24%	24%	24%	24%
Sensors	43%	43%	44%	45%	45%	45%	45%
MCU and other IC	33%	33%	34%	35%	35%	35%	35%
Foundry - 6"	17%	17%	18%	19%	19%	19%	19%
Foundry - 8"	19%	19%	19%	20%	20%	20%	20%
OSAT	17%	17%	17%	18%	18%	18%	18%
Others	17%	24%	24%	24%	24%	24%	24%
IDM	29%	30%	31%	32%	33%	34%	35%
Manufacturing service	18%	18%	18%	19%	19%	19%	19%
GP mix	100%	100%	100%	100%	100%	100%	100%
MOSFET	34%	36%	39%	40%	39%	38%	36%
IGBT	2%	2%	3%	4%	5%	7%	8%
SiC	0%	0%	1%	2%	3%	3%	4%
GaN	0%	0%	0%	0%	2%	2%	3%
Power IC	8%	8%	9%	12%	14%	16%	18%
Other power semi (SBD/FRD)	7%	6%	6%	6%	5%	5%	4%
Sensors	5%	5%	6%	7%	8%	8%	10%
MCU and other IC	3%	2%	2%	2%	2%	2%	2%
Foundry - 6"	13%	12%	10%	8%	7%	6%	5%
Foundry - 8"	19%	17%	14%	11%	9%	8%	7%
OSAT	10%	9%	7%	6%	5%	4%	3%
Others	2%	3%	2%	1%	1%	1%	1%
IDM	57%	60%	67%	73%	78%	82%	85%
Manufacturing service	43%	40%	33%	27%	22%	18%	15%

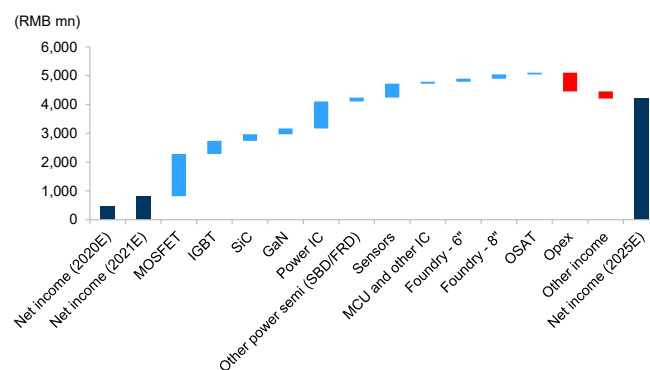
Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 30: Waterfall chart for 2020-21E



Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 31: Waterfall chart for 2021-25E



Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Montage

Montage financials

Income statement (Rmb mn)	12/19	12/20E	12/21E	12/22E	Balance sheet (Rmb mn)	12/19	12/20E	12/21E	12/22E
Total revenue	1,737.7	2,251.8	3,148.5	4,643.7	Cash & equivalents	7,257.1	7,826.8	8,943.2	10,235.6
Cost of goods sold	(452.5)	(587.1)	(830.2)	(1,270.0)	Accounts receivable	131.9	351.5	324.3	672.5
SG&A	(169.9)	(212.5)	(235.1)	(263.4)	Inventory	156.8	200.0	300.0	457.9
R&D	(266.9)	(338.5)	(408.2)	(498.0)	Other current assets	133.0	133.0	133.0	133.0
Other operating profit/(expense)	--	--	--	--	Total current assets	7,678.7	8,511.4	9,700.5	11,498.9
EBITDA	878.7	1,139.6	1,694.6	2,632.0	Net PP&E	27.7	30.0	34.5	39.6
Depreciation & amortization	(30.2)	(25.9)	(19.7)	(19.7)	Net intangibles	16.2	5.3	1.8	0.8
EBIT	848.5	1,113.7	1,674.9	2,612.3	Total investments	0.0	0.0	0.0	0.0
Interest income	79.6	108.9	117.4	134.1	Other long-term assets	58.1	58.1	58.1	58.1
Interest expense	0.0	0.0	0.0	0.0	Total assets	7,780.8	8,604.7	9,794.9	11,597.4
Income/(loss) from uncons. subs.	--	--	--	--	Accounts payable	91.3	123.7	184.8	287.1
Others	50.6	86.0	74.4	64.7	Short-term debt	--	--	--	--
Pretax profits	978.7	1,308.6	1,866.7	2,811.1	Other current liabilities	188.4	188.4	188.4	188.4
Income tax	(45.9)	(65.2)	(93.3)	(140.6)	Total current liabilities	279.7	312.1	373.3	475.5
Minorities	--	--	--	--	Long-term debt	--	--	--	--
Net income pre-preferred dividends	932.9	1,243.3	1,773.4	2,670.6	Other long-term liabilities	171.3	171.3	171.3	171.3
Preferred dividends	--	--	--	--	Total long-term liabilities	171.3	171.3	171.3	171.3
Net income (pre-exceptionals)	932.9	1,243.3	1,773.4	2,670.6	Total liabilities	451.0	483.4	544.6	646.8
Post-tax exceptionals	--	--	--	--	Preferred shares	--	--	--	--
Net income	932.9	1,243.3	1,773.4	2,670.6	Total common equity	7,329.7	8,121.3	9,250.4	10,950.6
EPS (basic, pre-except) (Rmb)	0.88	1.10	1.57	2.36	Minority interest	--	--	--	--
EPS (basic, post-except) (Rmb)	0.88	1.10	1.57	2.36					
EPS (diluted, post-except) (Rmb)	0.88	1.10	1.57	2.36	Total liabilities & equity	7,780.8	8,604.7	9,794.9	11,597.4
DPS (Rmb)	3.00	0.40	0.57	0.86	BVPS (Rmb)	6.49	7.19	8.19	9.69
Dividend payout ratio (%)	340.9	36.3	36.3	36.3					
Free cash flow yield (%)	1.2	0.8	1.3	1.7					
Growth & margins (%)	12/19	12/20E	12/21E	12/22E	Ratios	12/19	12/20E	12/21E	12/22E
Sales growth	(1.1)	29.6	39.8	47.5	CROCI (%)	12.5	14.7	18.9	24.8
EBITDA growth	18.3	29.7	48.7	55.3	ROE - common equity (%)	17.0	16.1	20.4	26.4
EBIT growth	17.5	31.2	50.4	56.0	ROE - total shareholders' equity (%)	17.0	16.1	20.4	26.4
Net income growth	26.6	33.3	42.6	50.6	ROA (%)	15.6	15.2	19.3	25.0
EPS growth	1.1	25.1	42.6	50.6	Inventory days	111.9	110.9	109.9	108.9
Gross margin	74.0	73.9	73.6	72.7	Receivables days	39.2	39.2	39.2	39.2
EBITDA margin	50.6	50.6	53.8	56.7	Payable days	66.8	66.8	67.8	67.8
EBIT margin	48.8	49.5	53.2	56.3	Net debt/equity (%)	(99.0)	(96.4)	(96.7)	(93.5)
					Interest cover - EBIT (X)	NM	NM	NM	NM
Cash flow statement (Rmb mn)	12/19	12/20E	12/21E	12/22E	Valuation	12/19	12/20E	12/21E	12/22E
Net income pre-preferred dividends	932.9	1,243.3	1,773.4	2,670.6	P/E (X)	78.9	106.5	74.7	49.6
D&A add-back	30.2	25.9	19.7	19.7	P/B (X)	10.7	16.3	14.3	12.1
Minorities interests add-back	--	--	--	--	EV/EBITDA (X)	75.5	109.3	72.9	46.4
Net (inc)/dec working capital	90.1	(230.5)	(11.6)	(403.8)	EV/GCI (X)	8.8	15.0	13.0	10.9
Other operating cash flow	(184.2)	--	--	--	Dividend yield (%)	4.3	0.3	0.5	0.7
Cash flow from operations	869.0	1,038.8	1,781.4	2,286.5					
Capital expenditures	(21.6)	(17.3)	(20.7)	(23.8)					
Acquisitions	--	--	--	--					
Divestitures	--	--	--	--					
Others	(1,987.3)	--	--	--					
Cash flow from investments	(2,008.8)	(17.3)	(20.7)	(23.8)					
Dividends paid (common & pref)	(292.3)	(451.8)	(644.3)	(970.3)					
Inc/(dec) in debt	--	--	--	--					
Common stock issuance (repurchase)	2,981.4	--	--	--					
Other financing cash flows	2,027.9	--	--	--					
Cash flow from financing	4,717.0	(451.8)	(644.3)	(970.3)					
Total cash flow	3,577.1	569.8	1,116.4	1,292.4					

Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

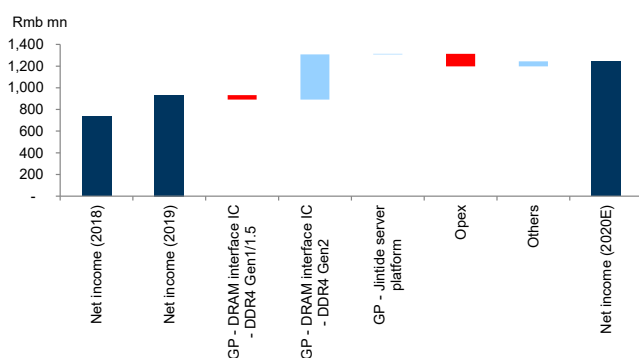
Exhibit 32: Montage revenue and gross profit mix

	2019	2020E	2021E	2022E	2023E
Revenue mix	100%	100%	100%	100%	100%
DRAM interface IC - DDR4 Gen1/1.5	10%	5%	3%	2%	1%
DRAM interface IC - DDR4 Gen2	89%	93%	74%	37%	19%
Jintide server platform	1%	1%	3%	6%	10%
DRAM interface IC - DDR5	0%	0%	20%	53%	65%
PCIe retimer	0%	0%	0%	3%	5%
GM	74.0%	73.9%	73.6%	72.7%	70.7%
DRAM interface IC - DDR4 Gen1/1.5	64.3%	56.0%	55.5%	55.0%	54.5%
DRAM interface IC - DDR4 Gen2	76.0%	75.9%	75.3%	74.8%	74.3%
Jintide server platform	-17.2%	7.3%	20.0%	25.0%	30.0%
DRAM interface IC - DDR5	-	-	78.0%	78.0%	78.0%
PCIe retimer	-	-	-	50.0%	50.0%
GP mix	100%	100%	100%	100%	100%
DRAM interface IC - DDR4 Gen1/1.5	9%	4%	2%	1%	1%
DRAM interface IC - DDR4 Gen2	92%	96%	75%	38%	20%
Jintide server platform	-0.2%	0.1%	1%	2%	4%
DRAM interface IC - DDR5	-	-	22%	57%	72%
PCIe retimer	-	-	-	2%	3%

Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 33: DDR4 Gen2 to be the main profit driver in 2020E

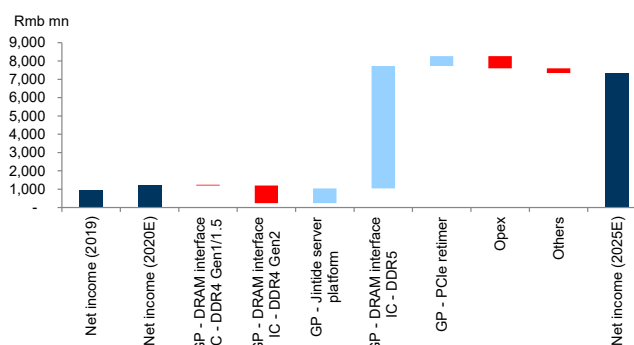
Net profit waterfall chart 2019-2020E



Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 34: DDR5 to have rising profit contribution during 2020-25E

Net profit waterfall chart 2020-25E



Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

NSIG

NSIG financials

Income statement (Rmb mn)	12/19	12/20E	12/21E	12/22E	Balance sheet (Rmb mn)	12/19	12/20E	12/21E	12/22E
Total revenue	1,492.5	1,710.4	2,366.6	3,385.6	Cash & equivalents	710.6	2,747.4	2,055.1	1,090.1
Cost of goods sold	(1,275.4)	(1,412.8)	(1,892.2)	(2,573.4)	Accounts receivable	348.6	260.6	387.8	539.7
SG&A	(247.9)	(220.1)	(279.1)	(306.0)	Inventory	440.1	248.9	425.0	491.6
R&D	(84.2)	(105.5)	(136.2)	(172.6)	Other current assets	158.8	158.8	158.8	158.8
Other operating profit/(expense)	--	--	--	--	Total current assets	1,658.0	3,415.6	3,026.6	2,280.1
EBITDA	200.1	323.9	467.0	811.7	Net PP&E	3,114.9	3,703.4	4,433.1	5,489.8
Depreciation & amortization	(315.1)	(351.9)	(407.8)	(478.2)	Net intangibles	403.7	374.7	348.5	325.0
EBIT	(115.0)	(28.0)	59.2	333.5	Total investments	0.0	0.0	0.0	0.0
Interest income	5.3	5.1	19.6	14.6	Other long-term assets	4,786.7	4,786.7	4,786.7	4,786.7
Interest expense	(82.3)	(122.1)	(121.8)	(121.8)	Total assets	9,963.2	12,280.4	12,594.9	12,881.5
Income/(loss) from uncons. subs.	(3.6)	--	--	--	Accounts payable	237.4	188.4	433.7	412.4
Others	122.3	111.7	115.8	115.8	Short-term debt	1,019.4	1,182.9	1,182.9	1,182.9
Pretax profits	(73.3)	(33.2)	72.8	342.2	Other current liabilities	985.3	985.3	985.3	985.3
Income tax	(28.0)	(8.5)	(3.6)	(34.2)	Total current liabilities	2,242.1	2,356.6	2,601.9	2,580.6
Minorities	11.3	5.6	5.6	5.6	Long-term debt	761.3	593.7	593.7	593.7
Net income pre-preferred dividends	(89.9)	(36.2)	74.8	313.6	Other long-term liabilities	1,785.4	1,785.4	1,785.4	1,785.4
Preferred dividends	--	--	--	--	Total long-term liabilities	2,546.7	2,379.1	2,379.1	2,379.1
Net income (pre-exceptionals)	(89.9)	(36.2)	74.8	313.6	Total liabilities	4,788.8	4,735.7	4,981.0	4,959.7
Post-tax exceptionals	--	--	--	--	Preferred shares	--	--	--	--
Net income	(89.9)	(36.2)	74.8	313.6	Total common equity	5,072.0	7,447.9	7,522.7	7,836.3
EPS (basic, pre-exception) (Rmb)	(0.05)	(0.02)	0.03	0.13	Minority interest	102.4	96.8	91.2	85.6
EPS (basic, post-exception) (Rmb)	(0.05)	(0.02)	0.03	0.13	Total liabilities & equity	9,963.2	12,280.4	12,594.9	12,881.5
EPS (diluted, post-exception) (Rmb)	(0.05)	(0.02)	0.03	0.13	BVPS (Rmb)	2.73	3.00	3.03	3.16
DPS (Rmb)	--	--	--	--					
Dividend payout ratio (%)	0.0	0.0	0.0	0.0					
Free cash flow yield (%)	NM	(0.4)	(0.6)	(0.8)					
Growth & margins (%)	12/19	12/20E	12/21E	12/22E	Ratios	12/19	12/20E	12/21E	12/22E
Sales growth	47.7	14.6	38.4	43.1	CROCI (%)	33.8	9.3	10.1	13.3
EBITDA growth	138.6	61.8	44.2	73.8	ROE - common equity (%)	(2.1)	(0.6)	1.0	4.1
EBIT growth	(56.8)	75.7	311.7	463.2	ROE - total shareholders' equity (%)	(2.1)	(0.6)	1.0	4.0
Net income growth	(902.4)	59.8	306.9	319.2	ROA (%)	(1.1)	(0.3)	0.6	2.5
EPS growth	(992.4)	66.7	281.1	319.2	Inventory days	88.8	89.0	65.0	65.0
Gross margin	14.5	17.4	20.0	24.0	Receivables days	61.3	65.0	50.0	50.0
EBITDA margin	13.4	18.9	19.7	24.0	Payable days	53.1	55.0	60.0	60.0
EBIT margin	(7.7)	(1.6)	2.5	9.9	Net debt/equity (%)	20.7	(12.9)	(3.7)	8.7
					Interest cover - EBIT (X)	NM	NM	0.6	3.1
Cash flow statement (Rmb mn)	12/19	12/20E	12/21E	12/22E	Valuation	12/19	12/20E	12/21E	12/22E
Net income pre-preferred dividends	(89.9)	(36.2)	74.8	313.6	P/E (X)	NM	NM	NM	NM
D&A add-back	315.1	351.9	407.8	478.2	P/B (X)	NM	16.0	15.9	15.2
Minorities interests add-back	(11.3)	(5.6)	(5.6)	(5.6)	EV/EBITDA (X)	--	NM	NM	148.1
Net (inc)/dec working capital	(352.0)	230.1	(58.0)	(239.8)	EV/GCI (X)	--	19.1	20.2	16.3
Other operating cash flow	1,024.8	--	--	--	Dividend yield (%)	NM	0.0	0.0	0.0
Cash flow from operations	886.7	540.2	419.0	546.3					
Capital expenditures	(904.8)	(911.3)	(1,111.3)	(1,511.3)					
Acquisitions	(119.5)	--	--	--					
Divestitures	--	--	--	--					
Others	(19.8)	--	--	--					
Cash flow from investments	(1,044.2)	(911.3)	(1,111.3)	(1,511.3)					
Dividends paid (common & pref)	(102.5)	--	--	--					
Inc/(dec) in debt	580.5	(4.1)	--	--					
Common stock issuance (repurchase)	(139.8)	2,412.0	--	--					
Other financing cash flows	(252.2)	--	--	--					
Cash flow from financing	86.0	2,407.9	0.0	0.0					
Total cash flow	(71.5)	2,036.8	(692.3)	(965.0)					

Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

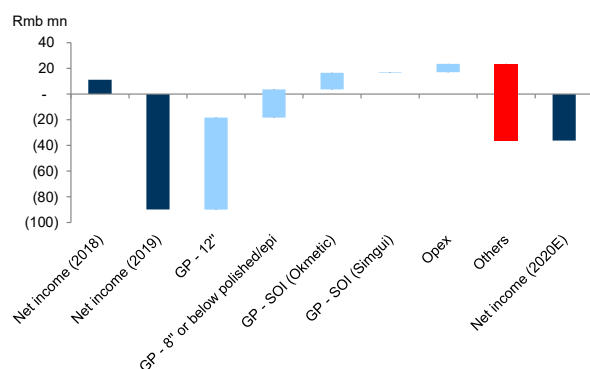
Exhibit 35: NSIG revenue and gross profit mix

	2019	2020E	2021E	2022E	2023E
Revenue mix	100%	100%	100%	100%	100%
12"	14%	19%	23%	33%	40%
8" or below	73%	71%	70%	61%	57%
Outsource processing	10%	9%	7%	5%	4%
Others	2%	1%	0%	0%	0%
GM	14.5%	17.6%	20.0%	24.0%	24.4%
12"	-48.0%	-10.0%	0.0%	17.0%	22.0%
8" or below	24.4%	24.9%	26.2%	27.7%	26.1%
Outsource processing	24.6%	25.0%	25.0%	25.0%	25.0%
Others	53.7%	0.0%	0.0%	0.0%	0.0%
Gross profit	100%	100%	100%	100%	100%
12"	-48%	-11%	0%	24%	36%
8" or below	123%	101%	91%	71%	60%
Outsource processing	17%	13%	9%	5%	4%
Others	7%	-4%	0%	0%	0%

Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 36: We expect NSIG loss to narrow in 2020E

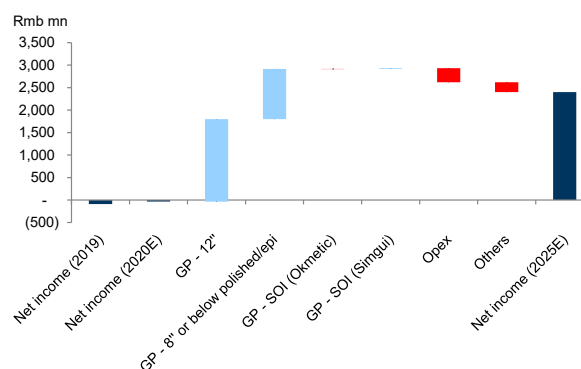
Net profit waterfall chart 2019-20E



Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 37: We expect 12" to have the largest contribution to profit

Net profit waterfall chart 2020-25E



Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Sanan

Exhibit 38: Sanan financials table

Income statement (Rmb mn)	12/19	12/20E	12/21E	12/22E	Balance sheet (Rmb mn)	12/19	12/20E	12/21E	12/22E
Total revenue	7,460.0	7,735.3	9,874.5	12,860.0	Cash & equivalents	2,318.3	1,870.1	1,174.4	1,395.9
Cost of goods sold	(5,268.9)	(5,578.1)	(6,872.4)	(8,718.0)	Accounts receivable	3,938.5	5,009.0	6,250.6	7,356.3
SG&A	(720.2)	(616.3)	(686.4)	(759.2)	Inventory	3,141.6	2,623.9	4,291.1	3,764.3
R&D	(197.0)	(169.0)	(185.7)	(202.4)	Other current assets	864.8	864.8	864.8	864.8
Other operating profit/(expense)	--	--	--	--	Total current assets	10,263.1	10,367.8	12,580.8	13,381.3
EBITDA	2,884.3	3,415.6	4,504.7	5,951.2	Net PP&E	9,264.8	10,050.2	10,983.8	12,394.2
Depreciation & amortization	(1,610.4)	(2,043.8)	(2,374.7)	(2,770.9)	Net intangibles	3,419.2	3,314.9	3,222.2	3,139.6
EBIT	1,273.9	1,371.8	2,130.0	3,180.4	Total investments	121.0	121.0	121.0	121.0
Interest income	43.3	69.5	56.1	35.2	Other long-term assets	6,612.5	6,612.5	6,612.5	6,612.5
Interest expense	(159.3)	(95.0)	(95.0)	(95.0)	Total assets	29,680.6	30,466.4	33,520.3	35,648.6
Income/(loss) from uncons. subs.	9.7	(3.7)	--	--	Accounts payable	2,535.7	1,714.1	3,333.5	2,926.4
Others	423.1	404.2	392.0	402.4	Short-term debt	1,196.6	1,342.0	1,342.0	1,342.0
Pretax profits	1,590.7	1,746.8	2,483.0	3,523.0	Other current liabilities	871.3	871.3	871.3	871.3
Income tax	(292.3)	(259.4)	(397.3)	(563.7)	Total current liabilities	4,603.5	3,927.4	5,546.8	5,139.6
Minorities	--	--	--	--	Long-term debt	120.0	558.9	558.9	1,058.9
Net income pre-preferred dividends	1,298.5	1,487.5	2,085.8	2,959.3	Other long-term liabilities	3,211.8	3,211.8	3,211.8	3,211.8
Preferred dividends	--	--	--	--	Total long-term liabilities	3,331.8	3,770.7	3,770.7	4,270.7
Net income (pre-exceptionals)	1,298.5	1,487.5	2,085.8	2,959.3	Total liabilities	7,935.3	7,698.1	9,317.5	9,410.3
Post-tax exceptionals	--	--	--	--	Preferred shares	--	--	--	--
Net income	1,298.5	1,487.5	2,085.8	2,959.3	Total common equity	21,745.3	22,768.3	24,202.9	26,238.3
EPS (basic, pre-exception) (Rmb)	0.32	0.36	0.51	0.73	Minority interest	--	--	--	--
EPS (basic, post-exception) (Rmb)	0.32	0.36	0.51	0.73	Total liabilities & equity	29,680.6	30,466.4	33,520.3	35,648.6
EPS (diluted, post-exception) (Rmb)	0.32	0.36	0.51	0.73	BVPS (Rmb)	5.33	5.58	5.93	6.43
DPS (Rmb)	0.10	0.11	0.16	0.23					
Dividend payout ratio (%)	31.3	31.2	31.2	31.2					
Free cash flow yield (%)	(0.4)	(0.5)	0.0	0.6					
Growth & margins (%)	12/19	12/20E	12/21E	12/22E	Ratios	12/19	12/20E	12/21E	12/22E
Sales growth	(10.8)	3.7	27.7	30.2	CROCI (%)	5.4	12.7	14.1	15.8
EBITDA growth	(33.2)	18.4	31.9	32.1	ROE - common equity (%)	6.0	6.7	8.9	11.7
EBIT growth	(55.7)	7.7	55.3	49.3	ROE - total shareholders' equity (%)	6.0	6.7	8.9	11.7
Net income growth	(54.1)	14.6	40.2	41.9	ROA (%)	4.3	4.9	6.5	8.6
EPS growth	(53.6)	14.0	40.2	41.9	Inventory days	201.6	188.6	183.6	168.6
Gross margin	29.4	27.9	30.4	32.2	Receivables days	221.1	211.1	208.1	193.1
EBITDA margin	38.7	44.2	45.6	46.3	Payable days	149.0	139.0	134.0	131.0
EBIT margin	17.1	17.7	21.6	24.7	Net debt/equity (%)	(4.6)	0.1	3.0	3.8
					Interest cover - EBIT (X)	11.0	53.8	54.7	53.2
Cash flow statement (Rmb mn)	12/19	12/20E	12/21E	12/22E	Valuation	12/19	12/20E	12/21E	12/22E
Net income pre-preferred dividends	1,298.5	1,487.5	2,085.8	2,959.3	P/E (X)	41.5	77.5	55.3	39.0
D&A add-back	1,610.4	2,043.8	2,374.7	2,770.9	P/B (X)	2.5	5.1	4.8	4.4
Minorities interests add-back	--	--	--	--	EV/EBITDA (X)	18.3	33.8	25.8	19.5
Net (inc)/dec working capital	1,467.4	(1,374.4)	(1,289.4)	(986.1)	EV/GCI (X)	2.0	3.9	3.4	3.0
Other operating cash flow	(1,586.9)	0.0	--	--	Dividend yield (%)	0.8	0.4	0.6	0.8
Cash flow from operations	2,789.3	2,156.9	3,171.0	4,744.1					
Capital expenditures	(2,997.5)	(2,724.9)	(3,215.5)	(4,098.6)					
Acquisitions	--	--	--	--					
Divestitures	13.7	--	--	--					
Others	1,412.4	--	--	--					
Cash flow from investments	(1,571.3)	(2,724.9)	(3,215.5)	(4,098.6)					
Dividends paid (common & pref)	(970.6)	(464.4)	(651.2)	(923.9)					
Inc/(dec) in debt	(2,143.4)	584.3	--	500.0					
Common stock issuance (repurchase)	0.7	--	--	--					
Other financing cash flows	(192.3)	--	--	--					
Cash flow from financing	(3,305.6)	119.9	(651.2)	(423.9)					
Total cash flow	(2,087.6)	(448.2)	(695.7)	221.5					

Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

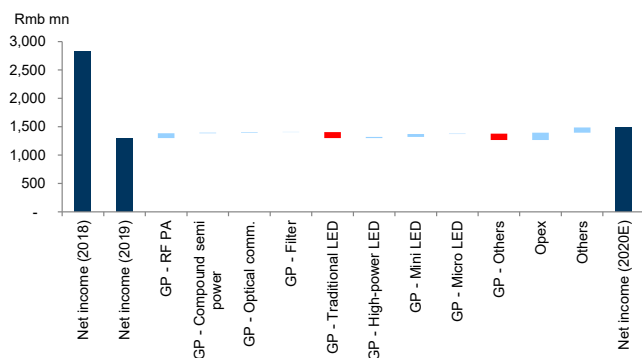
Exhibit 39: Sanan revenue and gross profit mix

	2019	2020E	2021E	2022E	2023E
Revenue mix	100%	100%	100%	100%	100%
RF PA	2%	8%	11%	13%	13%
Compound semi power	0%	1%	3%	6%	10%
Optical comm.	1%	1%	1%	2%	4%
Filter	0%	0%	1%	2%	3%
Traditional LED	69%	58%	47%	36%	29%
High-power LED	1%	2%	5%	7%	8%
Mini-/Micro-LED	3%	7%	15%	20%	24%
Others	23%	22%	17%	13%	10%
GM	29.4%	27.9%	30.4%	32.2%	33.9%
RF PA and compound semi	-	14%	28%	36%	39%
Traditional LED	13%	12%	13%	13%	13%
High-power LED	20%	20%	30%	32%	33%
Mini-/Micro-LED	6%	12%	23%	22%	23%
Others	85%	80%	80%	80%	80%
GP mix	100%	100%	100%	100%	100%
RF PA	0%	4%	10%	14%	14%
Compound semi power	0%	1%	3%	7%	11%
Optical comm.	0%	0%	1%	3%	4%
Filter	0%	0%	1%	2%	3%
Traditional LED	30%	26%	20%	15%	11%
High-power LED	1%	2%	5%	6%	8%
Mini LED	1%	3%	11%	14%	16%
Micro LED	0%	1%	3%	6%	7%
Others	68%	64%	46%	33%	25%

Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

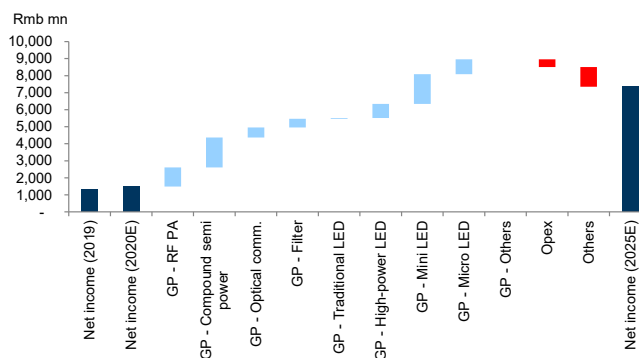
Exhibit 40: Sanan net income to gradually improve starting from 2020E

Net profit waterfall chart (2019-20E)



Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 41: Compound semi & RF PA, Mini/Micro LED are the major profit contributors



Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Silan

Exhibit 42: Silan financials

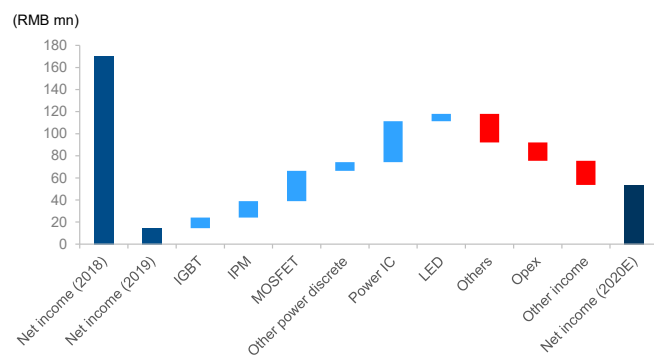
Income statement (Rmb mn)	12/19	12/20E	12/21E	12/22E	Balance sheet (Rmb mn)	12/19	12/20E	12/21E	12/22E
Total revenue	3,110.6	3,348.1	4,171.5	5,255.9	Cash & equivalents	1,082.3	690.5	346.4	329.4
Cost of goods sold	(2,504.8)	(2,664.8)	(3,243.5)	(3,999.1)	Accounts receivable	938.4	1,293.6	1,464.5	1,981.8
SG&A	(361.6)	(359.9)	(388.0)	(430.0)	Inventory	1,421.6	1,279.8	1,883.9	1,863.4
R&D	(334.4)	(352.7)	(395.0)	(454.2)	Other current assets	370.1	370.0	370.0	370.0
Other operating profit/(expense)	--	--	--	--	Total current assets	3,812.3	3,633.9	4,064.7	4,544.6
EBITDA	307.8	575.6	842.1	1,205.5	Net PP&E	2,869.2	3,041.3	3,230.0	3,409.0
Depreciation & amortization	(398.1)	(604.9)	(697.1)	(833.0)	Net intangibles	194.3	175.4	159.5	146.1
EBIT	(90.3)	(29.3)	145.0	372.5	Total investments	618.3	618.3	318.3	118.3
Interest income	13.1	13.0	8.3	7.6	Other long-term assets	1,419.1	1,419.1	1,419.1	1,419.1
Interest expense	(114.2)	(155.9)	(155.9)	(167.9)	Total assets	8,913.3	8,888.0	9,191.7	9,637.1
Income/(loss) from uncons. subs.	9.5	9.0	10.0	10.0	Accounts payable	882.7	968.9	1,249.2	1,441.8
Others	51.9	84.9	92.0	90.0	Short-term debt	2,239.5	2,039.5	1,839.5	1,639.5
Pretax profits	(129.9)	(78.3)	99.4	312.2	Other current liabilities	263.8	263.8	263.8	263.8
Income tax	22.6	10.2	(12.9)	(40.6)	Total current liabilities	3,386.0	3,272.2	3,352.6	3,345.1
Minorities	121.8	121.7	124.0	124.0	Long-term debt	486.2	558.9	558.9	558.9
Net income pre-preferred dividends	14.5	53.6	210.5	395.6	Other long-term liabilities	802.9	802.9	802.9	802.9
Preferred dividends	--	--	--	--	Total long-term liabilities	1,289.1	1,361.8	1,361.8	1,361.8
Net income (pre-exceptionals)	14.5	53.6	210.5	395.6	Total liabilities	4,675.1	4,634.0	4,714.3	4,706.9
Post-tax exceptionals	--	--	--	--	Preferred shares	--	--	--	--
Net income	14.5	53.6	210.5	395.6	Total common equity	3,379.0	3,416.5	3,563.8	3,840.8
EPS (basic, pre-except) (Rmb)	0.01	0.04	0.16	0.30	Minority interest	859.2	837.5	913.5	1,089.5
EPS (basic, post-except) (Rmb)	0.01	0.04	0.16	0.30	Total liabilities & equity	8,913.3	8,888.0	9,191.7	9,637.1
EPS (diluted, post-except) (Rmb)	0.01	0.04	0.16	0.30	BVPS (Rmb)	2.58	2.60	2.72	2.93
DPS (Rmb)	0.01	0.01	0.05	0.09					
Dividend payout ratio (%)	45.1	30.0	30.0	30.0					
Free cash flow yield (%)	(3.1)	(1.5)	(2.5)	(0.8)					
Growth & margins (%)	12/19	12/20E	12/21E	12/22E	Ratios	12/19	12/20E	12/21E	12/22E
Sales growth	2.8	7.6	24.6	26.0	CROCI (%)	3.2	8.6	10.5	12.7
EBITDA growth	(31.5)	87.0	46.3	43.1	ROE - common equity (%)	0.4	1.6	6.0	10.7
EBIT growth	(175.9)	67.5	594.8	156.9	ROE - total shareholders' equity (%)	0.3	1.3	4.8	8.4
Net income growth	(91.5)	269.0	292.5	88.0	ROA (%)	0.2	0.6	2.3	4.2
EPS growth	(91.7)	269.0	292.5	88.0	Inventory days	192.0	185.0	178.0	171.0
Gross margin	19.5	20.4	22.2	23.9	Receivables days	122.7	121.7	120.7	119.7
EBITDA margin	9.9	17.2	20.2	22.9	Payable days	128.8	126.8	124.8	122.8
EBIT margin	(2.9)	(0.9)	3.5	7.1	Net debt/equity (%)	38.8	44.8	45.8	37.9
					Interest cover - EBIT (X)	NM	NM	1.0	2.3
Cash flow statement (Rmb mn)	12/19	12/20E	12/21E	12/22E	Valuation	12/19	12/20E	12/21E	12/22E
Net income pre-preferred dividends	14.5	53.6	210.5	395.6	P/E (X)	NM	NM	106.2	56.5
D&A add-back	398.1	604.9	697.1	833.0	P/B (X)	5.7	6.5	6.3	5.8
Minorities interests add-back	(121.8)	(121.7)	(124.0)	(124.0)	EV/EBITDA (X)	71.0	43.6	30.1	21.0
Net (inc)/dec working capital	3.5	(127.2)	(494.6)	(304.3)	EV/GCI (X)	3.0	3.1	2.7	2.5
Other operating cash flow	(161.7)	0.1	--	--	Dividend yield (%)	0.0	0.1	0.3	0.5
Cash flow from operations	132.6	409.7	289.0	800.4					
Capital expenditures	(758.1)	(758.1)	(870.0)	(998.6)					
Acquisitions	--	--	--	--					
Divestitures	--	--	--	--					
Others	(205.4)	--	300.0	200.0					
Cash flow from investments	(963.4)	(758.1)	(570.0)	(798.6)					
Dividends paid (common & pref)	(173.3)	(16.1)	(63.1)	(118.7)					
Inc/(dec) in debt	714.9	(127.3)	(200.0)	(200.0)					
Common stock issuance (repurchase)	(21.5)	--	--	--					
Other financing cash flows	221.4	100.0	200.0	300.0					
Cash flow from financing	741.4	(43.4)	(63.1)	(18.7)					
Total cash flow	(89.4)	(391.8)	(344.1)	(16.9)					

Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

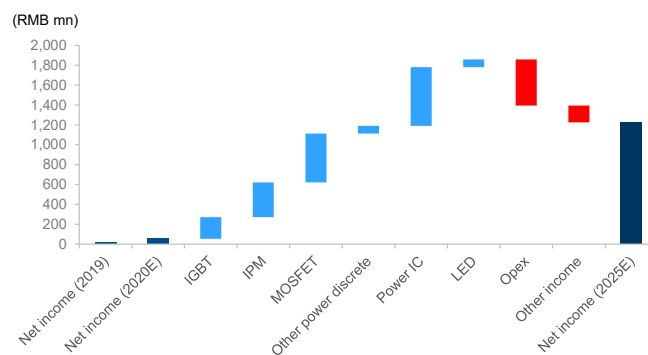
Exhibit 43: Silan Rev mix / GP mix / GM by products

	2019	2020E	2021E	2022E	2023E	2024E	2025E
Revenue mix	100%	100%	100%	100%	100%	100%	100%
IGBT	3%	4%	5%	5%	6%	7%	8%
IPM	5%	6%	7%	9%	10%	12%	14%
MOSFET	22%	22%	23%	24%	25%	26%	26%
Other power discrete (schottky, FRD, etc)	19%	17%	16%	14%	13%	11%	10%
Power IC	33%	34%	36%	37%	37%	37%	36%
LED	14%	13%	10%	8%	7%	6%	5%
Others	4%	3%	3%	2%	2%	1%	1%
GM	19%	20%	22%	24%	26%	27%	28%
IGBT	28%	29%	30%	31%	33%	34%	34%
IPM	28%	29%	30%	31%	33%	34%	34%
MOSFET	24%	25%	26%	27%	29%	30%	30%
Other power discrete (schottky, FRD, etc)	17%	18%	19%	19%	20%	20%	21%
Power IC	23%	24%	25%	26%	26%	27%	27%
LED	-6%	-4%	0%	4%	8%	12%	13%
Others	43%	27%	27%	27%	27%	27%	27%
GP mix	100%	100%	100%	100%	100%	100%	100%
IGBT	5%	5%	6%	7%	8%	9%	10%
IPM	7%	9%	10%	11%	13%	14%	16%
MOSFET	27%	28%	27%	27%	28%	29%	27%
Other power discrete (schottky, FRD, etc)	16%	15%	13%	12%	10%	8%	7%
Power IC	40%	41%	40%	39%	38%	36%	35%
LED	-4%	-3%	0%	1%	2%	3%	2%
Others	9%	4%	3%	2%	2%	1%	1%

Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 44: Waterfall chart 2019-20E

Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 45: Waterfall chart 2020-25E

Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

StarPower

Exhibit 46: StarPower financial table

Income statement (Rmb mn)	12/19	12/20E	12/21E	12/22E	Balance sheet (Rmb mn)	12/19	12/20E	12/21E	12/22E
Total revenue	779.4	859.3	1,238.6	1,988.2	Cash & equivalents	93.9	491.3	507.4	361.3
Cost of goods sold	(540.8)	(592.9)	(841.8)	(1,318.1)	Accounts receivable	262.7	325.9	454.5	776.5
SG&A	(42.8)	(44.0)	(50.1)	(59.4)	Inventory	197.4	224.9	328.6	523.7
R&D	(54.0)	(57.7)	(69.3)	(85.2)	Other current assets	6.7	6.7	6.7	6.7
Other operating profit/(expense)	--	--	--	--	Total current assets	560.6	1,048.8	1,297.2	1,668.2
EBITDA	170.1	202.9	322.6	578.6	Net PP&E	244.7	257.4	287.9	347.4
Depreciation & amortization	(28.2)	(38.2)	(45.2)	(53.1)	Net intangibles	28.8	25.3	23.9	22.5
EBIT	141.8	164.7	277.4	525.5	Total investments	0.0	0.0	0.0	0.0
Interest income	0.2	3.4	4.9	5.1	Other long-term assets	28.4	28.4	28.4	28.4
Interest expense	(8.7)	(0.2)	0.0	0.0	Total assets	860.5	1,360.0	1,637.3	2,066.5
Income/(loss) from uncons. subs.	--	--	--	--	Accounts payable	95.2	99.7	186.2	268.8
Others	11.5	21.3	20.8	20.0	Short-term debt	85.1	--	--	--
Pretax profits	144.8	189.2	303.1	550.5	Other current liabilities	22.2	22.2	22.2	22.2
Income tax	(9.0)	(18.0)	(30.3)	(55.1)	Total current liabilities	202.6	122.0	208.5	291.0
Minorities	(0.5)	0.0	0.0	0.0	Long-term debt	--	--	--	--
Net income pre-preferred dividends	135.3	171.2	272.8	495.4	Other long-term liabilities	101.6	101.6	101.6	101.6
Preferred dividends	--	--	--	--	Other long-term liabilities	101.6	101.6	101.6	101.6
Net income (pre-exceptionals)	135.3	171.2	272.8	495.4	Total liabilities	304.1	223.5	310.0	392.6
Post-tax exceptionals	--	--	--	--	Preferred shares	--	--	--	--
Net income	135.3	171.2	272.8	495.4	Total common equity	559.7	1,139.7	1,330.6	1,677.2
EPS (basic, pre-except) (Rmb)	1.13	1.07	1.70	3.10	Minority interest	(3.3)	(3.3)	(3.3)	(3.2)
EPS (basic, post-except) (Rmb)	1.13	1.07	1.70	3.10	Total liabilities & equity	860.5	1,360.0	1,637.3	2,066.5
EPS (diluted, post-except) (Rmb)	1.13	1.07	1.70	3.10	BVPS (Rmb)	4.66	7.12	8.32	10.48
DPS (Rmb)	0.25	0.32	0.51	0.93					
Dividend payout ratio (%)	22.5	30.0	30.0	30.0					
Free cash flow yield (%)	NM	0.2	0.2	0.0					
Growth & margins (%)	12/19	12/20E	12/21E	12/22E	Ratios	12/19	12/20E	12/21E	12/22E
Sales growth	15.4	10.3	44.1	60.5	CROCI (%)	22.9	18.9	20.6	29.6
EBITDA growth	28.5	19.3	59.0	79.4	ROE - common equity (%)	27.2	20.2	22.1	32.9
EBIT growth	30.3	16.1	68.4	89.4	ROE - total shareholders' equity (%)	27.4	20.2	22.1	33.0
Net income growth	39.8	26.6	59.3	81.6	ROA (%)	17.1	15.4	18.2	26.8
EPS growth	39.5	(5.3)	59.3	81.6	Inventory days	115.4	130.0	120.0	118.0
Gross margin	30.6	31.0	32.0	33.7	Receivables days	111.5	125.0	115.0	113.0
EBITDA margin	21.8	23.6	26.0	29.1	Payable days	51.8	60.0	62.0	63.0
EBIT margin	18.2	19.2	22.4	26.4	Net debt/equity (%)	(1.6)	(43.2)	(38.2)	(21.6)
					Interest cover - EBIT (X)	16.5	NM	NM	NM
Cash flow statement (Rmb mn)	12/19	12/20E	12/21E	12/22E	Valuation	12/19	12/20E	12/21E	12/22E
Net income pre-preferred dividends	135.3	171.2	272.8	495.4	P/E (X)	NM	NM	155.2	85.5
D&A add-back	28.2	38.2	45.2	53.1	P/B (X)	NM	37.1	31.8	25.2
Minorities interests add-back	0.5	0.0	0.0	0.0	EV/EBITDA (X)	--	NM	129.7	72.5
Net (inc)/dec working capital	(65.0)	(86.3)	(145.7)	(434.5)	EV/GCI (X)	--	29.9	25.5	20.6
Other operating cash flow	(10.7)	--	--	--	Dividend yield (%)	NM	0.1	0.2	0.4
Cash flow from operations	88.3	123.2	172.3	114.1					
Capital expenditures	(49.5)	(49.5)	(74.2)	(111.3)					
Acquisitions	--	--	--	--					
Divestitures	--	--	--	--					
Others	0.4	--	--	--					
Cash flow from investments	(49.1)	(49.5)	(74.2)	(111.3)					
Dividends paid (common & pref)	(18.7)	(51.4)	(82.0)	(148.8)					
Inc/(dec) in debt	(7.5)	(85.1)	--	--					
Common stock issuance (repurchase)	0.6	459.5	--	--					
Other financing cash flows	(0.6)	0.8	--	--					
Cash flow from financing	(26.2)	323.7	(82.0)	(148.8)					
Total cash flow	13.0	397.4	16.1	(146.1)					

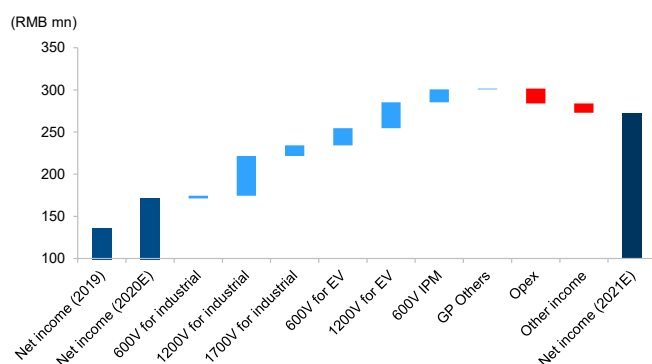
Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 47: StarPower Rev mix / GP mix / GM by products

	2019	2020E	2021E	2022E	2023E	2024E	2025E
Rev mix	100%	100%	100%	100%	100%	100%	100%
600V for industrial	5%	4%	4%	3%	2%	2%	1%
1200V for industrial	59%	58%	53%	44%	35%	28%	22%
1700V for industrial	10%	10%	9%	8%	7%	6%	5%
600V for EV	9%	9%	11%	11%	11%	11%	10%
1200V for EV	12%	12%	15%	16%	17%	18%	18%
600V IPM for home appliance	4%	4%	6%	8%	11%	14%	18%
≥3300V IGBT	0%	0%	0%	6%	10%	13%	16%
IGBT gate driver IC	0%	0%	0%	2%	3%	3%	4%
SiC	0%	0%	0%	0%	3%	4%	5%
Others	2%	2%	2%	1%	1%	1%	1%
GM	31%	31%	32%	34%	35%	36%	37%
600V for industrial	26%	26%	27%	27%	28%	29%	29%
1200V for industrial	27%	27%	28%	28%	29%	30%	30%
1700V for industrial	38%	38%	39%	39%	40%	41%	41%
600V for EV	37%	37%	38%	39%	39%	40%	40%
1200V for EV	38%	38%	39%	40%	40%	41%	41%
600V IPM for home appliance	34%	34%	35%	35%	36%	37%	37%
≥3300V IGBT	0%	0%	0%	39%	40%	40%	41%
IGBT gate driver IC	0%	0%	0%	38%	39%	39%	40%
SiC	0%	0%	0%	0%	0%	40%	41%
Others	32%	31%	32%	32%	33%	33%	34%
GP mix	100%	100%	100%	100%	100%	100%	100%
600V for industrial	4%	4%	3%	3%	2%	1%	1%
1200V for industrial	52%	51%	46%	37%	29%	23%	18%
1700V for industrial	12%	12%	11%	9%	7%	6%	5%
600V for EV	11%	11%	13%	13%	12%	12%	11%
1200V for EV	15%	15%	18%	19%	19%	20%	19%
600V IPM for home appliance	4%	4%	7%	8%	11%	14%	18%
≥3300V IGBT	0%	0%	0%	7%	11%	15%	17%
IGBT gate driver IC	0%	0%	0%	3%	4%	4%	4%
SiC	0%	0%	0%	0%	0%	4%	6%
Others	2%	2%	2%	1%	1%	1%	0%

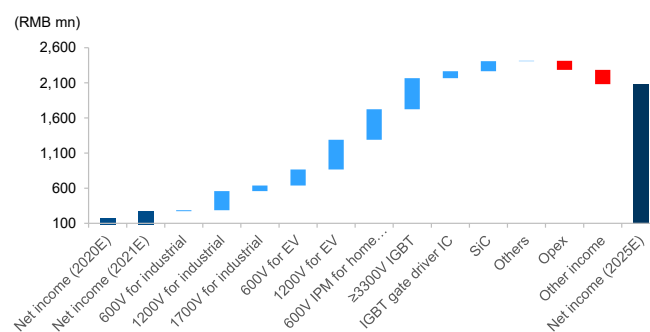
Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 48: Waterfall chart, 2020-21E



Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 49: Waterfall chart, 2021-25E



Source: Goldman Sachs Global Investment Research, Gao Hua Securities Research

Wingtech

Exhibit 50: Wingtech financials

Income statement (Rmb mn)	12/19	12/20E	12/21E	12/22E	Balance sheet (Rmb mn)	12/19	12/20E	12/21E	12/22E
Total revenue	41,578.2	68,088.5	91,522.5	91,389.4	Cash & equivalents	7,714.2	7,644.3	8,920.7	15,968.7
Cost of goods sold	(37,286.2)	(59,399.9)	(79,727.6)	(78,827.1)	Accounts receivable	14,022.0	9,109.5	21,732.3	8,814.3
SG&A	(1,098.9)	(2,081.3)	(2,785.0)	(2,650.3)	Inventory	5,677.8	7,341.4	10,351.6	7,357.5
R&D	(1,319.6)	(2,140.7)	(2,837.2)	(2,833.1)	Other current assets	3,409.5	3,409.5	3,409.5	3,409.5
Other operating profit/(expense)	(74.0)	(139.1)	(182.6)	(181.5)	Total current assets	30,823.5	27,504.7	44,414.1	35,550.0
EBITDA	2,367.2	7,195.4	9,329.3	10,528.4	Net PP&E	5,118.5	5,232.6	5,814.6	6,102.0
Depreciation & amortization	(567.8)	(2,868.0)	(3,339.2)	(3,630.9)	Net intangibles	4,075.3	4,117.8	4,157.5	4,194.8
EBIT	1,799.4	4,327.5	5,990.1	6,897.5	Total investments	42.3	42.3	42.3	42.3
Interest income	40.6	128.8	160.5	187.3	Other long-term assets	25,072.1	25,072.1	25,072.1	25,072.1
Interest expense	(574.5)	(825.7)	(691.2)	(691.2)	Total assets	65,131.8	61,969.6	79,500.7	70,961.3
Income/(loss) from uncons. subs.	563.6	0.6	--	--	Accounts payable	15,828.9	12,162.3	25,189.5	11,524.5
Others	(356.1)	88.9	0.0	0.0	Short-term debt	4,726.6	2,009.0	2,009.0	2,009.0
Pretax profits	1,473.1	3,720.0	5,459.4	6,393.6	Other current liabilities	10,513.4	10,754.3	10,973.5	11,086.6
Income tax	(93.8)	(436.3)	(545.9)	(639.4)	Total current liabilities	31,068.9	24,925.6	38,172.0	24,620.1
Minorities	(125.8)	(239.2)	(239.2)	(239.2)	Long-term debt	11,306.0	11,412.8	11,412.8	11,412.8
Net income pre-preferred dividends	1,253.6	3,044.5	4,674.2	5,515.0	Other long-term liabilities	1,335.0	1,335.0	1,335.0	1,335.0
Preferred dividends	--	--	--	--	Total long-term liabilities	12,640.9	12,747.7	12,747.7	12,747.7
Net income (pre-exceptionals)	1,253.6	3,044.5	4,674.2	5,515.0	Total liabilities	43,709.8	37,673.4	50,919.7	37,367.8
Post-tax exceptionals	--	--	--	--	Preferred shares	--	--	--	--
Net income	1,253.6	3,044.5	4,674.2	5,515.0	Total common equity	21,189.4	23,824.4	27,869.9	32,643.2
EPS (basic, pre-exception) (Rmb)	1.48	2.71	4.16	4.91	Minority interest	232.6	471.8	711.0	950.3
EPS (basic, post-exception) (Rmb)	1.48	2.71	4.16	4.91	Total liabilities & equity	65,131.8	61,969.6	79,500.7	70,961.3
EPS (diluted, post-exception) (Rmb)	1.48	2.71	4.16	4.91	BVPS (Rmb)	24.94	21.20	24.79	29.04
DPS (Rmb)	0.20	0.36	0.56	0.66					
Dividend payout ratio (%)	13.5	13.5	13.5	13.5					
Free cash flow yield (%)	8.8	1.7	1.1	4.4					
Growth & margins (%)	12/19	12/20E	12/21E	12/22E	Ratios	12/19	12/20E	12/21E	12/22E
Sales growth	139.8	63.8	34.4	(0.1)	CROCI (%)	84.3	153.4	78.7	51.2
EBITDA growth	286.0	204.0	29.7	12.9	ROE - common equity (%)	10.1	13.5	18.1	18.2
EBIT growth	444.1	140.5	38.4	15.1	ROE - total shareholders' equity (%)	10.0	13.3	17.7	17.7
Net income growth	NM	142.9	53.5	18.0	ROA (%)	3.1	4.8	6.6	7.3
EPS growth	1,441.2	83.5	53.5	18.0	Inventory days	35.7	40.0	40.5	41.0
Gross margin	10.3	12.8	12.9	13.7	Receivables days	83.9	62.0	61.5	61.0
EBITDA margin	5.7	10.6	10.2	11.5	Payable days	106.8	86.0	85.5	85.0
EBIT margin	4.3	6.4	6.5	7.5	Net debt/equity (%)	38.8	23.8	15.7	(7.6)
					Interest cover - EBIT (X)	3.4	6.2	11.3	13.7
Cash flow statement (Rmb mn)	12/19	12/20E	12/21E	12/22E	Valuation	12/19	12/20E	12/21E	12/22E
Net income pre-preferred dividends	1,253.6	3,044.5	4,674.2	5,515.0	P/E (X)	33.1	59.1	38.5	32.6
D&A add-back	567.8	2,868.0	3,339.2	3,630.9	P/B (X)	2.0	7.6	6.5	5.5
Minorities interests add-back	125.8	239.2	239.2	239.2	EV/EBITDA (X)	21.1	25.9	19.8	16.9
Net (inc)/dec working capital	(3,138.7)	(417.7)	(2,605.9)	2,247.1	EV/GCI (X)	32.5	25.6	12.4	7.6
Other operating cash flow	5,811.6	(1.0)	--	--	Dividend yield (%)	0.4	0.2	0.3	0.4
Cash flow from operations	4,620.0	5,733.0	5,646.8	11,632.3					
Capital expenditures	(965.4)	(2,723.5)	(3,660.9)	(3,655.6)					
Acquisitions	--	--	--	--					
Divestitures	1,101.6	--	--	--					
Others	(12,440.7)	(300.0)	(300.0)	(300.0)					
Cash flow from investments	(12,304.4)	(3,023.5)	(3,960.9)	(3,955.6)					
Dividends paid (common & pref)	(405.8)	(168.6)	(409.5)	(628.7)					
Inc/(dec) in debt	13,909.4	(2,610.8)	--	--					
Common stock issuance (repurchase)	16,373.9	--	--	--					
Other financing cash flows	(16,382.2)	--	--	--					
Cash flow from financing	13,495.4	(2,779.4)	(409.5)	(628.7)					
Total cash flow	5,811.0	(69.9)	1,276.4	7,048.0					

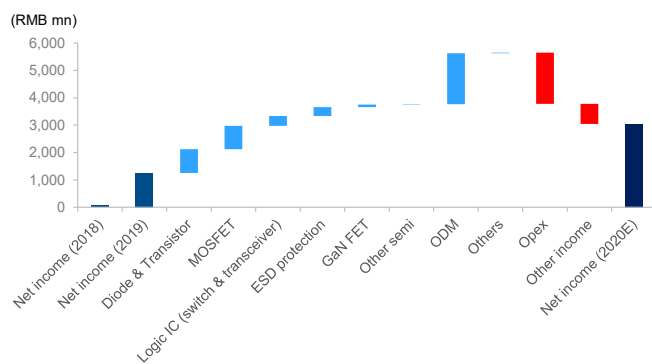
Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 51: Wingtech Rev mix / GP mix / GM by products

	2019	2020E	2021E	2022E	2023E	2024E	2025E
Rev mix	100%	100%	100%	100%	100%	100%	100%
Diode & Transistor	2%	6%	5%	5%	7%	9%	15%
MOSFET	1%	5%	5%	8%	12%	16%	28%
Logic IC (switch & transceiver)	1%	2%	2%	2%	2%	3%	5%
ESD protection	1%	2%	2%	2%	2%	3%	4%
GaN FET	0%	0%	1%	1%	2%	4%	7%
SiC	0%	0%	0%	0%	0%	0%	1%
PMIC	0%	0%	0%	0%	0%	2%	4%
Other semi	0%	0%	0%	0%	0%	0%	0%
ODM	96%	85%	85%	81%	74%	64%	36%
Others	0%	0%	0%	0%	0%	0%	0%
GP mix	10%	13%	13%	14%	15%	17%	24%
Diode & Transistor	27%	27%	30%	30%	30%	30%	31%
MOSFET	29%	30%	30%	30%	30%	30%	31%
Logic IC (switch & transceiver)	27%	28%	30%	30%	30%	30%	31%
ESD protection	27%	28%	30%	30%	30%	30%	31%
GaN FET	40%	40%	40%	40%	40%	40%	40%
SiC	0%	0%	0%	0%	40%	40%	40%
PMIC	0%	0%	0%	0%	33%	33%	33%
Other semi	27%	26%	27%	28%	28%	28%	28%
ODM	9%	10%	10%	10%	9%	9%	9%
Others	63%	63%	63%	63%	63%	63%	63%
GP mix	100%	100%	100%	100%	100%	100%	100%
Diode & Transistor	4%	12%	11%	12%	15%	16%	20%
MOSFET	3%	11%	13%	18%	23%	28%	36%
Logic IC (switch & transceiver)	2%	5%	5%	5%	5%	5%	6%
ESD protection	2%	5%	4%	4%	4%	4%	5%
GaN FET	0%	1%	2%	4%	6%	8%	12%
SiC	0%	0%	0%	0%	0%	1%	1%
PMIC	0%	0%	0%	0%	1%	4%	6%
Other semi	0%	0%	0%	0%	0%	0%	0%
ODM	87%	64%	64%	56%	45%	34%	12%
Others	3%	2%	1%	1%	1%	1%	1%

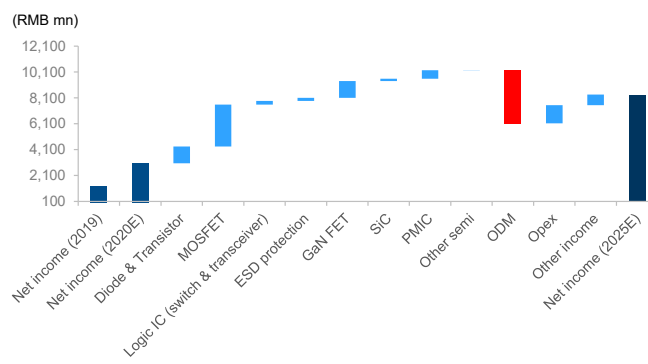
Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 52: Waterfall chart for 2019-20E



Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 53: Waterfall chart for 2020-25E



Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Power Semiconductors: US\$41bn TAM, positive on IGBT and MOSFET

Bottom line: We are positive on IGBT and MOSFET markets within the power semiconductor space on (1) growing demand driven by increasing energy efficiency demand in China, (2) large Chinese brand customers with high demand while local supply remains limited, and (3) being early beneficiaries within the semiconductor market as Chinese brand customers more willing to diversify suppliers given lower costs and Chinese suppliers' improving technology capabilities and product offerings.

Buy StarPower (IGBT design house), **CR Micro** (IDM in MOSFET), **Silan** (IDM in MOSFET), **Wingtech** (Automotive MOSFET, merged Nexperia), with c.55% EPS CAGR in 2020-25E on average.

What are Power semiconductors?

A power semiconductor device is used as a switch (controlling power on or off) or rectifier (converting AC to DC) in power electronics, for example, in frequency conversion home appliance, EVs, EV chargers, welding inverter, industrial robots, etc. As of 2019, Power semiconductors was a US\$41bn global market, or c.10% of global semiconductor market size.

Power semiconductors could be divided into two parts: (1) Power discrete and (2) Power IC, with each parts roughly contributing 50% of the power semiconductors market size by revenue. When a power semiconductor device is in the form of integrated circuit, it is called Power IC, otherwise referred to as a power discrete.

Power discrete includes three main products:

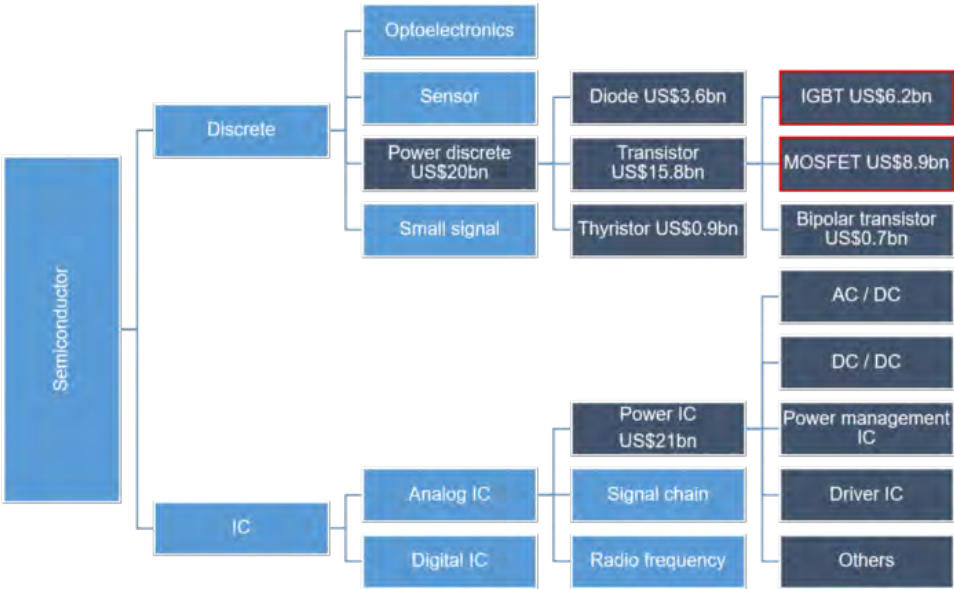
- **Transistor (~80% of power discrete market):** A transistor is a semiconductor device with three connections, capable of amplification in addition to rectification. The transistor includes three types of products: (1) **MOSFET (56% of transistor):** a metal-oxide-semiconductor field-effect transistor where the voltage determines its conductivity, used for switching or amplifying signals. (2) **IGBT (39% of transistor):** an insulated gate bipolar transistor is a fusion between a BJT (bipolar junction transistor) and MOSFET, used in very high current applications, such as industrial automobile power train, with voltage up to 6500V vs. 900V of MOSFET. (3) **Bipolar transistor (5% of transistor):** a semiconductor device used to amplify analog or digital signals, or to switch DC or function as an oscillator, which converts DC to an alternating waveform with desired frequency.
- **Diode (18% of power discrete market):** an electrical component that allows the flow of current in only one direction, acting as a one-way switch for the current.
- **Thyristor (2% of power discrete market):** a semiconductor device for high-power switching applications without the function of amplification.

Power ICs include various types and below we list four types as examples:

- **AC / DC:** convert AC (alternating current, an electric current which periodically reverses direction) to DC (direct current, an electric current which flows only in one direction).

- **DC / DC:** convert DC from one voltage level to another.
- **Power management IC:** controls power to enable various functions, such as battery charging and management, power source selection, power rail sequencing, power rail ramp up / down timing, etc.
- **Driver IC:** a circuit component used to control another circuits or components. Take LED driver IC for example - It transfers the AC voltage into a constant power supply with a defined voltage and current, to enable the LED device to produce stable light.

Exhibit 54: Global power semi TAM US\$41bn



Source: Goldman Sachs Global Investment Research, Gao Hua Securities Research

Why are we positive on IGBT and MOSFET?

Power semiconductors is a US\$41bn market globally, and within this market, we are positive on (1) IGBT, which makes up 15% of power semiconductor market revenue, and (2) MOSFET, 22%, given the growing market driven by (1) rising energy efficiency requirement in multiple applications such as EV, industrial control, and home appliances, and (2) the rising demand for Chinese suppliers driven by a large domestic market and multiple Chinese brands in home appliances, automobiles and industrial look to diversify their supply chains amid growing trade tensions.

IGBT vs MOSFET

Both IGBT and MOSFET are core components in electronic devices, which serve as power switches to convert the current from disordered voltage/frequency into specific electrical parameters through a series of conversion and modulation. IGBT is typically used in high power (100W-10MW) and high voltage (up to 6500V) applications such as industrial and automobile powertrain, while MOSFET is mainly used in low power (below 1kW) and low-voltage (20-900V) applications such as consumer electronics and non-powertrain in automobiles.

Other Not Covered/private Chinese power semi suppliers**Peri (300831.SZ, NC)**

Peri provides high-power IGBT switching power supply (380v), used in chemical, copper foil, electroplating and welding. These fields require high current and low voltage. By product mix, it mainly offers thyristor for high voltage DC valves (80% of 2019 rev), common electronic (15%), and other device (5%, incl.IGBT).

The company IPOd on the Shenzhen Stock Exchange in May, 2020. According to Peri, the IPO proceeds will mainly support its high-power power semiconductor device and new power device industrialization project (investment amount at RMB570.3 mn). The project aims to develop high-power power semiconductor devices and SiC devices. For 1H20, the company guided revenue to range from RMB104 -105mn, or down 14-15% YoY. The company also guided net income of RMB29 -36mn, or up 0.3%-22% YoY.

Sino Micro (600360.SS, NC)

According to the company, its 360V-1350V Trench-FS IGBT platform has completed developing a full range of products, and is expanding into new energy vehicles, inverter home appliances, industrial and photovoltaic applications. It also has multiple power semiconductor wafer production lines of 4", 5", and 6". In 2019, the production capacity of wafers of various sizes was at 4mn pieces/year. By product mix, it mainly offers semiconductor discrete devices (96% of 2019 revenue).

It has started the construction of an 8" production line since 2017, with the planned capacity of 960k pieces/year. It is also actively developing 3rd-generation semiconductor device of SiC and GaN. For super junction MOSFET, it completed developing 600V-800V super junction MOS product series, continuing to expand in TV, industrial power supply fields. For IGBT, it is expanding the share of IGBT products in white goods, industrial inverters and UPS applications.

Yangjie (300373.SZ, NC)

It develops IGBTs with 50A/75A/100A-1200V half-bridge specifications. It has expanded into consumer electronics, and, according to the company, its current key initiative is to develop into the industrial inverter, servo motors and security applications markets, as well as high-end markets such as network, photovoltaic micro-inverters and automotive electronics. Meanwhile, it is also involved in the designing of high-voltage SiC products. The company continues to expand the R&D efforts in 8" MOS products. Trench MOSFET and SGT MOS series products have contributed largely to its sales. It has also signed a strategic cooperation agreement with SMIC, which, per the company, was to ensure it has sufficient foundry capacity resources. The company has launched a variety of 6" high-voltage MOSFETs and 8" medium and low-voltage MOSFET products. The company's MOSFET annual revenue was over RMB 100 million in 2019, and it has also entered the downstream fields of 5G, AC-DC fast charging, security, and automotive electronics. By product mix, it mainly offers semiconductor devices (80% of 2019 rev), followed by chips (14%), wafer and others (6%).

The company notes it is actively developing SiC devices, and is also in the certification process for some key clients. It has developed high-performance Trench FS IGBT chip, and has gradually realized a mass production scale. For shielded trench MOS SGTN150V (5th generation technology), production is expected in 2H20, per the company. For shielded trench MOS SGTN100V (5th generation technology), the wafer has been successfully developed and is switching to mass production.

Jiejie (300623.SZ, NC)

The company specializes in R&D, design, production and sales of power semiconductor chips and devices. It uses IDM model, with products mainly used in home appliances, leakage circuit, power modules, as well as lightning protection, communication networks and automotive electronics, etc. By product mix, it mainly offers semiconductor devices (74% of 2019 revenue), followed by chips (23%), and others (2%).

The company aims to further strengthen its production lines and production capacity and product planning, developing thyristors (IDM), diode chips and devices, FRD (IDM), MOSFET (Fabless+OSAT→IDM), IGBT (Fabless+OSAT→IDM). It plans to accelerate the development of SiC, GaN devices, and enter into new energy vehicles, 5G, mobile phone fast charging, tablet computers, intelligent monitoring and other power supply applications.

GoodArk (002079.SZ, NC)

The company's main products include automotive rectifier diodes, power modules, rectifier diode chips, silicon rectifier diodes, switching diodes, zener diodes, discrete device products, etc. The company offers more than 50 series and more than 3000 varieties. Products are widely used in 5G, aerospace, power electronics, consumer electronics, security, industrial control, automotive electronics, green lighting, new energy, and power equipment. By product mix, it mainly offers integrated circuits (13% of 2019 revenue), along with discrete devices (38%), sensors (0.04%), new energy materials (49%).

NCE Power (private)

The company's main business is the R&D, design and sales of semiconductor power devices such as MOSFETs and IGBTs. It is one of the leading suppliers of shielded gate power MOSFETs and super junction power MOSFETs. Its products are widely used in consumer electronics, automotive electronics, industrial electronics, new energy vehicles/charging piles, smart equipment manufacturing, Internet of Things, photovoltaic and other fields. By product mix, it mainly offers power semi chips (27% of 1H19 revenue) and power semi devices (73%).

As of 2019, its main customers included Wuxi Jinghui Electronics (motor), Guangdong Ketong Electronics (semi manufacturing), Suzhou Industrial Park Southeast Technology (distributor), Shenzhen Gaosibao Electrical (ODM), Cansun Industrial (LED), Xuzhou Keya (controller).

Future projects such as: 1) "Ultra-low energy consumption and high reliability semiconductor power device R&D, upgrade and industrialization" project (investment amount at RMB 481mn), 2) "Construction of power device packaging and testing line" project (investment amount at RMB 320mn), 3) "SiC wide - band gap semiconductor power devices" project (investment amount at RMB 114mn).

Power semiconductors - China vs. global suppliers: We compare the key power semiconductor Chinese suppliers vs. the global peers and note that the global market share for Chinese suppliers is much smaller at less than 3% in 2018 vs. global peers up to 35% global market share. Chinese suppliers' scale in revenues, R&D spending and number of employee was also much smaller than global peers (90-95% smaller on average). Wingtech, which acquired Nexperia in late 2019, is the largest among Chinese peers, with revenues scale around 2x larger on average, and number of employees at around 1.5x its Chinese peers. With an overall slowdown in the semiconductor market, suppliers across China and globally saw slower revenue growth in 2019; however, StarPower still outpaced the market at +11% YoY and +25% YoY in operating income. On profitability, Chinese peers are still lower than global peers, and we see further upside for Chinese suppliers from product mix upgrades.

Exhibit 55: Power Semi China vs. global peers



Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

IGBT: Intro, TAM, Competitive Landscape, Stock Ideas



Bottom line: IGBTs (insulated-gate bipolar transistors) represent the key product area in the power semiconductor sector. The market for IGBTs is growing on the back of specification upgrades, driven by green / energy-saving requirements across various applications (vehicles, home appliances, industrial controls). We forecast the global IGBT TAM to grow at an 8% CAGR in 2020-25E to US\$10.3bn, with China's IGBT TAM growing at 7% CAGR in 2020-25E to US\$3.6bn. Within this report, we initiate coverage on a leading IGBT pure-play company in China, Starpower, with a Buy rating and add to our regional Conviction List.

IGBT intro

What are IGBTs?

IGBTs (insulated gate bipolar transistors) are found mainly in the power electronics applications that are part of nearly every electronic device, from Electric Vehicles (EVs) and home appliances, all the way up to large-scale power transmission systems that connect electrical grids. Specifically, an IGBT is a three-terminal power-semiconductor device, which combines the insulated gate technology of the MOSFET (metal-oxide-semiconductor field-effect transistor) with the output performance characteristics of a conventional BJT (bipolar junction transistors which act as electronic switches or signal amplifiers). IGBTs have the advantages of high-input impedance and high switching speeds of MOSFETs, as well as the low on-resistance and low saturation voltage of a BJT. IGBTs are mainly used in large-current environments and can withstand high-voltage applications, such as converter systems with DC voltage of 600V and above, motors, frequency converters, switching power supplies, traction drives, etc.

Discrete IGBT chips vs. IGBT modules vs IPMs

IGBTs come in three formats: discrete IGBT chips, IGBT modules, and IPMs (Intelligent Power Modules). In 2018, IGBT modules accounted for 52% of the IGBT market, followed by IPMs at 27%, and discrete IGBT chips at 21%. Discrete IGBT chips are mainly used in applications with power requirements of <1kW and voltage requirements of 600-1700V, while IGBT modules are mainly used in applications with power requirements of 1kW~10MW and voltage requirements of 600-6500V.

An IGBT module integrates several IGBT chips (usually six) into one module by assembling multiple chips on a metal substrate and packaging with insulation materials such as silicone grease. The IGBT module enables higher current levels, reduces the complexity of external circuit connections, improves reliability, and ensures better parameter consistency within a module. IGBT modules are widely adopted in high-voltage applications.

An IPM integrates an IGBT chip, a drive circuit, a protection circuit, and a control unit into one module. Key advantages of IPM modules over discrete IGBT solutions are lower costs in terms of design, development, and manufacturing, as well as better system performance and reliability. IPM modules also reduce time-to-market and reduce the number of components that customers need to purchase, store, and assemble. With the integration of protection circuits, the IPM can protect itself in fault situations.

IGBT technology trends

Thus far, there have been seven generations of IGBT. IGBT4 is currently the most widely used IGBT chip technology, with voltage of 600V, 1200V, 1700V, and currents ranging from 10A to 3600A. For higher voltage IGBTs (3300V, 4500V, 6500V), the mainstream products still use IGBT3 technology. Most local/domestic IGBT suppliers already have capabilities in IGBT4 technology, but they still lag behind global peers in IGBT5-7 technologies, which have better performance such as higher current density, lower switching losses, and better reliability.

Exhibit 56: IGBT technology roadmap

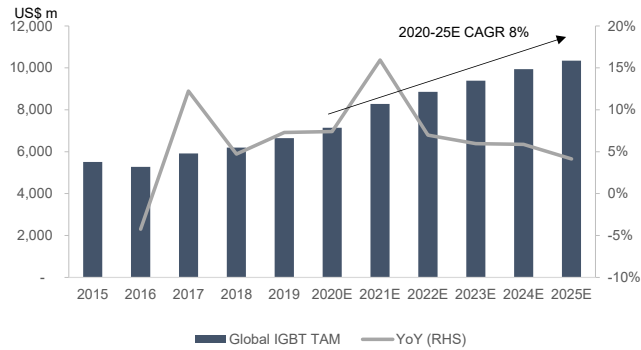
Tech Generation	IGBT 1/2 Non Punch Through	IGBT3 Trench+Field-Stop	IGBT4 Trench+Field-Stop	IGBT5 Trench+Field-Stop III	IGBT6 TrenchStop	IGBT7
Infineon	1990-1997		2000-2006	2012		2018
Fuji	1997	2002	2008	2014		2017
StarPower	2011		2015			2022E
CR Micro			2019			
Silan				2020		
BYDE	2009-2012		2017			
CRRC	2011		2017			
China players gap vs. global	>10 years	>10 years		< 10 years		< 5 years

Source: Company data, compiled by Goldman Sachs Global Investment Research and Gao Hua Securities Research

IGBT TAM

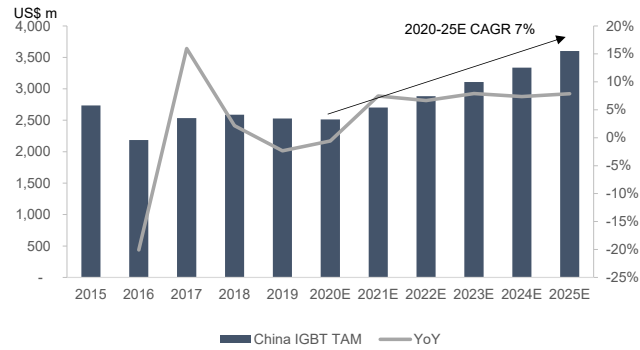
Based on our proprietary TAM model, we forecast revenues for the global IGBT market to grow at an 8% CAGR and China’s IGBT market to grow at a 7% CAGR in 2020-25E. By applications, we expect automotives will enjoy the strongest growth in both the global (15% CAGR) and China (19% CAGR) markets, thanks to the rising penetration of electric vehicles, which have higher IGBT content than a typical ICE car. Industrial controls, EV charging piles, and consumer electronics are also key areas for IGBT and these applications should see sales volume growth at a 5-7% CAGR in 2020-25E in both the global and China markets. In terms of revenue mix, industrial controls, consumer electronics, and power generation are three key applications, each contributing 20-25% of the overall IGBT market in 2020E.

Exhibit 57: Global IGBT TAM



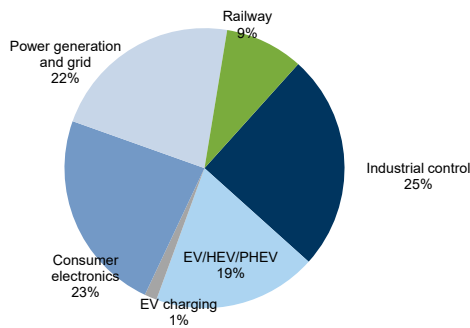
Source: Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 58: China IGBT TAM



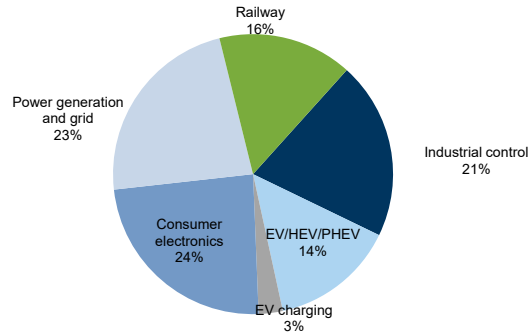
Source: Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 59: Global IGBT TAM by applications, 2020E



Source: Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 60: China IGBT TAM by applications, 2020E



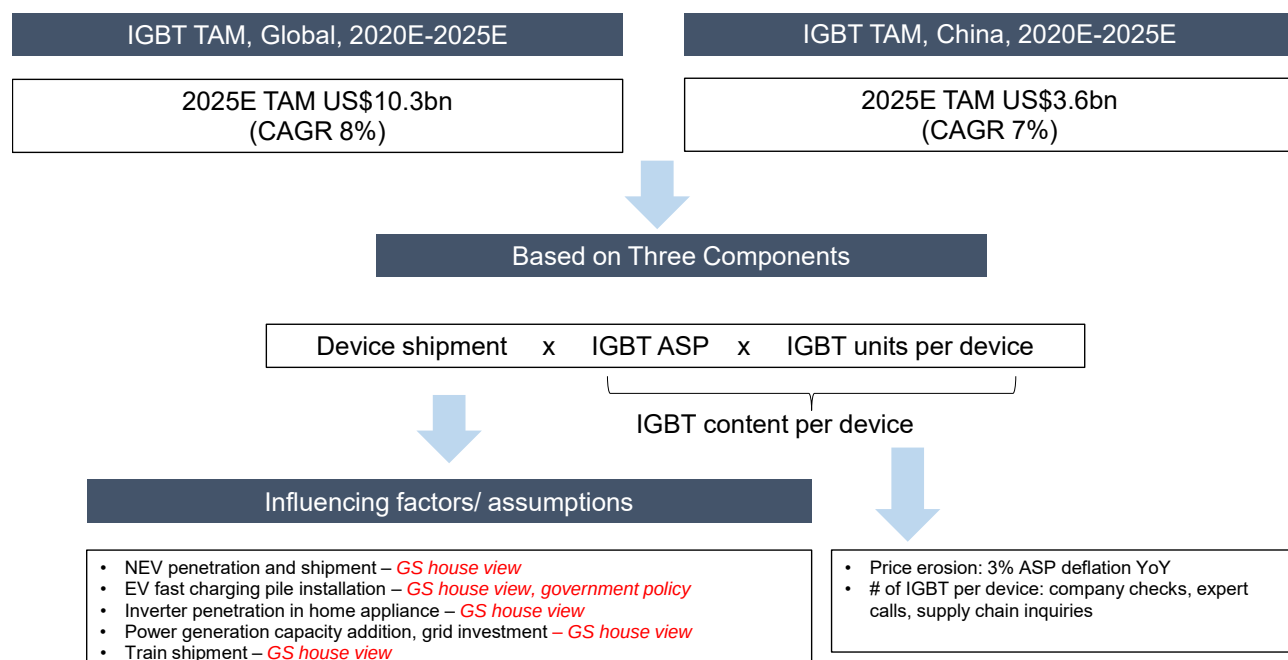
Source: Goldman Sachs Global Investment Research, Gao Hua Securities Research

IGBT TAM methodology

We form our IGBT TAM model based on three key components: device shipments, IGBT ASPs, and IGBT units per device. On device shipments, we divide them into six applications (industrial controls, automotive, EV charging piles, consumer electronics, power generation/grids, and railway/trains) with 21 end-products/systems including industrial motor drives (for the control of fans, pumps, and compressors, etc.) industrial robots, welding inverters, EV, PHEV, 48v/HEV, air conditioners, refrigerators, washing

machines, etc. We base our device shipment assumptions on supply chain checks and also refer to our house view for certain areas such as NEV penetration and shipments, home appliance shipments, power generation capacity additions, etc. For IGBT ASPs/ASP deflation and units per device, we base our assumptions on our supply chain checks with IGBT suppliers, distributors, and customers.

Exhibit 61: Our IGBT TAM approach



Source: Goldman Sachs Global Investment Research, Gao Hua Securities Research

IGBT market growth by applications

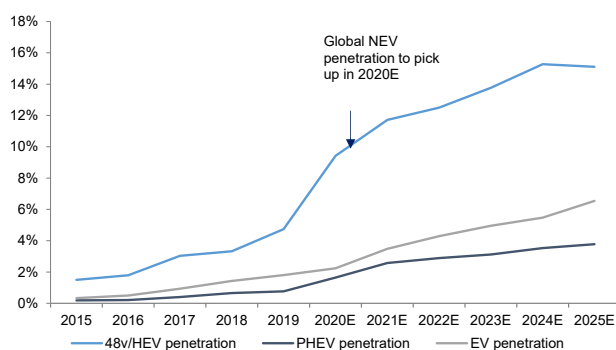
Automotives as the strongest growth driver: +15% CAGR in 2020-25E driven by EV penetration

We expect automotive applications to contribute 19% of global IGBT market revenue in 2020E, and we forecast these revenues to grow at a +15% CAGR from US\$1.4bn in 2020E to US\$2.8bn in 2025E, which is the strongest growth among all applications in the IGBT market. In China's IGBT market, we expect automotive applications to account for 14% of revenue in 2020E, and we model a +19% revenue CAGR from US\$362m in 2020E to US\$873m in 2025E. We expect this growth to be driven by growing EV penetration, in areas such as EVs (electric vehicles), PHEV (plug-in hybrid), and 48v HEV (hybrid) which consume IGBT content of US\$308, \$269, \$79 per vehicle, respectively, versus a traditional ICE car which typically does not use IGBTs. We assume EV/PHEV/48v HEV penetration (as a % of total vehicles) to increase from 13% in 2020E to 25% in 2025E globally, and from 7% to 25% in China over the same period. In a basic EV, IGBTs are used in the main inverter, DC-DC converter, on-board chargers, high-voltage heaters, and auxiliary inverters. These applications mainly utilize 600-750V IGBTs and to a lesser extent 400V/1200V IGBTs. IGBT modules are used in inverters and DC-DC converters while discrete IGBTs are used in industrial motor drives, air

conditioners/HVAC (heating, ventilation, air conditioning), PTC (positive temperature coefficient) heaters, DC-DC converters, and on-board chargers.

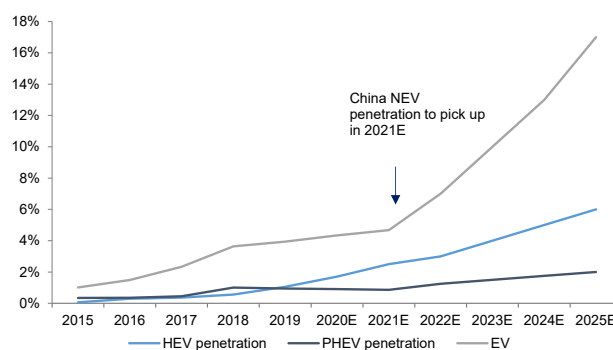
Notably, for some high-end, full EV models, we see a growing trend toward the use of SiCs (silicon carbide semiconductors) instead of IGBTs, given the advantages of SiC's with their higher power density and better efficiency. However, given the higher cost of SiCs, we believe they will only be used in high-end full EVs in the next five years. In our IGBT TAM model, we assume IGBT market share in full EVs will decline from 84% in 2020E to 55% in 2025E, while we model SiC market share increasing from 16% to 45%. If the penetration of SiCs increases faster/slower than our expectations, there could be downside/upside to our IGBT TAM forecast.

Exhibit 62: Global NEV penetration



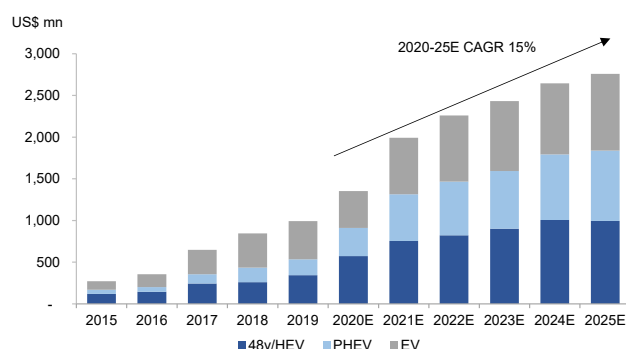
Source: Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 63: China NEV penetration



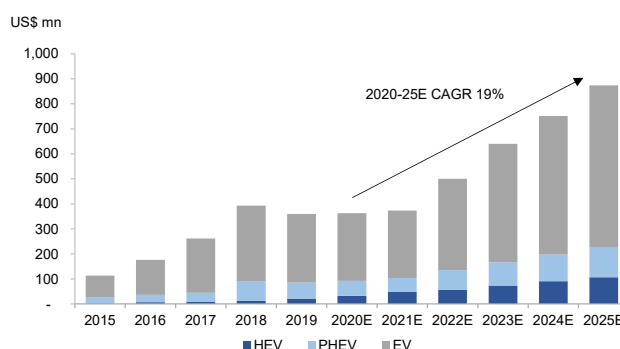
Source: Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 64: Global IGBT demand from xEV growing at 15% CAGR in 2020-25E



Source: Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 65: China's IGBT demand from EVs is mainly driven by full EV growth



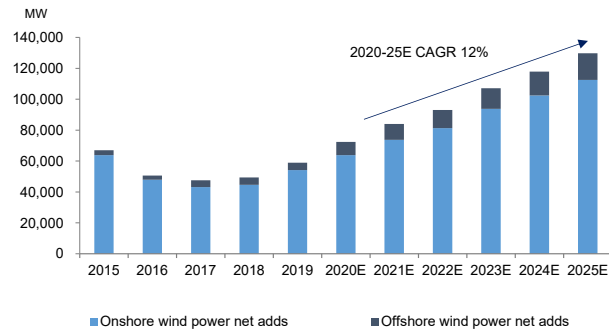
Source: Goldman Sachs Global Investment Research, Gao Hua Securities Research

Power generation and grid: +7% CAGR in 2020-25E driven by solar and wind power

We expect power generation and grid applications to contribute 22% of global IGBT market revenue in 2020E, and we forecast revenues to grow at a +7% CAGR from US\$1.6bn in 2020E to US\$2.3bn in 2025E, which would make this area the second largest revenue growth driver for the global IGBT market over the next five years. In China's IGBT market, we expect power generation and grid applications to account for 23% of revenue in 2020E, and we model +4% revenue CAGR from US\$576m in 2020E

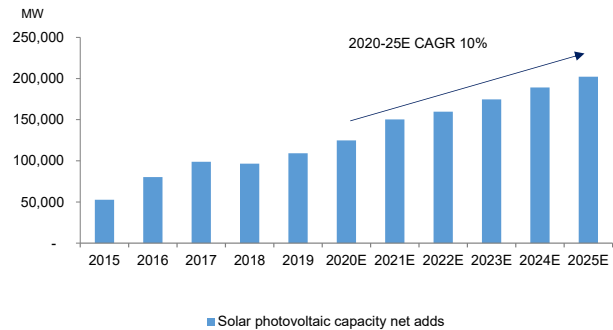
to US\$691m in 2025E. Key growth drivers are likely to be wind power and solar power capacity additions, which we expect to grow at +12%/+10% CAGR in 2020-25E globally. Wind power systems use IGBTs ranging from 1200-3300V with IGBT content per MW of capacity at US\$9,000. Solar PV inverters use IGBTs ranging from 1200-1700V with IGBT content per MW of capacity at US\$7,000.

Exhibit 66: Global wind power capacity net additions: 12% CAGR



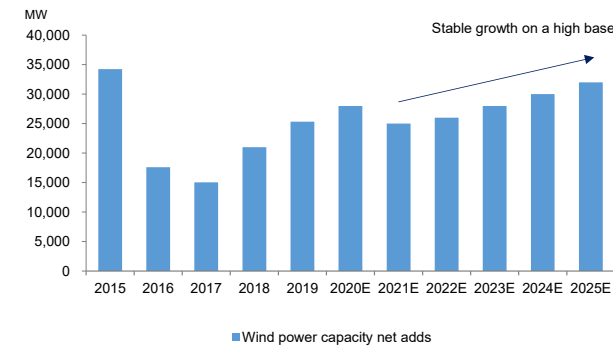
Source: Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 67: Global PV capacity addition: growing at 10% CAGR



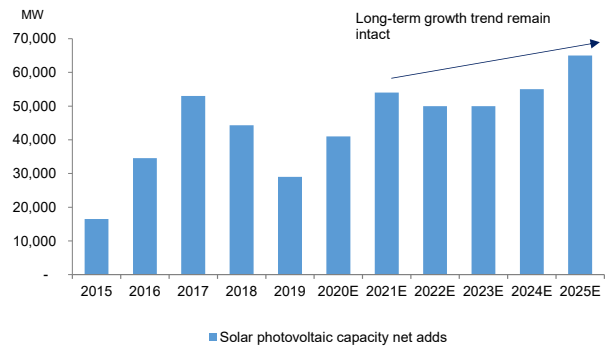
Source: Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 68: China's wind power capacity addition makes up c.40% of global capacity



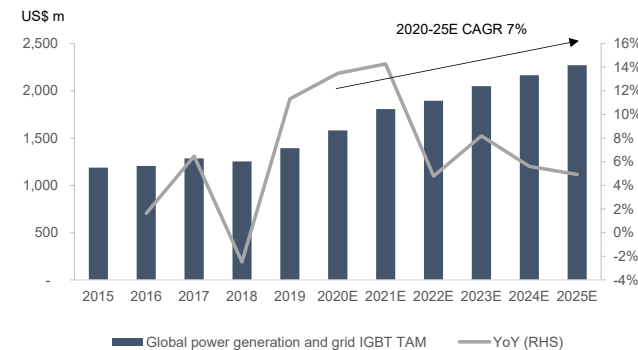
Source: Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 69: China PV capacity additions make up 33% of global capacity



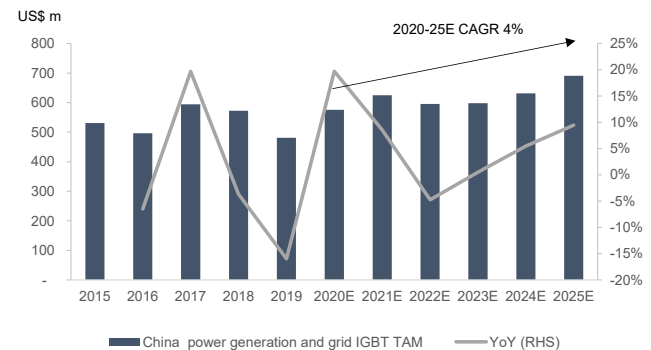
Source: Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 70: Global power generation and grid IGBT TAM



Source: Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 71: China power generation and grid IGBT TAM

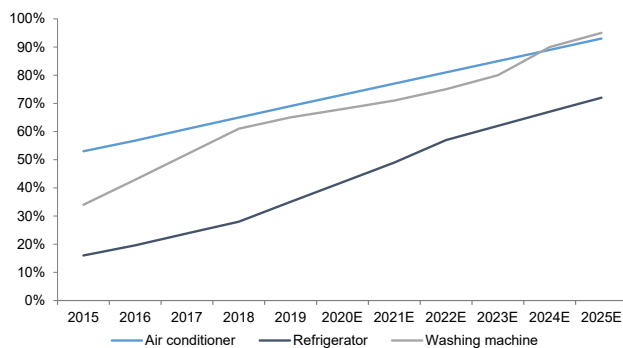


Source: Goldman Sachs Global Investment Research, Gao Hua Securities Research

Consumer electronics: +5% CAGR in 2020-25E driven by invertization of home appliances

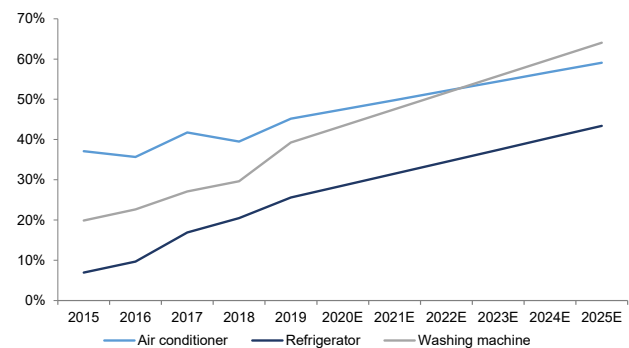
Consumer electronics applications contribute 23% of global IGBT market revenue in 2020E, and we expect this market to grow at +5% revenue CAGR from US\$1.7bn in 2020E to US\$2.2bn in 2025E, which would make this area the third largest revenue growth driver in the global IGBT market. In China's IGBT market, we expect consumer electronics applications to account for 24% of revenue in 2020E, and we model a +7% revenue CAGR from US\$600m in 2020E to US\$823m in 2025E, which would make this area the second largest revenue growth contributor for China's IGBT market. The growing penetration of inverter-based air conditioners, refrigerators, and washing machines should be the key growth drivers. Inverter-based home appliances are more energy efficient, and IPMs are the key components for inverters inside home appliances, providing smaller insertion loss and protecting the appliance from short-circuit. A typical inverter air conditioner uses three IPMs (US\$8 of content per A/C unit) for compressor motors, outdoor fans, and indoor fans. A typical inverter refrigerator uses one IPM (US\$2 of content per refrigerator) for compressor motors while an average inverter washing machine uses up to two IPMs (US\$3 of content per machine) for drum controls and the drain pump.

Exhibit 72: Global inverter penetration in home appliances



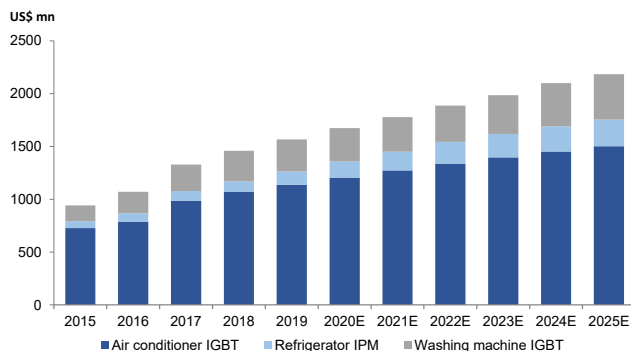
Source: Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 73: China's inverter penetration in home appliances



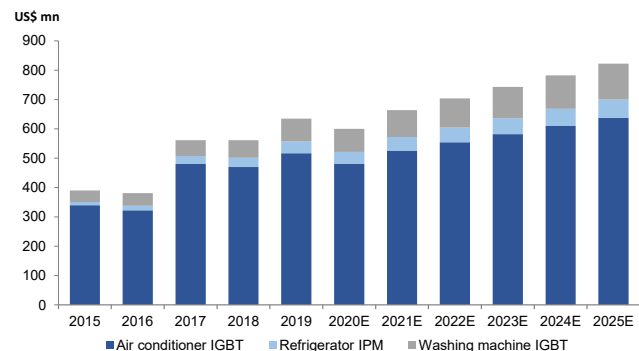
Source: Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 74: Steady growth in global home appliance IPM market driven by invertization



Source: Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 75: Air conditioners remain the key driver of China IPM demand

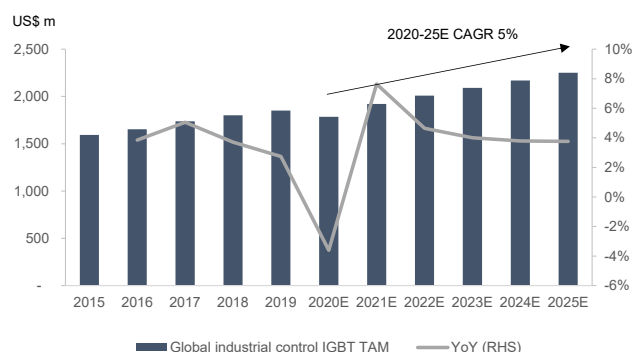


Source: Goldman Sachs Global Investment Research, Gao Hua Securities Research

Industrial controls: +5% CAGR in 2020-25E driven by industrial robots and inverters

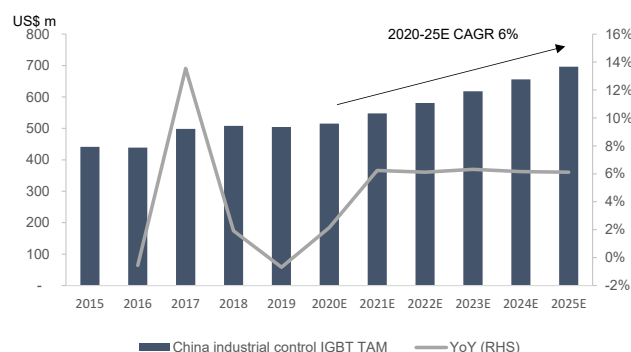
We expect industrial control applications to contribute 25% of global IGBT market revenue in 2020E, and we forecast revenues to grow at a +5% CAGR from US\$1.8bn in 2020E to US\$2.3bn in 2025E. In China's IGBT market, we expect industrial control applications to account for 21% of revenue in 2020E, and we model a +6% revenue CAGR from US\$515m in 2020E to US\$696m in 2025E, which would make this area the third largest revenue growth contributor for China's IGBT market. Within industrial controls, IGBT demand from industrial robots will likely be the strongest, while the broad industrial segment is closely tied to the macro environment. For industrial converters, the key requirements for power semiconductors are cost-effectiveness, small form-factor, long operation time without disruption, and high efficiency energy-saving. For different types of motor drive applications, servo drives mainly use IPM (40-1200V) and 650-1200V IGBT modules, while low-power drives (370w~500kW) mainly use IPM (40-1200V) and 600-1700V IGBT modules and mid- and high-power drives (500kW~10mW) mainly use 1200-4500V IGBT modules.

Exhibit 76: Global industrial IGBT TAM



Source: Goldman Sachs Global Investment Research, Gao Hua Securities Research

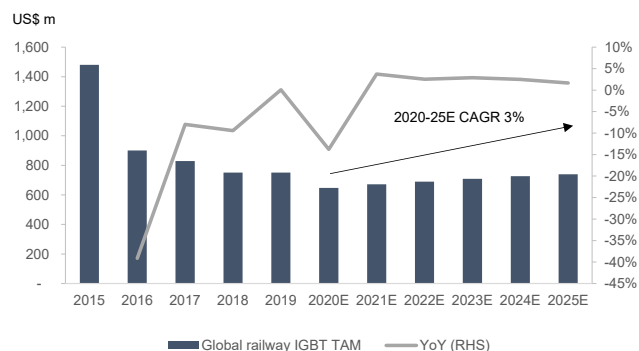
Exhibit 77: China industrial IGBT TAM



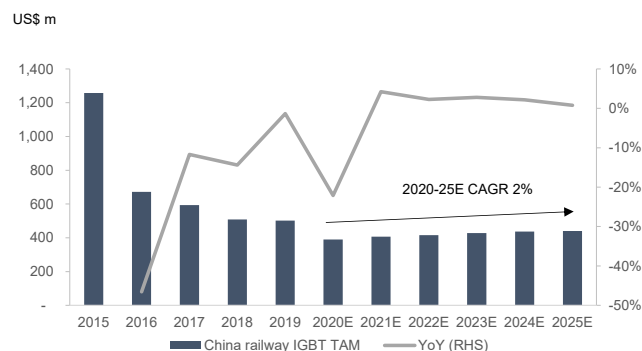
Source: Goldman Sachs Global Investment Research, Gao Hua Securities Research

Railway/train: +3% CAGR in 2020-25E

We expect railway and train applications to contribute 9% of global IGBT market revenue in 2020E, and we forecast a +3% revenue CAGR from US\$0.6bn in 2020E to US\$0.7bn in 2025E. In China's IGBT market, railway/train applications should account for 16% of revenue in 2020E, and we model +2% revenue CAGR from US\$390m in 2020E to US\$440m in 2025E. We expect stable growth in railway trains globally and in China.

Exhibit 78: Global railway IGBT TAM

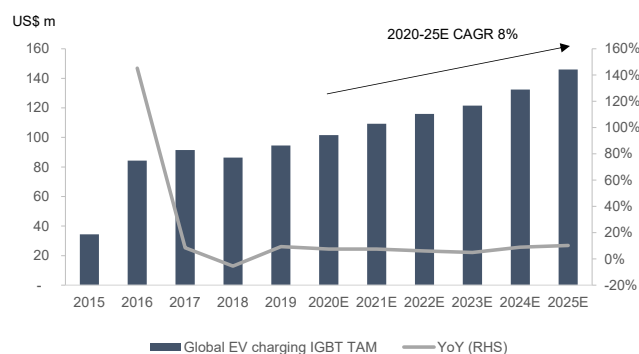
Source: Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 79: China railway IGBT TAM

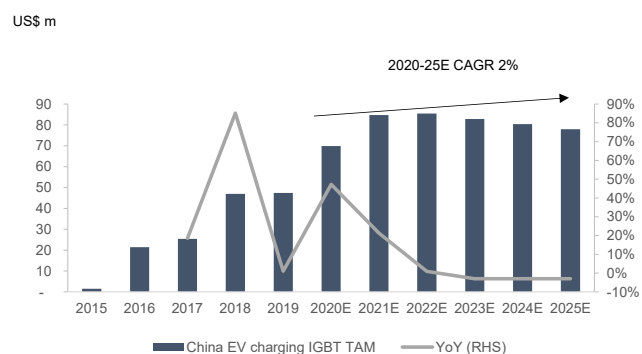
Source: Goldman Sachs Global Investment Research, Gao Hua Securities Research

EV charging systems: +8% CAGR in 2020-25E

We expect EV charging to contribute 1% of global IGBT market revenue in 2020E, and we expect revenues to grow at an +8% CAGR from US\$102m in 2020E to US\$146m in 2025E. In China's IGBT market, EV charging applications should account for 1% of revenue in 2020E, and we model a +2% revenue CAGR from US\$70m in 2020E to US\$78m in 2025E. We expect growing EV penetration will also drive demand for EV charging piles, which also require IGBTs as a key component. Growing shipments of fast charging systems with IGBT content at US\$300-3500 will likely be the key growth driver for this segment.

Exhibit 80: Global EV charging IGBT TAM

Source: Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 81: China EV charging IGBT TAM

Source: Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 82: Global IGBT TAM summaries

Global TAM by applications	2020E TAM (US\$ bn)	2023E TAM (US\$ bn)	CAGR	% of Total	Key drivers
Industrial control	1,784	2,090	5%	25%	Industrial Robots; Segment closely ties to macro growth
Automotive	1,352	2,431	22%	19%	Rising Electric Vehicles penetration; IGBT content growth in EV vs. ICE (US\$269-308 vs. c.US\$0)
EV charging pile	102	122	6%	1%	Volume growth: DC EV charging infrastructure ramps up as EV demand increases
Consumer electronics	1,674	1,985	6%	23%	Content growth: invertization in home appliances drives incremental demand for IGBT
Power generation and grid	1,582	2,049	9%	22%	Renewable energy (wind/solar) capacity addition
Railway/train	648	709	3%	9%	Steady growth as China's train demand off the peak
Total	7,142	8,857	7%	100%	EV/EV infrastructure, power generation

Source: Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 83: China IGBT TAM summaries

China TAM by applications	2020 TAM (US\$ mn)	2023E TAM (US\$ mn)	CAGR	% of Total	Key drivers
Industrial control	515	618	6%	21%	Industrial Robots; Increase in automation, higher demand for inverters
Automotive	362	640	21%	14%	EV growth: EV / HEV/ PHEV penetration in automotive shipment: 6% in 2019 vs. 11% in 2022E
EV charging pile	70	83	6%	3%	EV charging infrastructure growth;
Consumer electronics	600	743	7%	24%	Home appliance invertization to drive up IGBT content per box
Power generation	576	598	1%	23%	Renewable energy capacity addition
Railway/Train	390	428	3%	16%	Stable growth in train purchases by China
Total	2,514	3,110	7%	100%	EV growth, EV infrastructure, home appliance

Source: Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 84: IGBT dollar content by application

End market	IGBT content per box/device by applications (US\$)	
Industrial	Industrial robot IGBT content	240
	Low V inverter IGBT content	43
	High V inverter IGBT content	4,725
EV/HEV/PHEV	IGBT content per 48v/HEV	81
	IGBT content per PHEV	276
EV charging piles	DC - 150kW (5 racks of 30kW each)	300
	DC - 50kW and below (# racks of 20kW, 10kW)	100
Air conditioner	a. IPM in compressor motor	5
	b. Micro module in outdoor fan	2
	c. PSC discrete	0.6
	Total IGBT content per inverter AC	8
Refrigerator	IPM content per refrigerator	2
Washing machine	IPM content per washing machine	3
Wind power generation	IGBT content per MW	9,000
	IGBT content per MW	7,000
Railway	IGBT content per MU	110,592
	IGBT content per locomotive	432,000
	IGBT content per subway train	9,216

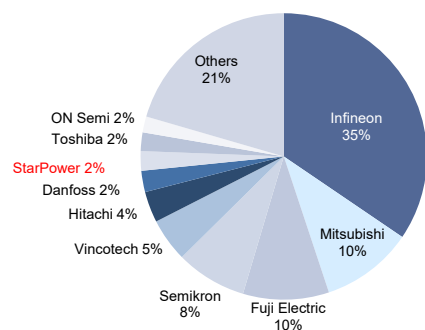
Source: Goldman Sachs Global Investment Research, Gao Hua Securities Research

IGBT competitive landscape

Global and China market share

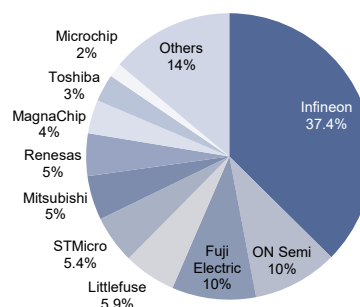
In the IGBT market, Infineon (covered by Alexander Duval) is the global leader with 2018 market share of 35% and 37% in the IGBT module market and discrete IGBT market, respectively, according to the company. Other leading suppliers include Mitsubishi (covered by Yuichiro Isayama) (32%/10%/5% market share in IPM/IGBT module/discrete IGBT markets), On Semi (covered by Toshiya Hari) (19%/10%/2% market share in IPM/discrete IGBT/IGBT module markets), Fuji Electric (Not Covered) (10% market share each in the three markets), ST Micro (covered by Alexander Duval), etc. Among domestic players, StarPower is the largest local IGBT module supplier with 2% global market share in 2018, and Sino-Micro (Not Covered) is the largest local IPM supplier with 1% global market share in 2018.

Exhibit 85: Global IGBT module market share, 2018



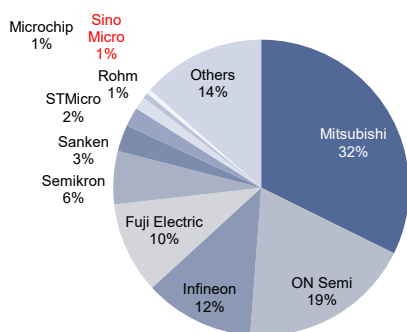
Source: Company data

Exhibit 86: Global discrete IGBT market share, 2018



Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 87: Global IPM market share, 2018



Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

IGBT business model: global majors are IDMs; fabless/foundry business model emerges in China

In the IGBT market, the major global suppliers employ IDM (integrated device manufacturer) business models, which means they do everything from design, manufacturing, packaging, to selling products. In contrast to some logic device markets

(such as smartphone application processors) that have been gradually taken over by fabless/foundry players, the power semiconductor market is still dominated by global IDM players, which we believe is due to: 1) power semiconductors usually do not require leading edge technologies and have lower capex burdens compared to logic devices; 2) a bigger portion of the power semiconductor market is for automotive/industrial applications, which usually take a relatively long time for product qualification, and can take an even longer time for new entrants to build a track record/brand recognition from customers. In China, the fabless and foundry model has emerged in the power semiconductor market, with companies such as Hua Hong (leading power semiconductor foundry in China) and StarPower (leading IGBT design house in China).

Exhibit 88: Power Semi supply chain: global majors all tend to be IDMs

	Design	Die fabrication	Discrete	Power module
Infineon	✓	✓	✓	✓
ST Micro	✓	✓	✓	✓
On Semi	✓	✓	✓	✓
BYD	✓	✓	✓	✓
CRRC	✓	✓	✓	✓
Silan	✓	✓	✓	✓
CR Micro	✓	✓	✓	✓
Yangjie	✓	✓	✓	✓
Sien	✓	✓	✓	✓
IMECAS	✓			
Hua Hong		✓	✓	
Sino Micro		✓	✓	
ASMC		✓	✓	
StarPower (IGBT only)	✓			✓

Source: Company data

Technology gap between China and global players

Technology gap in IGBT technology generations: Global leaders such as Infineon and Fuji started production of the first/second generation of IGBT (Non-Punch Through) in the 1990's, while local suppliers such as StarPower only started NPT in 2011. The global leaders started production of the third and fourth generations of IGBT (Trench Field-Stop) in the 2000's, while StarPower started in 2015 and other local suppliers started in 2017-19. Global leaders currently have seventh generation IGBT technology, while StarPower's is still under R&D and is targeted for launch in 2022E. Despite local suppliers still lagging in IGBT technology generations, we see the gap narrowing from >10 years in IGBT gen 1-4, to <10 years in IGBT5, and see the gap further shrinking to <5 years in IGBT 6/7.

Exhibit 89: IGBT technology roadmap

Local players shortening tech gap vs. global leaders

Tech Generation	IGBT 1/2 Non Punch Through	IGBT3 Trench+Field-Stop	IGBT4 Trench+Field-Stop	IGBT5 Trench+Field-Stop III	IGBT6 TrenchStop	IGBT7
Infineon	1990-1997		2000-2006			2018
Fuji	1997	2002	2008	2012		2017
StarPower	2011		2015	2014		2022E
CR Micro			2019			
Silan				2020		
BYDE	2009-2012		2017			
CRRC	2011		2017			
China players gap vs. global	>10 years	>10 years	>10 years	< 10 years	< 5 years	< 5 years

Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Technology gap in voltage: Global leaders such as Infineon and Mitsubishi can cover all ranges of voltage (100V-6500V), while some smaller players only have coverage of low (<1200V) to medium voltage IGBT (<1700V). Among local IGBT suppliers, StarPower can provide 100V-1700V IGBT modules, while CR Micro and Silan can only provide 600V/1200V IGBT discretes or modules. StarPower's 3300-6500V IGBTs are currently under R&D, and we expect the company to start shipments of 3300-6500V IGBT by 2022E. We also expect CR Micro and Wingtech to continue to expand their IGBT technology to higher voltage, yet we see limited revenue contribution in the near term from high-voltage IGBTs.

Exhibit 90: Key IGBT players globally by voltage offerings

Local players: centered on low voltage but expanding

Company	450v and less	600/700v	900/1000v	1200/1300v /1350v	1500/1600v	1700/1800v	2400/2500v	3300v	4500v	6500v
Market mix	3%	30%	30%		25%		7%		5%	
Microchip		✓								
Vishay		✓		✓						
ST Micro	✓	✓	✓	✓						
Renesas		✓	✓	✓						
Rohm	✓	✓		✓		✓				
CR Micro		✓		✓						
Silan		✓		✓						
BYDE		✓								
On Semi	✓	✓	✓	✓	✓	✓				
StarPower		✓	✓	✓		✓				
Toshiba	✓	✓	✓	✓		✓				
SiEn		✓	✓	✓	✓	✓				
Infineon	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Fuji Electric		✓	✓	✓	✓	✓	✓	✓	✓	✓
Littelfuse (incl. IXYS)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
ABB		✓	✓	✓	✓	✓	✓	✓	✓	✓
Mitsubishi	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
CRRC				✓		✓		✓	✓	✓

Discrete	✓
Module	✓

Source: Goldman Sachs Global Investment Research, Gao Hua Securities Research, Company data

Product application gaps: The global IGBT leaders usually cover a full range of applications from consumer electronics, automotive, and industrial controls, to power generation, infrastructure, and railway. In contrast, most local IGBT suppliers mainly focus on the consumer electronics markets and generally lack a proven track record in the automotive market, which has stricter requirements relative to product reliability. Given these stricter product reliability requirements, it could take up to five years for a new supplier to go through a customer's publication process. Therefore, product portfolios for domestic suppliers are not currently as comprehensive as those of global leaders, thus they usually lag behind global peers on system-level knowledge and total solutions. In the coming years, we expect StarPower to further expand into power generation, and railway applications, thanks to improved technological capabilities into higher voltage IGBTs.

Exhibit 91: IGBT suppliers by applications

Local players: centered on low-V applications but expanding

	Home appliance 23%			Automotive 20%		Industrial control 25%			Power generation 21%		Infrastructure 1%	Railway 9%
Application	Air conditioner	Refrigerator	Washing machine	EV/ HEV/ PHEV	EV charging piles	Motor drive	Robots	Welding inverter	Solar	Wind	Grid	Traction
Market mix	17%	2%	4%	19%	1%	23%	1%	1%	12%	9%	1%	9%
ST Micro	√	√	√	√	√	√	√	√	√	√	√	√
On Semi	√	√	√	√	√	√	√	√	√	√		
Infineon	√	√	√	√	√	√	√	√	√	√	√	√
ABB				√	√	√	√	√	√	√	√	√
Mitsubishi	√	√	√	√	√	√	√	√	√	√	√	√
StarPower	√	√	√	√	√	√	√	√				
CR Micro	√	√	√	√	√	√						
Silan	√	√	√			√						
BYDE				√	√	√		√				
Sien	√	√	√			√		√	√		√	
CRRC												√

Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

IGBT on 12" wafer fabs: Global leader, Infineon, started mass production of IGBT/MOSFET on its 12" wafer fab in 2015, which the company believes can lead to cost savings of 20-30% compared with devices produced on 8" wafer fabs. In contrast, Hua Hong (covered by Allen Chang) is the first company in China to produce IGBT/MOSFET on 12" wafer fabs, which it targets to start in 2H20. Other than Hua Hong, local names such as Silan and GTA Semiconductor (private, Not Covered) also plan to produce MOSFET on their new 12" wafer fabs in 2021 and 2023, respectively. We believe Silan is also likely to do IGBT on their 12" wafer fab once its MOSFET on 12" wafer fab becomes more mature.

Manufacturing process gap: The backside thinning process is one of the key manufacturing processes for IGBT. This process makes the wafer thinner which leads to reduced power consumption and improved switching speed. On this front, Hua Hong is the leader among local peers with the capability to reduce wafer thickness to 60um, which still lags behind global leaders who can reduce wafer thickness to 40um, but is ahead of other domestic peers who can only reduce wafer thickness to 100um or above.

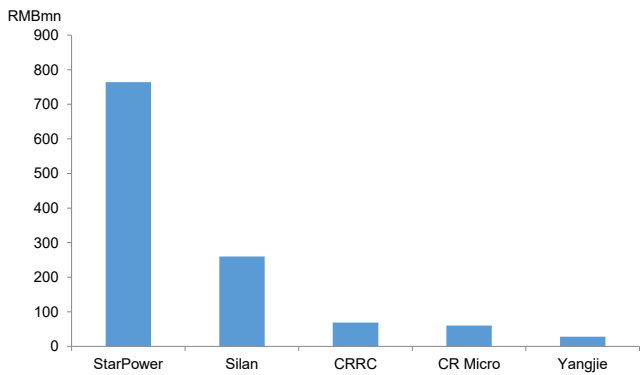
IGBT stock ideas

In the IGBT space, we are positive on StarPower (Buy, on CL), the IGBT leader among domestic suppliers with 2% global market share, and the only pure-play IGBT name in the A-share market with 98% of revenue from IGBT in 2019. Other than StarPower, CR Micro (1% of revenue from IGBT in 2019) and Silan (8% of revenue from IGBT in 2019) also supply the IGBT market, but their respective IGBT revenue scales are still relatively small and their IGBT product offerings are not as diversified as StarPower’s. We therefore view StarPower as our preferred idea in the IGBT space among China semiconductor names.

Comparison among domestic IGBT suppliers: StarPower, Silan, CR Micro

StarPower is an IC design house and module maker, while CR Micro and Silan are IDMs. Among these names, StarPower has the most comprehensive IGBT product lines, covering IGBT modules and IPMs with voltage ranges of 100-1700V for industrial controls, automotive/EVs, home appliances, and power generation applications. CR Micro currently mainly makes discrete IGBTs (600-1200V) for small home appliances such as induction cookers and plans to expand into IGBT modules and IPMs for applications such as inverter home appliances and EVs. Silan provides 600-1200V IGBT modules and IPMs for home appliances and industrial control applications, and targets to expand into the EV market. In terms of revenue scale, StarPower generated Rmb762m in revenue from IGBTs in 2019, with Silan at Rmb260m, and CR Micro at Rmb60m.

Exhibit 92: StarPower has the largest IGBT revenue scale among local players (data as of 2019)



Source: Company data

StarPower’s IGBT products, customers, and growth drivers

Products: covering 100-1700V IGBT for industrial, EV, home appliance applications

StarPower is an IGBT chip design house and module maker, with foundry partners Hua Hong and ASMC (Not Covered)/GTA Semiconductor. This business model enables it to focus resources on IGBT technology R&D, module design, and customer engagement, as well as reduce its capex burden. Founded in 2005, StarPower is an early entrant with larger scale relative to its local peers. The company began shipment of its fourth generation (NPT or Non Punch-Through) IGBT in 2012 and its sixth generation (Field Stop

Trench) IGBT in 2016. It currently manufactures 1200V NPT IGBT chips and 650V, 750V, 1200V, and 1700V FS-Trench IGBT chips. The company also makes 600-1700V IGBT modules for industrial use (73% of revenue in 2019), 100-1200V IGBT modules for EV (21%), and 600V IPM for home appliances (4%), and it targets to expand into higher voltage (3300V and above) IGBTs for power generation and railway applications in the coming years. StarPower's major product lines are listed below:

- **IGBT modules for industrial applications:** 1700V IGBT for mid-/high-V converters, power grids, wind power; 1200V IGBT for low-V converters, welding machines, UPS (Uninterruptible power supply), PV (Photovoltaic); 600V for low-V converters and UPS.
- **IGBT modules for EV applications:** 100V/150V/600V/650V/1200V IGBT modules for main motor drives, air conditioners, electric power steering systems, charging piles, etc.
- **IPM for home appliances:** 600V IPM for inverter-based air conditioner, refrigerator, and washing machines.

Customers:

StarPower has a diversified customer base with leading names in NEVs (new energy vehicles), industrial controls, and home appliances:

- **NEV:** Changan, BAIC, GAC, Yutong, Jinlong, Chery, Zotye, JAC, etc.
- **Industrial:** INVT, Inovance, Zhongchen Electronic Technology, Jee Power System, Hiconics Eco-energy Technology, etc.
- **Home appliances:** Midea, Gree Electric, Hisense, etc.

Growth drivers: new design-wins, allocation upside, customer expansion, product expansion

1. New design-wins and strong customer base in IGBT for industrial market to support share gains

We expect StarPower's market share to expand from 16% in 2019 to 31% in 2023E in IGBT for the industrial market in China. In 2019, StarPower gained new design-wins with its 1700V Trench Field Stop IGBT for wind power and high-voltage converters, which should see stronger growth from 2020 driven by better energy efficiency. The company has also penetrated into IGBT modules for elevator controllers and central air conditioning systems for commercial buildings in 2019. As a leader in China, we expect StarPower to gain share in the China market given its advantages of competitive pricing (could be 10-15% lower than solutions from foreign peers), wide product portfolio covering 600V/1200V/1700V IGBT for industrial applications, customized solutions, and stronger relationships with domestic customers.

2. Allocation upside and new customer expansion in IGBT for in the EV market

StarPower's key EV customers include BAIC (covered by Fei Fang), GAC (covered by Fei Fang), JAC (Not Covered), Changan (covered by Fei Fang), and Chery (Not Covered).

These companies had 26% aggregated market share in China's NEV market in 2019. Based on StarPower's shipments in 2019, we estimate it has <30% allocation to these existing customers, and based on its competitive advantages (e.g., pricing, wide portfolio, customized products, timely service), we see upside for StarPower to increase allocations and become the second supplier (from 3rd or 4th supplier currently) for existing customers in the next three to five years as customers seek to diversify supply chain risk. We also see upside for StarPower to further penetrate into other NEV customers in China as domestic brands have >70% market share in China's NEV market.

In 2019, StarPower completed R&D on key technologies for the next generation of automotive power modules such as double-sided welding, high-temperature molding processes, and double-sided heat dissipation technology. These technologies increase the power density of IGBT modules for EV significantly. In 2019, StarPower also entered mass production of the next generation of IGBT modules for EVs with double-sided welding, and penetrated into power modules for 48V BSG (belt-driven starter generator) in MHEV (mid-hybrid electric vehicles), which should drive new design-wins and bring revenue streams from 2020E. The company also achieved new design-wins with its Trench Field Stop 650/750V IGBT chips for NEV customers in 2019.

3. Allocation upside and new customer expansion in IGBT for the home appliances market

StarPower's key customers in home appliances include Midea, Gree Electric, and Hisense (all covered by Nicholas Yi). These companies had 51% aggregated market share in the China home appliances market in 2019. StarPower's 600V IPM products were qualified (i.e., passed product tests) by major home-appliance brand customers in 2019, and we see upside for StarPower to increase allocation and become the second supplier (from 3rd or 4th supplier currently) for existing customers in the next three to five years as customers seek to diversify supply chain risks. We also see upside for StarPower to further penetrate into other home appliances customers in China as domestic brands have majority market share in China's home appliances market.

StarPower investment thesis

We are positive on StarPower, the IGBT leader among domestic players, and model net income growth at a 70% CAGR in 2020-23E, driven by

- **New design-wins and share gains in 600-1700V IGBT for high-V converters and elevator controllers:** We expect StarPower's 600-1700V industrial IGBT revenues to grow at a 30% CAGR in 2020-23E driven by: 1) leading market position among local peers in the industrial IGBT market, with a best-in-class customer base and technology (600-1700V); 2) rising demand for 1700V IGBTs for use in high-voltage frequency converters, and 3) new design-wins for IGBT modules for elevator controllers and central air conditioning systems.
- **Expanding into 600-1200V IGBTs for EV and IPM for home appliances:** We model StarPower's IGBT revenue for EVs and IPMs for home appliances to grow at a 68% CAGR and 121% CAGR, respectively in 2020-23E, driven by market growth,

new design-wins, and market share gains from a low base. We see market share upside for StarPower from: 1) allocation upside from existing customers; and 2) penetrating into new customers such SAIC, Geely, Haier, etc. We model China's IGBT revenues for the EV/IPM for home appliance markets to grow at +21%/+7% CAGR in 2020-23E, and StarPower's EV/IPM for home appliance market share to increase from 7%/1% in 2020E to 19%/6% in 2023E, respectively. The company is also developing 3300-6500V IGBTs for power generation/grid applications, which we expect to contribute 6%/10% of revenue in 2022/23E.

StarPower valuation and downside risks

Valuation: Our 12M target price of Rmb402 (implies a 130x 2022E P/E) is derived from a discounted P/E methodology, which we believe is appropriate given Starpower is still at an early growth stage compared to global leaders. In our view, a discounted P/E methodology captures the company's long-term business opportunities and helps justify its current premium P/E multiple versus peers. We apply a 40x target P/E multiple to StarPower's 2025E EPS and discount it back to 2022E at COE of 9% (1.0 Beta, 3% risk-free rate, and 6% market risk premium). The 40x target P/E multiple is derived from the sector P/E-EPS YoY correlation, and we note the market has generally rewarded higher EPS growth companies in the semiconductor industry based on our regression analysis. Our target price implies 130x 2022E P/E, or PEG at 2.0x based on average 2023-24E EPS YoY growth (64%). Our DCF valuation crosscheck assumes a WACC of 9% and terminal growth rate of 3% and also shows a similar theoretical valuation of Rmb405 per share, or 131x 2022E P/E. The stock currently trades at 85x our 2022E EPS and at 1.3x our PEG based on average 2023-24E EPS YoY growth, which we believe is attractive considering its strong earnings growth at +65% CAGR in 2020-25E.

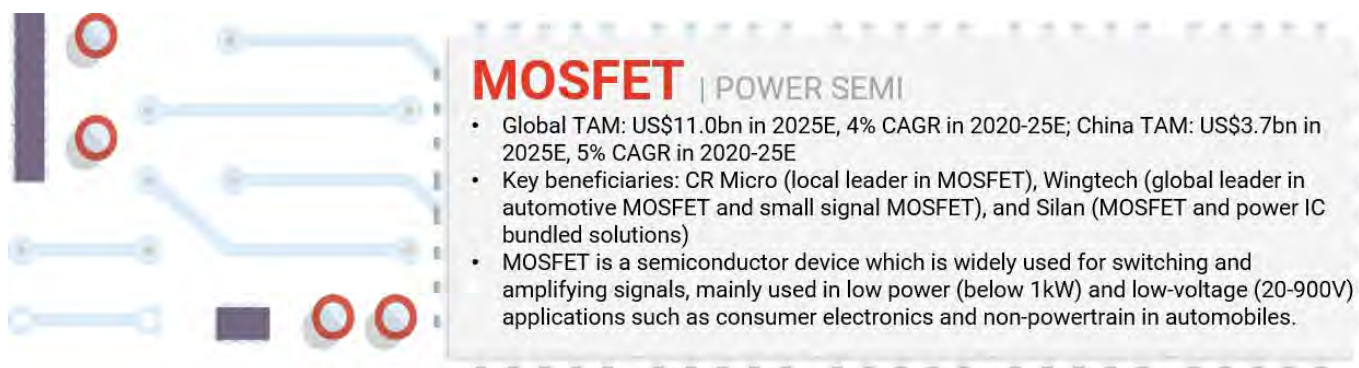
Downside risks:

- 1. Weaker-than-expected IGBT market growth:** We forecast China's IGBT market to see revenues grow at a 7% CAGR in 2020-25E, mainly driven by EV and home appliance applications. If the penetration of EV and inverter-based home appliances is slower than our forecast, or if the usage of IGBT in EV/inverter-based home appliances is lower than our expectation, IGBT market growth could be weaker than our current forecasts.
- 2. Slower-than-expected new design-wins and market share gains:** We model StarPower to gain market share in China's IGBT market from 4% in 2020E to 25% in 2025E, mainly in EV and home appliances applications. If StarPower's new design-wins or market share gains are slower than our expectation, there could be downside to our earnings estimates.
- 3. New product ($\geq 3300V$ IGBT) development progress:** We expect StarPower to start shipments of $\geq 3300V$ IGBT for power generation application in 2022E, and model $\geq 3300V$ IGBT to contribute 6-16% of total revenue in 2022-25E. If the R&D progress or customer qualification of $\geq 3300V$ IGBT is slower than our expectation, it could result in slower earnings growth in 2022-25E.
- 4. Intensifying competitive pressure:** New entrants into the IGBT market in China include CR Micro, Wingtech, Silan, etc. We expect StarPower to have 25% market

share in China IGBT market by 2025E. If other domestic competitors demonstrate faster R&D/new design-wins/market share gains from StarPower, there could be downside risk to our earnings estimates.

- 5. Potential impact from COVID-19:** StarPower's revenues come mainly from the domestic market (~95% of revenue) but its customers' end products are sold globally, we therefore believe StarPower could be impacted by the macro economic slowdown globally in 2020. StarPower's revenue declined 7% YoY in 1Q20 due to reduced production in February and early-March, and we model slower revenue growth of +10% YoY in 2020E (vs +15% YoY in 2019).

MOSFET: Intro, TAM, Competitive Landscape, Stock Ideas



Bottom line: MOSFET is a growing market driven by green / energy saving requirements across multiple applications (EVs, home appliances). We forecast the global MOSFET TAM will show a 4% CAGR over 2020-25E to US\$11bn, with China's IGBT TAM showing a 5% CAGR over 2020-25E to US\$3.7bn. We initiate **on CR Micro** (the Chinese leader in MOSFET, mainly for consumer electronics), **Silan** (IDM with both IGBT and MOSFET) and **Wingtech** (global leader in automotive MOSFET) at Buy.

MOSFET intro

What is MOSFET?

A MOSFET (Metal Oxide Semiconductor Field Effect Transistor) is a semiconductor device which is widely used for switching and amplifying electronic signals in electronic devices. A MOSFET has advantages of small on-resistance, low loss, simple drive circuit, and good thermal resistance characteristics. Compared to an IGBT, a MOSFET has the advantages of higher switching speed and better operation efficiency at low voltages. MOSFETs are mainly used in small-capacity and high-speed switching applications, such as PCs, mobile phones, power banks, EVs, UPS power supply and other power control applications.

By voltage, the MOSFET market can be divided into three segments: low-voltage (30V and smaller), mid-voltage (40-200V), and high-voltage (500-1000V). The low-voltage (47% of MOSFET market) MOSFETs are mainly used in smartphones, tablets, notebook PCs, servers, motherboards, graphic cards. The mid-voltage (25% of market) MOSFETs are mainly used in power tools, PoE (power of Ethernet), telecoms, industrial automation, ICE cars. The high-voltage (24% of market) MOSFETs are mainly used in power supply, EV charging piles, LED lighting, smart meters, and EVs. Global leaders such as Infineon, On Semi, Renesas, and Chinese leaders such as CR Micro, Silan can cover all ranges of voltage; while smaller Chinese leaders like Yangjie can only cover mid-to-low levels.

MOSFET technology trend

There are three different types of MOSFET structure: Planar, Trench, and Super Junction. Super Junction is the more advanced technology and is mainly used in high-voltage MOSFET (500V and above). Super Junction has higher frequency, higher output power, higher current and speed compared to Planar and Trench. Planar has lower frequency

and output power, but can be used for voltage up to 900V, while Trench is mainly used in low voltage (250V and below).

Exhibit 93: MOSFET types by technology

Chinese players can largely cover main types of MOSFET

Process	Planar	Trench	Super Junction
Application	Consumer electronics	Consumer electronics	Industrial, home appliance
Working frequency	Moderate	Moderate	High
Output Watt	Low	Low	High
Voltage	Up to 900V	Up to 250V	>=500V
High current	Moderate	Excellent	Excellent
High speed	Good	Good	Excellent
Infineon (IFXGn.DE)	√	√	√
ST Micro (STM.PA)	√	√	√
CR Micro (688396.SS)	√	√	√
Silan (600460.SS)	√	√	√
Sino Micro (600360.SS)	√		√
Yangjie (300373.SZ)	√	√	√
Wingtech (600745.SS)	√	√	√
Panjit (2481.TW)		√	√
TSC (2330.TW)	√	√	√

Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 94: MOSFET performance, applications by different types

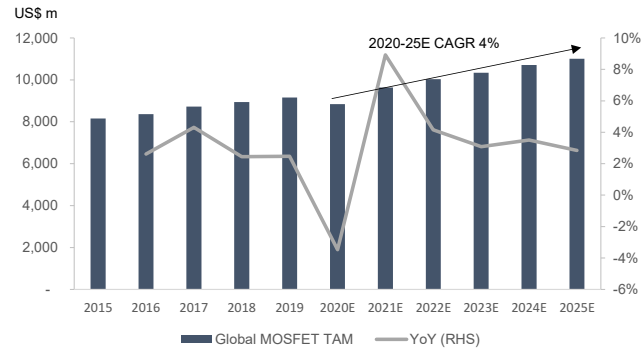
Grade	Typical MOSFET type	Performance			Main applications
		Working frequency	Output Watt	Power consumption	
Low-end	Planar, Trench	Moderate	Low	Moderate	Consumer electronics
Mid-end	Super Junction, Advanced Trench	High	High	Moderate	Industrial, home appliance
High-end	SiC, GaN	High	High	High	Automotive, aerospace

Source: Goldman Sachs Global Investment Research, Gao Hua Securities Research

MOSFET TAM

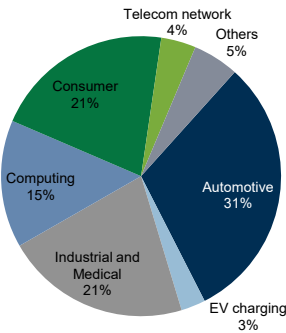
Based on our proprietary TAM model, we forecast global and China MOSFET markets to grow at 4% / 5% CAGRs in 2020-25E, respectively. By applications, automotive and EV charging will be the major growth driver in both global and China markets, thanks to the rising penetration of electric vehicles. We expect the automotive MOSFET market to grow at 8%/6% CAGRs in 2020-25E in global and China markets. Industrial control and consumer applications will enjoy steady growth of 2-5% CAGRs in 2020-25E in both global and China markets. In terms of revenue mix, automotive is the largest application and accounts for 31% of the global IGBT market in 2020E, followed by industrial 21%, consumer 21%, computing 15%, telecom network 4%, EV charging 3%, and others 5%.

Exhibit 95: Global MOSFET TAM



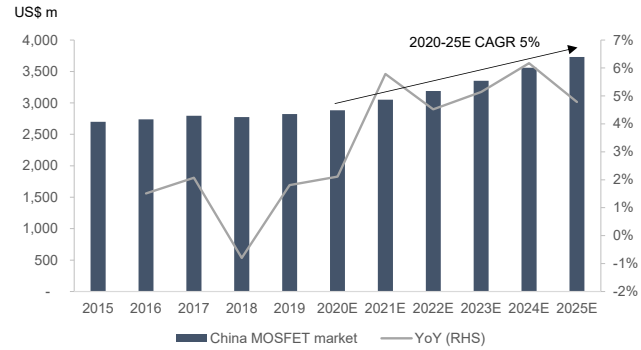
Source: Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 96: Global MOSFET TAM by applications 2020E



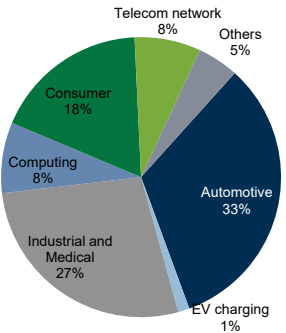
Source: Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 97: China MOSFET TAM



Source: Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 98: China MOSFET TAM by applications 2020E



Source: Goldman Sachs Global Investment Research, Gao Hua Securities Research

MOSFET TAM methodology

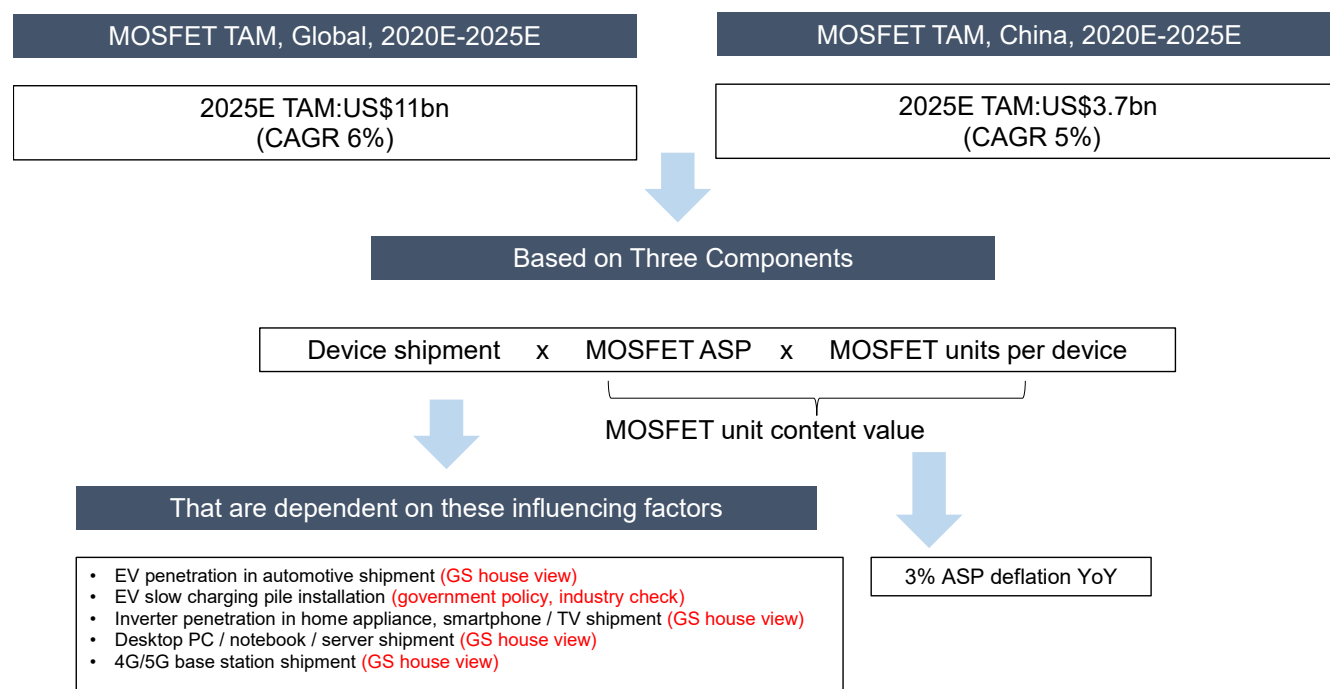
We form our MOSFET TAM model based on three key components: device shipments, IGBT ASP, and IGBT units per device. On device shipments, we divide them into 7 applications (industrial control, automotive, EV charging, consumer electronics, computing, telecom network, and others) with multiple end-products/systems including EV, ICE cars, air conditioners, refrigerators, washing machines, PCs, smartphones, servers etc. We use assumptions of device shipments by supply chain checks and also

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referring to our house views for certain areas such as NEV penetration and shipments, home appliance shipments, PCs, servers, smartphone shipments, etc. On MOSFET ASP and units per device, we form the assumptions based on our supply chain checks with IGBT suppliers, distributors, and customers.

Exhibit 99: Our MOSFET TAM approach

How we model TAM: device shipments, MOSFET unit content value



Source: Goldman Sachs Global Investment Research, Gao Hua Securities Research

MOSFET market growth by applications

Automotive: +9% CAGR in 2020-25E, driven by EV penetration

Automotive applications should contribute 31% of global MOSFET market revenue in 2020E and we expect it to grow at a 8% CAGR from US\$2.6bn in 2020E to US\$4bn in 2025E, which is the major revenue growth driver for the MOSFET market. In the China MOSFET market, automotive applications account for 33% of revenue in 2020E and we model a 6% CAGR from US\$0.9bn in 2020E to US\$1.2bn in 2025E. This is driven by growing penetration of EV, as each EV consumes US\$55 of MOSFET content, higher than that of an ICE car (US\$25 MOSFET content per car). We assume the penetration for EV/PHEV/48v HEV to increase from 13% in 2020E to 25% in 2025E globally, and from 7% to 25% in China.

In the automotive MOSFET market, 48% are used in powertrains (including start-stop system, engine control unit, BMS, DC/DC converter, on-board charger), 19% used in body and comfort, 13% in chassis and safety, 11% in infotainment, 8% in lighting, and 1% in ADAS. Hybrid EVs consume US\$30 more MOSFET than ICE, and the extra MOSFET content is mainly in BSG, DC/DC, and inverter. The growing penetration of EV and ADAS functions will drive MOSFET usage in cars, up to 400 units of MOSFETs per

car for a high-end EV. MOSFETs are mainly used for AC/DC conversion in automotive applications and the growing trends of ADAS and electrification will increase the usage of MOSFET in cars.

Exhibit 100: MOSFET is used in various parts of vehicle (2019)
For Non-EV: MOSFET content is US\$25 per car; for EV: MOSFET content is US\$55

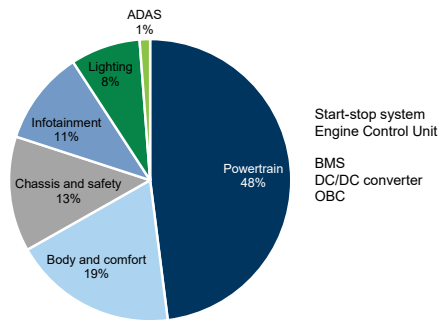
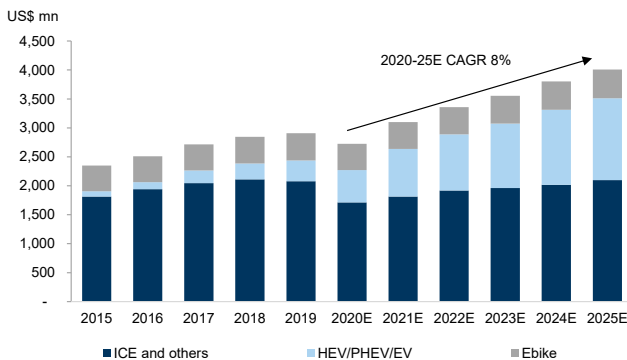


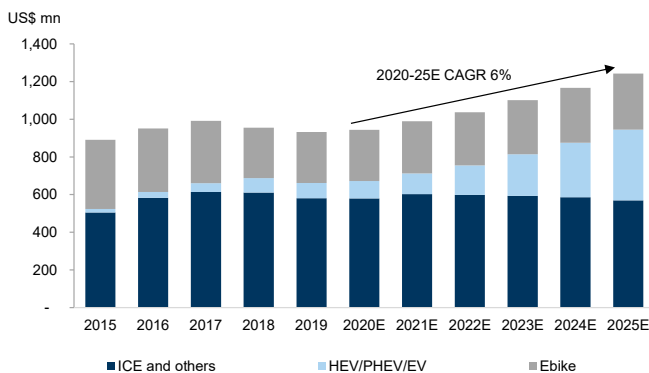
Exhibit 101: EVs remain the key growth driver of automobile MOSFET
Global MOSFET TAM in automobiles



Source: Goldman Sachs Global Investment Research, Gao Hua Securities Research

Source: Goldman Sachs Global Investment Research, Gao Hua Securities Research

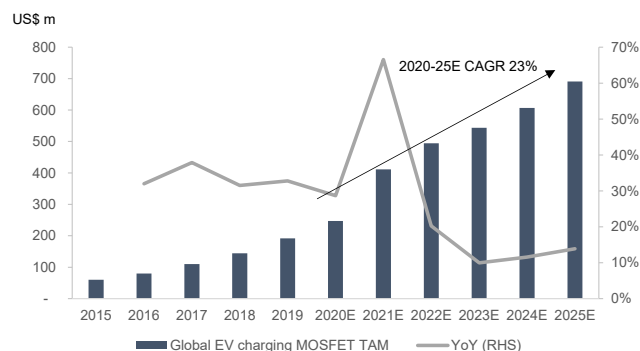
Exhibit 102: China MOSFET TAM in automobiles



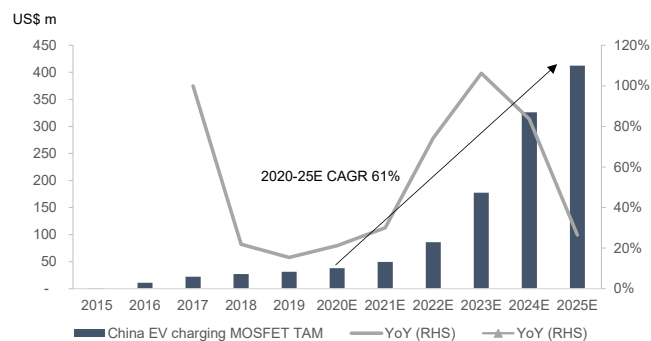
Source: Goldman Sachs Global Investment Research, Gao Hua Securities Research

EV charging: +23% CAGR in 2020-25E, driven by EV penetration

EV charging applications should contribute 3% of global MOSFET market revenue in 2020E and we expect it to grow at a +23% CAGR from US\$247m in 2020E to US\$691m in 2025E, which is the second largest revenue growth driver for the MOSFET market. In the China MOSFET market, EV charging applications account for 1% of revenue in 2020E and we model a +61% CAGR from US\$38m in 2020E to US\$413m in 2025E. MOSFETs are mainly used in low power public chargers (20kW) and private chargers (2-7kW), while IGBT/SiC are mainly used in public fast-charging stations (150kW/350kW).

Exhibit 103: Global EV charging MOSFET TAM

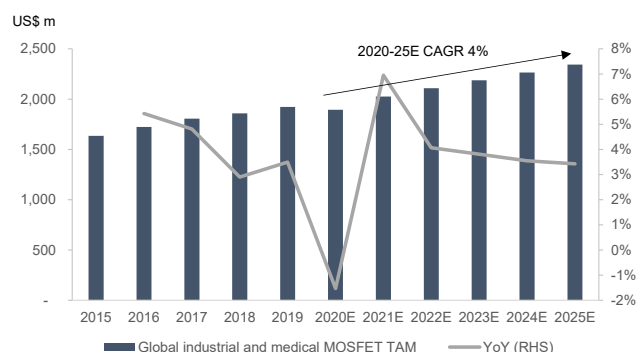
Source: Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 104: China EV charging MOSFET TAM

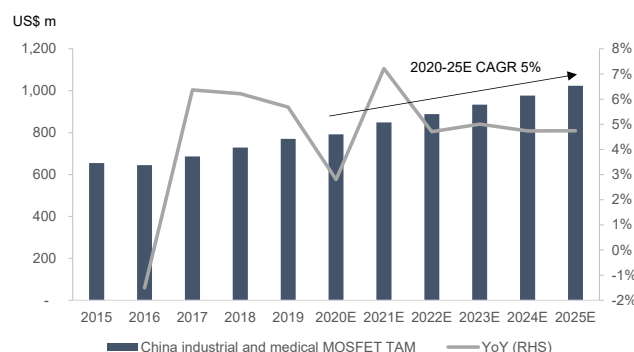
Source: Goldman Sachs Global Investment Research, Gao Hua Securities Research

Industrial and medical: +4% CAGR in 2020-25E, driven by Motor control, solar PV, and medical

Industrial and medical applications should contribute 21% of global MOSFET market revenue in 2020E and we expect it to grow at a +4% CAGR from US\$1.9bn in 2020E to US\$2.3bn in 2025E, which is the second largest revenue growth driver for the MOSFET market. In the China MOSFET market, industrial and medical applications account for 27% of revenue in 2020E and we model a +5% CAGR from US\$792m in 2020E to US\$1024m in 2025E. Motor control, solar PV, and medical are major end-markets that require MOSFET, and the growth is typically in line with the macro economy.

Exhibit 105: Global industrial and medical MOSFET TAM

Source: Goldman Sachs Global Investment Research, Gao Hua Securities Research

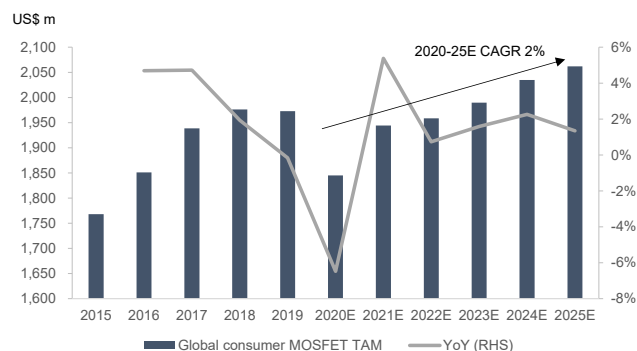
Exhibit 106: China industrial and medical MOSFET TAM

Source: Goldman Sachs Global Investment Research, Gao Hua Securities Research

Consumer: +2% CAGR in 2020-25E, driven by shipment growth of home appliances

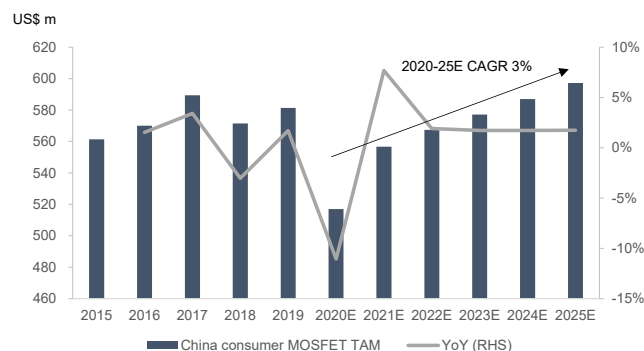
Industrial applications should contribute 21% of global MOSFET market revenue in 2020E and we expect it to grow at a +2% CAGR from US\$1.8bn in 2020E to US\$2.1bn in 2025E. In the China MOSFET market, consumer applications account for 18% of revenue in 2020E and we model a +3% CAGR from US\$517m in 2020E to US\$597m in 2025E. The key growth driver for this segment is the unit shipment growth of home appliances such as TVs, air conditioners, refrigerators, and washing machines.

Exhibit 107: Global consumer MOSFET TAM



Source: Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 108: China consumer MOSFET TAM

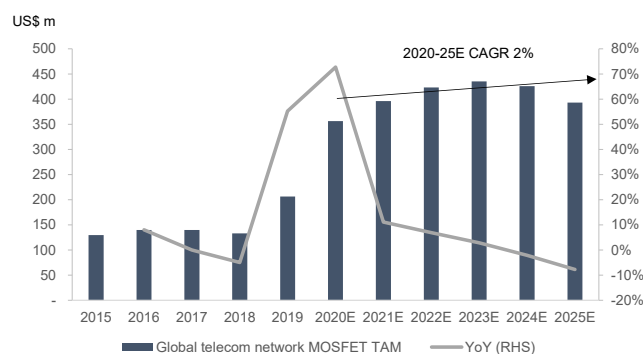


Source: Goldman Sachs Global Investment Research, Gao Hua Securities Research

Telecom network: +2% CAGR in 2020-25E driven by 5G builds

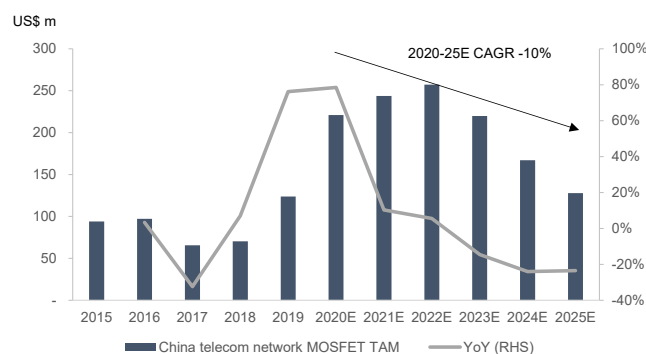
Telecom network applications should contribute 4% of global MOSFET market revenue in 2020E and we expect it to grow at a +2% CAGR from US\$356m in 2020E to US\$393m in 2025E. In China's MOSFET market, telecom network applications should account for 8% of revenue in 2020E and we model a -10% CAGR from US\$221m in 2020E to US\$128m in 2025E as the network builds peak out in 2022E. 5G base stations are the key growth driver for this segment as it requires 4 times the MOSFET content of a 4G base station. The mmWave antenna and massive MIMO antenna are key new drivers for the higher MOSFET content in 5G base stations.

Exhibit 109: Global telecom network MOSFET TAM



Source: Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 110: China telecom network MOSFET TAM

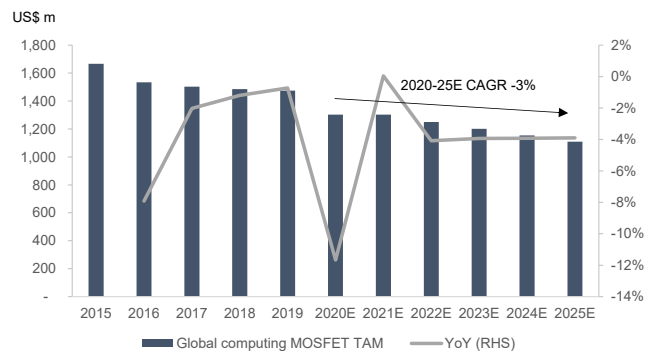


Source: Goldman Sachs Global Investment Research, Gao Hua Securities Research

Computing: -3% CAGR in 2020-25E, due to slowing PC shipments

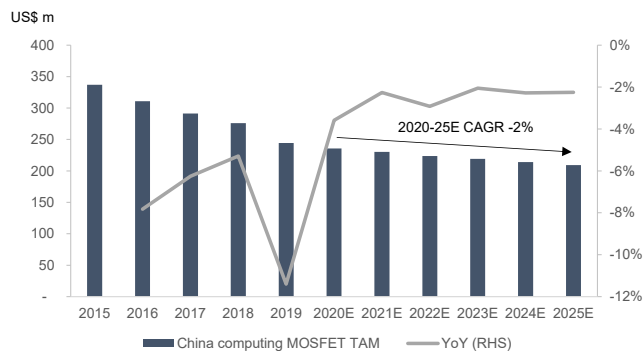
Computing applications should contribute 15% of global MOSFET market revenue in 2020E and we expect a -3% CAGR from US\$1.3bn in 2020E to US\$1.1bn in 2025E. In the China MOSFET market, computing network applications account for 8% of revenue in 2020E and we model a -2% CAGR from US\$236m in 2020E to US\$209m. The decline is due to cautious assumptions for PC unit shipments to decline mildly in the coming years.

Exhibit 111: Global computing MOSFET TAM



Source: Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 112: China computing MOSFET TAM



Source: Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 113: MOSFET dollar content by applications

End market	MOSFET content per device by applications (US\$)	
Automotive	MOSFET \$ content per ICE car	25
	MOSFET \$ content per HEV/PHEV/EV	55
	MOSFET \$ content per electric bike	10
EV charging piles	MOSFET \$ content per AC charger	88
Solar power generation	MOSFET \$ content per solar PV MW	1,400
Computing	MOSFET \$ content per desktop PC	4
	MOSFET \$ content per NB PC	6
	MOSFET \$ content per server	15
Air conditioner	a.MOSFET \$ content per compressor motor	0.5
	b.MOSFET \$ content per outdoor fan motor	0.4
	c.MOSFET \$ content per indoor fan motor	1.5
	Total MOSFET \$ content per air conditioner	2.4
TV	MOSFET \$ content per box	0.8
Telecom network	MOSFET \$ content per 4G base station	75
	MOSFET \$ content per 5G base station	300

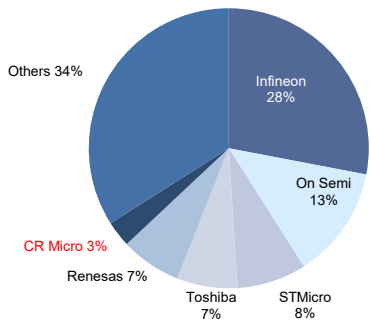
Source: Goldman Sachs Global Investment Research, Gao Hua Securities Research

MOSFET competitive landscape

Global and China market share

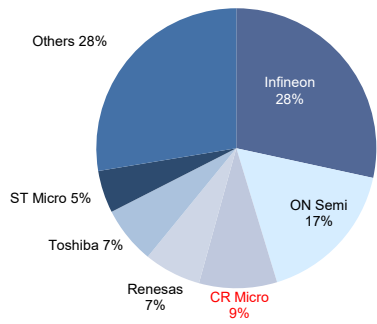
In the MOSFET market, Infineon is the global leader with 28% market share in 2018, according to the company, followed by On Semi (13%), STMicro (8%), Toshiba (7%), Renesas (7%), etc. Among Chinese players, CR Micro is the largest Chinese MOSFET supplier with 9% market share in China’s MOSFET market (or 3% global market share). Other MOSFET suppliers in China include Silan, Yangjie, Jiejie, etc.

Exhibit 114: Global MOSFET market share, 2018



Source: Company data

Exhibit 115: China MOSFET market share, 2018



Source: Company data

China suppliers’ technology/product gaps vs global peers

Technology gap in MOSFET types/voltage is not as much as that in IGBT: Chinese leaders (e.g., CR Micro) can cover higher-end MOSFET such as Super Junction and a wide range of voltage (up to 1500V), similar to global leaders like Infineon, On Semi, Renesas, ST Micro, etc, while smaller Chinese suppliers can only cover lower-end MOSFET and lower voltage. As a companion, on IGBT, Chinese suppliers still lag behind by at least 5 years on 7th generation IGBT, and can only cover lower voltage (1700V and below), while global peers can cover up to 6500V.

MOSFET technology gap in manufacturing process and materials: While Chinese leaders like CR Micro in MOSFET can cover similar MOSFET types and voltage with that of global peers, there are still certain manufacturing process where Chinese players still lag behind global peers. For example, on Super Junction MOSFET, there are two types of manufacturing approach: multi-epi process and trench filling. Multi-epi process is the conventional one that CR Micro is using. Trench filling is the more advanced one used by global leaders, which can make P/N Junction deeper, further reducing the ON-resistance compared to the multi-epi process. In terms of materials, global leaders already have GaN and SiC MOSFETs, while Chinese suppliers’ GaN and SiC MOSFETs are still under R&D.

MOSFET/IGBT on 12” wafer fabs: Global leader Infineon started mass production of MOSFET/IGBT on its 12” wafer fab in 2011, which the company believe can save cost by 20-30%. In contrast, Hua Hong will be the first Chinese firm to produce MOSFET/IGBT on a 12” wafer fab, which it targets to start in 2H20. Other than Hua Hong, Chinese names such as Silan and GTA also plan to produce MOSFET on their new 12” fabs in 2021 and 2023, respectively.

Product application gaps: The global MOSFET leaders usually cover the full range of applications from consumer electronics, automotive, computing, motor driver, power supply, telecom network, EV charging, LED lighting, to medical. In contrast, most Chinese MOSFET suppliers mainly focus on consumer electronics markets and lack proven track records in automotive, EV charging, medical markets, which have stricter requirements on product reliability. In coming years, we expect CR Micro to expand its product portfolio in MOSFET for automotive and industrial applications.

Exhibit 116: CR Micro and peers' product offerings

Applications	Consumer	Computing	Electric bike	Telecom network	Motor drive & power supply	Medical	Automotive	EV charging pile	LED lightings
Market mix	21%	15%	5%	4%	21%	1%	25%	3%	5%
Infineon	√	√	√	√	√	√	√	√	√
ST Micro	√	√	√	√	√	√	√	√	√
On Semi	√	√	√	√	√	√	√	√	√
Toshiba	√	√	√	√	√	√	√	√	√
CR Micro	√	√	√		√		√		√
Sino Micro	√	√		√	√		√		√
Silan	√				√				√
Yangjie	√			√	√			√	√
Wingtech	√	√		√	√	√	√		√
SiEn	√	√		√					√
Panjit	√	√	√		√		√	√	√
TSC	√				√		√		

Source: Company data

MOSFET stock ideas

In the MOSFET space, we are positive on CR Micro (Buy), Silan (Buy) and Wingtech (Buy). Although these three companies are all exposed to the MOSFET market, we see different strengths and attractive valuations considering the strong earnings growth ahead:

- **CR Micro:** leading MOSFET supplier with 8% share in China's MOSFET market in 2019 and comprehensive product coverage from -100V to 1500V MOSFET. We expect CR Micro's MOSFET revenue to grow at a 31% CAGR over 2020-25E, driven by expansion from consumer electronics to automotive and industrial applications, new design-wins, product portfolio expansion, and customized solutions.
- **Silan:** its key differentiation from other domestic power semi IDM peers is that it not only focuses on power discrete, but also has comprehensive product portfolios in power IC such as AC-DC, DC-DC, power management IC, fast charging, etc, which can be bundle solutions with its MOSFET. We model Silan's MOSFET revenue to grow at a +25% CAGR in 2020-25E, driven by growing demand from automotive and industrial applications, as well as Silan's bundle sale of MOSFET and power IC.
- **Wingtech:** merged with Nexperia in late 2019, and is now a global top three supplier for small signal / small power MOSFET and automotive MOSFET with a rich product portfolio, ranging over 30V-100V. We expect Wingtech net income to grow at a 22% CAGR over 2020-25E, driven by market share expansion, semiconductors' product line expansion, and blended GM expansion based on rising semiconductor contribution.

CR Micro in MOSFET: 26% of total revenue in 2019

Products: wider coverage of voltage and device structure than domestic peers

CR Micro is a leading power semiconductor IDM in China with 8% share in China's MOSFET market in 2019. CR Micro's MOSFET products cover voltage ranges from -100V to 1500V, wider than domestic peers: Silan at 30-900V, Sino Micro at 40-900V, and Yanjie at -60-150V. In terms of MOSFET device structure, CR Micro also have more comprehensive coverage of six types of structure including Super Junction, Planar, Trench, Shielded-gate, Depletion, and P-channel. In comparison, domestic peers Silan / Sino Micro / Yanjie only have 5/ 2 / 4 types of the structures among the 6 types that CR Micro has. Compared to foreign peers, CR Micro's key advantage is that it can provide customized products per customers' requirement even for a small volume product. Among the 6 types of MOSFETs structures, Trench, Planar, and Super Junction are 3 key types for CR Micro, with key features as below:

- **Trench MOS:** 1) Better on-resistance per unit area and figure of merit coefficient (FOM), 2) Strong short circuit resistance, 3) High reliability
- **Planar VDMOS:** 1) Better resistance per unit area and figure of merit, 2) better avalanche tolerance (UIS), 3) Lower EMI characteristics
- **Multi-epi Super Junction MOS:** 1) multi-epi process, 2) better on-resistance per unit area and figure of merit coefficient, 3) high reliability, strong applicability

Customers: diversified customer base

CR Micro's IDM segment products are mainly in consumer electronics (42% of IDM revenue in 2019), followed by automotive/ electric bike at 26%, industrial at 13%, and others at 19%. Its key end-customers by applications include:

- **Consumer electronics:** Haier, Midea, TCL, Hisense, Skyworth, Joyoung, Leedarson, Opple Lighting, Yankon, etc
- **Power:** Salcomp, Huntkey, Lite-On, Chicony, AcBel Polytech, Flextronics, Aohai, Ten Pao, etc
- **Industrial:** Bosch, TTI, Santak, TDC etc
- **Electric bike:** Jinhui, Lingbo, Enpower, etc.

Growth drivers: expanding into automotive/industrial applications

We expect CR Micro's MOSFET revenue to grow at a 31% CAGR in 2020-25E, mainly driven by MOSFET for automotive and industrial control segments. Key growth drivers are growing usage of MOSFET in cars and CR Micro's market share gains from a low base, leading to +52%/+48%/+46% YoY revenue growth in 2021-23E for CR Micro's MOSFET for automotive and industrial control. We expect CR Micro to outgrow the market, driven by:

1. New design-wins in automotive/industrial applications

CR Micro won design-wins in electric tailgate and air conditioner compressors in cars, UPS, servo drive, and welding machines in 2019, and is on track to expand its MOSFET products from consumer electronics to automotive and industrial applications.

Compared to consumer electronics, it usually takes longer time for a new supplier to be qualified by automotive customers given the stricter requirement on product reliability, performance, and quality. CR Micro's new design-wins in automotive shows its capability to meet the strict requirement from automotive customers.

2. Technology upgrades and product portfolio expansion

The company has also completed the R&D of multi-epi Super Junction 650-700V process platform and launched several products for fast-charging, adapter, lighting, and high-power power supply in 2019. CR Micro is also developing new generation Trench MOS for low-voltage applications such as power tool, smartphone fast charging, new energy battery, energy storage battery, etc.

3. Customized solutions

One of CR Micro's key advantages compared to foreign peers is that it can provide customized solutions even for small volume products. This could help CR Micro to penetrate into new customers while keep similar pricing with foreign peers (instead of offering a lower price to gain share from peers), and win more order allocations in existing customers.

Silan in MOSFET: 22% of total revenue in 2019

Products

Silan's MOSFETs are used in PCs, UPS, car inverters, consumer electronics, electric bikes, etc. Silan used to manufacture MOSFET on 6" wafer fabs and started to migrate to 8" wafer fabs since 2017. The company also plans to migrate MOSFET to 12" wafer fabs and is also developing low-voltage, high-voltage, and trench MOSFET on 12" wafer fabs, which would be more efficient than 8" wafer fabs, and there is more equipment available for 12" wafer fabs. Its key MOSFET product lines include Trench LVMOS (30-600V), Planar MOS (250-1500V), and Super Junction MOS (600-800V). Other than discrete MOSFET, Silan also sells MOSFETs together with its power IC. For example, Silan's SSR (secondary side regulated) flyback power management chip has a built-in high-power MOSFET, which can be used in adapters for fast charging, display, tablets, etc.

Customers

Silan has a diversified customer base with top 5 customers only contributing 15% of revenue in 2019. Key customers in each product line are as below:

- **Power discretes (MOSFET, IGBT, TVS, FRD, etc):** Oppo, Vivo, Xiaomi, Lenovo, TCL, ZTE, LG, Amazon, Cisco, Delta, Flextronics, etc,
- **IPM:** Midea, Hisense, Haier, etc
- **AC-DC:** Acbel Polytech, Exar, etc
- **LED driver:** Osram, Yankon, etc

Growth drivers

MOSFET and power IC bundle solutions: Silan's key differentiation from other domestic power semi IDM peers is that it not only focuses on power discrete, but also has a comprehensive product portfolio in power IC such as AC-DC, DC-DC, power management IC, fast charging, etc, which can be bundle solutions with its MOSFET. We model Silan's MOSFET revenue to grow at a +25% CAGR in 2020-25E, driven by growing demand from automotive and industrial applications, as well as Silan's bundle sale of MOSFET and power IC.

Wingtech in MOSFET: 31% of Nexperia 2019 revenues

Products

Wingtech consolidated Nexperia in 4Q19, leading Nexperia to 4% of Wingtech's 2019 revenues, and we expect it to rise to 15% in 2020. MOSFET is one of key products in Nexperia, with 31% revenue contribution in 2019, while the remaining revenues came from: Diode and Transistor (39% of Nexperia 2019 revenues), logic IC (16%), and ESD protection (14%). In MOSFET, Wingtech mainly provides three type of products: automotive, small signal / small power, and power MOSFET. We introduce these three segments, Wingtech's SKUs, edges, and product examples in these three segments.

Products:

- **Automotive MOSFET:** used to turn on and off the power rails in certain units in cars, such as (1) body control, for example, fan control, door control, seat control, windows control, etc., (2) infotainment system, for example, audio control, GPS control, (3) safety system, for example, airbag control, LED lighting control.
- **Small signal / small power MOSFET:** used in non-automotive applications, such as TVs, set-top boxes, tablets, PCs, etc.
- **Power MOSFET:** used in communication DC-to-DC solution, VRM (voltage regulator module), POL (power supply module), synchronous rectifier controller, etc.

SKU and edges:

- **Automotive MOSFET:** Wingtech has over 400 product types, ranging from 20 to 100V with drain currents from 0.3 to 425 A, housed in leading package technologies.
- **Small signal / small power MOSFET:** Wingtech offers broad portfolio with both leaded and leadless options with high power density.
- **Power MOSFET:** Wingtech offers power MOSFET with super junction technology along with leading packaging technology of LPAK, and their products could operate up to 100V.

Product examples:

- **Automotive MOSFET:** Take LPAK56D for example. The product equals to two MOSFETS into one package without compromising on performance, saving 77% space. The product could be used in engine management, ABS (antilock brake system) / ESP (electronic stability program) systems, transmission control, body control, and LED lighting.
- **Small signal / small power MOSFET:** Take PMN30XPA for example. The product launched in Apr 2020, a 20V, P-channel Trench MOSFET used in relay driver (IC to drive or operate a relay appropriately, open or close for example), high-speed line driver (device amplifies a signal), high-side load switch (connect / disconnect a power source), and switching circuits.
- **Power MOSFET:** Take PSMN2R6 - 100SSF for example. The product launched in Jun 2020, a 100V, N-channel MOSFET in LPAK88 package used in industrial and consumer applications, for example: synchronous rectifier in AC-DC and DC-DC, primary side switch in DC-DC, BLDC (brushless DC) motor control, full-bridge and half-bridge applications, and battery protection.

Exhibit 117: Wingtech product examples (ASP and features)

Category	Products	ASP (US\$)	Key features			Others
			Voltage	Power	Current	
Diode	Voltage regulator diode	0.02	27V	250mW	50nA	
Diode	Schottky barrier diode	0.01	30V		200mA	
Transistor	NPN switching transistor	0.01	40V	250mW	200mA	
Transistor	NPN medium power transistor	0.06	80V	1.25W	1A	
MOSFET	N-channel Trench MOSFET	0.02	60V	830mW	300mA	
MOSFET	N-channel Trench MOSFET	0.03	60V	350mW	360mA	
Logic IC	4-bit bus switch	0.25	2.3V~3.6V		250 mA	
Logic IC	Single 2-input multiplexer	0.08	1.65V~5.5V		250 mA	
Logic IC	Shift register with output latches	0.09	2V ~ 6V			8 inputs/bits per element
Logic IC	Quad 2-input AND gate	0.10	2V ~ 6V			2 inputs/bits per element
ESD protection	Low capacitance bidirectional ESD protection diode	0.05	3.3V		18A	
ESD protection	Low capacitance bidirectional ESD protection diode	0.04	5V		15A	

Source: Company data

Customers

Wingtech's semiconductors are mainly exposed to automotive electronics (44% of 2019 Nexperia revenues), followed by mobile and wearables at 21%, industrial and power supply at 20%, and PC and consumer electronics at 15%.

- **Automotive electronics:** Bosch, BYD, Continental, Delphi, Denso, etc.
- **Mobile and wearables:** Apple, Google, Fitbit, Huawei, Samsung, Xiaomi, etc.
- **Industrial and power supply:** Emerson, Cisco, Delta, Schneider, etc.
- **PC and consumer electronics:** ASUS, Dell, HP, Amazon, DJI, Dyson, LG, etc.

Drivers

We are positive on Wingtech's MOSFET and expect its global market share to rise from 4.8% in 2019 to 5.1% / 7% / 10% in 2020-22E and up to 17% by 2025E, driven by:

1. Growing SKUs

Wingtech's overall semiconductors SKU is at 16K currently, which is lower than global leaders Infineon (60K SKUs) and On Semi (30K SKUs); however, it is higher than the Chinese suppliers, which mostly have not reached 10K SKUs yet. Wingtech will continue to expand its SKUs, targeting to expand by ~60% in coming 3-5 years to drive its market share gains.

2. Technology win

Nexperia has over 60 years' experience in semiconductors with leading global market share in (1) discrete devices, global top 1, (2) ESD protection, global top 1, (3) logic IC, global top 2, only after TI, (4) automotive MOSFET, global top 2, only after Infineon, and (5) small signal / small power MOSFET, global top 3, only after On Semi and Rohm.

We see its leading technology as enhancing its global market position. The company is strong in packaging innovative technology, enabling smaller in size, better heat dissipation, lower power consumption, and lower in costs.

Apart from innovative technology, Nexperia also has an equipment R&D center, ITEC, established in 1991. The center mainly develops the packaging and testing equipment, along with revision and maintenance. The R&D center enables Nexperia to provide cost competitive products with mass production at high yield rate and efficiency. ITEC also

continues to upgrade the equipment to support higher automated production and AI (image comparison, big data analysis, etc.) to further drive the yield rate, efficiency and production stability.

3. Upside in China market share

Nexperia's market share in China is at 10% only in 2019 and management targets to drive it up to 30-40% in 3-5 years via expanding SKUs, product lines, and synergy with Wingtech to introduce more Chinese customers to Nexperia. Wingtech is the global leader in Smartphone ODM, with customers across Samsung, Huawei, Xiaomi, OPPO, etc. which could help drive Nexperia's consumer electronics customers in China.

In addition, Wingtech also sees Chinese customers in automotive and industrial are looking to diversify supply chains given trade tensions, to lower the single country supplier risks. Nevertheless, automotive and industrial areas require higher reliability in product performance, stable production and in time services. With Nexperia being merged by Wingtech, the company could help lower Chinese customers' supply chain risks and also provides a wide range of products, higher product performance, stable production (IDM, in house foundry and OSAT), and in time services.

The company's MOSFET is only at 4.8% global market share in 2019, vs. other products at 25%+ global market share: 32% global market share in ESD protection, 26% global market share in logic IC, 25% in Diode & Transistor. We see MOSFET as the next product for Wingtech to target to drive the market share in coming years.

CR Micro investment thesis

We are positive on CR Micro, the leading power semi IDM in China, and model a 55% net income CAGR in 2020-25E, driven by:

- **MOSFET expanding from consumer electronics to auto/industrial applications:** We expect China's MOSFET market to grow at a 5% CAGR in 2020-25E, driven by automotive, industrial, and consumer electronics applications. CR Micro has 8% market share in the consumer MOSFET market in China in 2020E and the company is expanding into automotive and industrial markets, driving CR Micro's MOSFET revenue growth at a 31% CAGR in 2020-25E. The company won new design-wins in electric tailgate and air conditioner compressor in cars, UPS, servo drive, and welding machines in 2019, paving the way for expanding its MOSFET products from consumer electronics to automotive and industrial applications.
- **IGBT, power IC, and smart sensors as mid-long term drivers:** We expect CR Micro to expand its IGBT, power IC, and smart sensor business by leveraging its customer base in its MOSFET business and product expansion in areas such as IPM, fast-charging power control ICs, smart audio amplifiers, and MEMS sensors for medical devices. We model revenue contribution from IGBT, power IC, smart sensors to increase from 10% in 2020E to 29% in 2025E. These products also carry higher GM at 32-43% in 2020E (vs. overall IDM segment GM at 30% in 2020E), driving margin expansion in the long-term.

Silan investment thesis

We are positive on Silan, a leading power semi IDM focusing on IGBT, MOSFET, and power IC; and we model net income growth at a 55% CAGR in 2021-25E, driven by

- **MOSFET and power IC bundle solutions:** Silan's key differentiation from other domestic power semi IDM peers is that it not only focuses on power discrete, but also has a comprehensive product portfolio in power IC such as AC-DC, DC-DC, power management IC, fast charging, etc, which can be bundle solutions with its MOSFET. We model Silan's MOSFET revenue to grow at a +24% CAGR in 2021-25E, driven by growing demand from automotive and industrial applications, as well as Silan's bundle sales of MOSFET and power IC.
- **IGBT expansion into EV and industrial markets:** Silan's IGBT are 600-1200V for consumer electronics products, and it is expanding into higher voltage (1700V and above) IGBT for EV and industrial applications. For EV applications, Silan has developed IGBT for car air conditioners, main motor drives, and on board chargers. We model Silan's IGBT revenue to grow at a 41% CAGR in 2021-25E, contributing 22% of revenue by 2025E (vs 10% in 2020).
- **Margin recovery:** Silan's GM was at 25-27% in 2015-18, but declined to 19.5% due to low utilization rate of 8" fab. We model the GM to recover from 20.4% in 2020E to 22.2%/23.9%/25.6% in 2021-23E on the back of improving utilization and product mix improvement. By products, both IGBT (GM at 29% in 2020E) and MOSFET (GM at 25% in 2020E) carry higher GM than other product lines (other power discretes, power IC, and LED). The increasing revenue contribution from IGBT/IPM (from 10% in 2020E to 26% in 2025E) and MOSFET (from 22% in 2020E to 25% in 2025E) should drive GM expansion.

Wingtech investment thesis

We expect Wingtech net income to grow at a 22% CAGR in 2020-25E, with semiconductors revenues / GP to grow at a 25% / 28% CAGR during the same period, and blended GM to expand to 24% by 2025E (vs. 10.3% / 12.8% in 2019 / 20E), driven by:

- **Semiconductors market share expansion:** We are positive on market share expansion given Wingtech's (1) large SKUs (16K, vs. Chinese peers hardly at 10K), (2) leading technology (innovative packaging to shrink size, enhance heat dissipation, lower costs, and in-house equipment R&D center to enhance product yield rate and production stability), and (3) upside in Chinese brand customers after Nexperia became a Chinese supplier, participating in the Chinese brand customers' trend of diversifying supply chains given the trade tensions to lower the single country supply risk.
- **Semiconductors product lines expansion:** Wingtech's semiconductors / Nexperia enjoyed 14% global market share in 2019, with four main products: Diode & Transistor, Logic IC, ESD protection, and MOSFET. In the future, management targets to expand products to GaN FET, SiC, and power management IC. Wingtech stated their GaN FET products started mass production in Oct 2019 at 650V, and the

company targets to introduce 900V product by end of 2020E, and 1200V product by end of 2021E. The target end markets include EVs (e.g. ON-Board Controller module, or OBC module), data centers, telecom equipment, industrial automation, and high-end power supply. For SiC, the company is doing R&D currently, and targets to launch products in the coming 2-3 years. For management IC, possibly through in-house R&D or M&A.

- **Growing semiconductors support GM:** We expect Wingtech's semiconductors gross profits contribution to rise from 10% / 34% in 2019 / 20E to 86% in 2025E driven by market share gains and product line expansion, with the ODM business at a declining GM trend given the fierce competition, China 5G smartphone shipment growth to peak out in 2021E and the company's more focus on semiconductors business. The semiconductor GM is at 30.7% on average in 2020-25E vs. ODM at 9.3% on average during the same period. With growing high GM business, we expect the blended GM to rise to 24% in 2025E from 10.3% / 12.8% in 2019 / 20E.

CR Micro valuation and downside risks

Valuation: Our 12-month target price of Rmb88 is based on discounted P/E valuation as we expect CR Micro to enjoy stronger EPS growth than peers through 2025E on the back of market share gains, product mix upgrades, and margin expansion. We apply 33x target P/E multiple to CR Micro's 2025E EPS and discount back at a COE of 9% (1.0 Beta, 3% risk-free rate, and 6% market risk premium). The 33x target P/E multiple is derived from the sector P/E-EPS YoY correlation, as the market has generally rewarded higher EPS growth companies in the semiconductor industry based on our regression analysis. Our target price implies 80x 2022E P/E, or PEG at 1.6x based on average 2023-24E EPS YoY growth (50%). Our valuation crosscheck using the DCF method also shows a similar theoretical share value of Rmb89.7, or 81x 2022E P/E. The stock currently trades at 51x our 2022E EPS and at 1.0x our PEG based on average 2023-24E EPS YoY growth, which we believe is attractive considering its strong earnings growth at a +64% CAGR in 2020-23E.

Downside risks:

1. **Weaker-than-expected MOSFET market growth:** We forecast a 5% China MOSFET market CAGR in 2020-25E, mainly driven by automotive, industrial, and home appliance applications. If the penetration of EV and inverter-base home appliances is slower than our forecast, or if the usage of MOSFET in EV/inverter-base home appliances are lower than our expectation, the MOSFET market growth could be weaker than our current forecast.
2. **Slower-than-expected new design-win and market share gain:** We model CR Micro to gain market share in China's MOSFET market from 9% in 2020E to 21% in 2025E, mainly in automotive, industrial, and consumer applications. If CR Micro's new design-wins or market share gains are slower than our expectations, there could be downside to our earnings estimates.
3. **New product (IGBT and power IC) development progress:** We expect CR Micro's IGBT revenue to increase from 1% of total revenue in 2019 to 2-7% in 2020-25E,

and power IC revenue to increase from 5% of total revenue in 2019 to 6-16% in 2020-25E. If the R&D progress or customer qualification of IGBT and power IC is slower than our expectation, it could result in slower earnings growth in 2020-25E.

4. **Severer-than-expected competition:** There are new entrants in MOSFET in China such as Wingtech, Jiejie Micro, etc. We expect CR Micro to have 26% market share in the China MOSFET market by 2025E. If other domestic competitors have faster R&D/new design-wins/market share gains from CR Micro, there could be downside to our earnings estimates.
5. **Potential impact from COVID-19:** CR Micro's revenue is mainly from the domestic market (~80% of revenue) but its customers' end products could be sold globally; we thus believe CR Micro could be impacted by the macro economic slowdown globally in 2020. We're more cautious on CR Micro's revenue growth in near-term and model -2% revenue YoY in 2H20E (vs +17% YoY in 1Q20).

Silan valuation and downside risks

Valuation: Our 12-month target price of Rmb21.5 (implies a 71x 2022E P/E) is derived from discounted P/E, as we believe Silan is still at an early stage compared to global leaders. Discounted P/E captures the company's long-term business opportunity to justify its current higher-than-peers' P/E multiple. We apply 30x target P/E multiple to Silan's 2025E EPS and discount back at COE of 9.2% (1.0 Beta, 3% risk-free rate, and 6% market risk premium). The 30x target P/E multiple is derived from the sector P/E-EPS YoY correlation, as the market has generally rewarded higher EPS growth companies in the semiconductor industry based on our regression analysis. Our target price implies 71x 2022E P/E, or PEG at 1.3x based on average 2023-24E EPS YoY growth (54%). Our valuation crosscheck using the DCF method also shows a similar theoretical share value of Rmb22.2, or 74x 2022E P/E. The stock currently trades at 57x our 2022E EPS and at 1.0x our PEG based on average 2023-24E EPS YoY growth, which we believe is attractive considering its strong earnings growth at a +55% CAGR in 2021-25E. Our 12M target price implies 7.3x 2022E P/B, higher than its historical trading avg+1std of 5.4x as we expect Silan's ROE to expand from 2% in 2020E to 6%/11% in 2021/22E. The stock is currently trading at 5.8x 2022E P/B, higher than global power semiconductor peers' trading range of 1.0x-3.3x, we think given Silan's stronger earnings growth and ROE expansion in coming years.

Downside risks:

1. **Weaker-than-expected IGBT market growth:** We forecast 7% China IGBT market CAGR in 2020-25E, mainly driven by EV and home appliance applications. If the penetration of EV and inverter-base home appliances is slower than our forecast, or if the usage of IGBT in EV/inverter-base home appliances is lower than our expectation, the IGBT market growth could be weaker than our current forecast.
2. **Weaker-than-expected MOSFET market growth:** We forecast 5% China MOSFET market CAGR in 2020-25E, mainly driven by automotive and EV charging. If the penetration of EV is slower than our forecast, or if the usage of MOSFET in automotive and EV charging systems are lower than our expectation, the MOSFET market growth could be weaker than our current forecast.

3. **Slower-than-expected new design-wins and market share gains:** We model Silan to gain market share in China's IGBT market from 1.9% in 2020E to 7.6% in 2025E, and in China's MOSFET market from 3.6% to 8.5%, mainly in EV, home appliances, and industrial applications. If Silan's new design-wins or market share gain are slower than our expectation, there could be downside to our earnings estimates.
4. **Potential impact from COVID-19:** Silan's revenue is mainly from the domestic market (~98% of revenue) but its customers' end products could be sold globally, we thus believe Silan could be impacted by the macro economic slowdown globally in 2020.

Wingtech valuation and downside risks

Valuation: Our 12-month target price of Rmb189 (implied 39x 2022E PE) is derived from discounted P/E. We derive our target PE multiple based on its global peers correlation between EPS growth and PE. On this basis we apply a target P/E of 33x to 2025E EPS. We then discount implied value per share back to 2022E at a COE at 9%, which is derived from a 1.0x rate, a 3% risk-free rate, and a 6% market risk premium. Our 12M target price is thus at Rmb189, with implied 39x 2022E PE-

Downside risks:

Slower-than-expected GM expansion: Our strong earnings growth ahead is based on the company's extension toward semiconductors. A slower-than-expected GM expansion could be caused by tougher-than-expected competition in semiconductor business or ODM business, slower-than-expected market share gains in semiconductor business, slower-than-expected semiconductor new products rolling out, or the company's strategy change, back to a focus on ODM business.

Slower-than-expected semiconductor revenues growth: Our strong earnings growth ahead is driven by Wingtech's strong semiconductor revenues growth. A slower-than-expected semiconductor revenues growth could be caused by fiercer-than-expected competition in semiconductor business, slower-than-expected market share gains in semiconductor business, or slower-than-expected semiconductor new products roll-out.

Slower-than-expected ODM revenues growth: Our strong earnings growth ahead is also supported by Wingtech's ODM revenues growth. A slower-than-expected ODM revenues growth could be caused by fiercer-than-expected competition, lower-than-expected ODM ratio or slower-than-expected market share expansion.

Slower than expected ODM product lines expansion: Our strong earnings growth ahead is also supported by Wingtech's ODM product lines expansion, such as for notebooks and TWS. Slower-than-expected ODM product lines expansion could be caused by new notebook brand makers' slower-than-expected market share expansion, given the new entrants are mostly smartphone brand makers, including Xiaomi, Huawei, OPPO, etc. which are all Wingtech's existing smartphone ODM customers. With these

smartphone brand makers' expansion into notebooks and TWS, Wingtech has better opportunity to expand their ODM product lines, and vice-versa.

Slower-than-expected synergies / integration between Wingtech and Nexperia:

Wingtech merged with Nexperia in late 2019, and our strong earnings growth ahead is also driven by the two entities' synergies, for example, Wingtech to introduce more Chinese customers to Nexperia while Nexperia expands Wingtech's business from ODM to semiconductors. Slower-than-expected synergies / integration between the two entities could bring downside risks to our revenue assumptions.

Power Semiconductors: Competitive Landscape, Stock Ideas

This section shows: (1) Chinese suppliers of power semiconductors vs. global peers in terms of their financials (revenues scale, R&D investments, margins, ROE, etc.), (2) stock ideas.

Bottom line: Chinese suppliers are smaller scale but have stronger growth with government support in R&D. We see Hua Hong, a foundry, as a key beneficiary in the growing IGBT and MOSFET markets.

Power Semi financial comparison among Chinese and global players

Revenue

StarPower's revenue was only 1.3% of the scale of global leader Infineon in 2019, but we expect this to grow to 2.8% in 2022E, driven by stronger growth in sales of IGBT modules for EV and IPM for energy-efficient home appliances from a low base. CR Micro's revenue scale is only 9% of Infineon's in 2019 and we model CR Micro's revenue to expand to 14% of the scale of Infineon's in 2022E, driven by its stronger growth in MOSFET, power ICs, and smart sensors.

OPM and EBITDA margin

StarPower's OPM was 18% in 2019, higher than global peers' 13-14% given StarPower's asset-light business model of fabless IC design and module manufacturing. For EBITDA margin, StarPower's was 22% in 2019, which was at the lower-end of global peers' EBITDA margin of 22%-26% in 2019. We expect StarPower's OPM and EBITDA margin to expand to 26% and 28% in 2022E, respectively, driven by improving product mix toward IGBT modules for EV and IPMs.

CR Micro's OPM was 5% in 2019, lower than global peers' 13-14%, and its EBITDA margin was 17% in 2019 (vs. peers at 22-26%). We believe CR Micro's lower margins were mainly due to its product mix as its products are mostly used in consumer electronics applications, while global peers have higher revenue exposure to automotive and industrial applications, which usually carry higher margins given the stricter requirement on product reliability. We expect CR Micro's OPM and EBITDA margin to expand to 13% and 24% in 2022E, respectively, driven by improving product mix toward industrial/automotive applications.

R&D and R&D ratio

StarPower's/CR Micro's R&D ratio was 7%/8% in 2019, lower than global peers at 12%-16% but higher than domestic peers at 3%-6%. In terms of R&D expenses, StarPower/CR Micro's scale was only 0.7%/6.4% of Infineon's in 2019 (US\$1.1bn). In next 3 years, we expect both StarPower and CR Micro to maintain their R&D ratio at similar levels vs 2019, and for their R&D expenses to rise to 1.1%/8.0% of Infineon's level in 2022E.

ROE and ROA

StarPower's ROE and ROA were 27% and 17% in 2019, higher than global peers' ROE of 12%-19% and ROA of 3%-9% in 2019, respectively. This was due to StarPower's asset-light business model, whereas global peers are all IDMs with in-house semiconductor manufacturing capacity. CR Micro's ROE and ROA were lower than peers at 8% and 4% in 2019, respectively, mainly due to its lower margins. In the next 3 years, we expect both StarPower and CR Micro's ROE/ROA to improve, thanks to an improving product mix and margins.

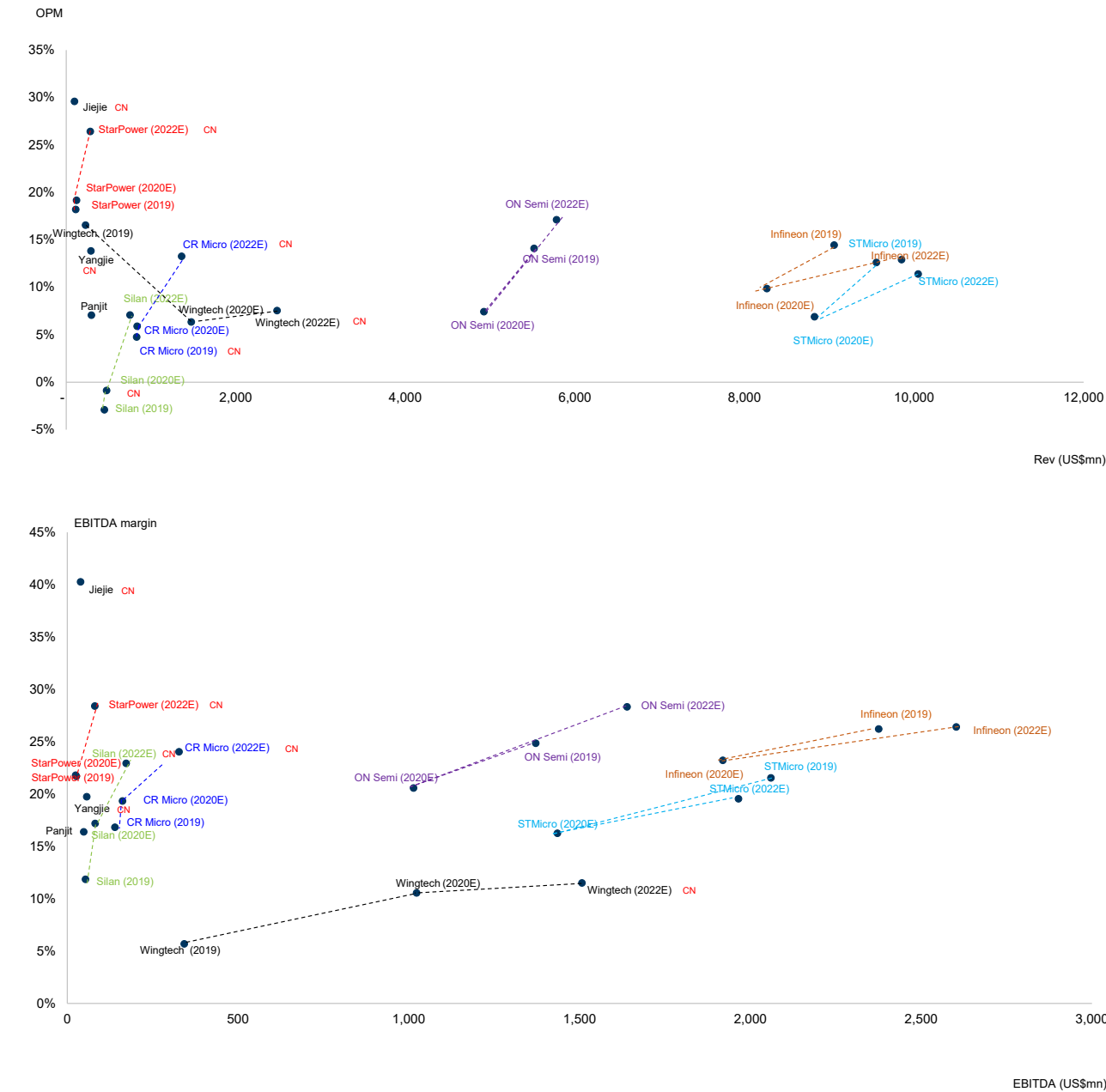
Cash conversion cycle (CCC)

StarPower's CCC was 144 days in 2019, longer than global peers' 79-110 days, mainly due to its longer account receivable days (101 days vs. global peers' 43-51 days). CR Micro's CCC was 45 days in 2019, shorter than global peers due to its longer account receivable days (105 days) and longer account payable days (152 days vs global peers' 60-82 days). StarPower's CCC level is similar to domestic peers, while CR Micro's is lower than domestic peers.

Capex and capex ratio

StarPower's capex-to-sales ratio was 6% in 2019, lower than global peers at 10%-18% due to its asset-light business model. CR Micro's capex-to-sales ratio was 11% in 2019, at the lower-end of global peers of 10%-18%. We expect both StarPower and CR Micro to maintain their capex-to-sales ratio at similar levels with 2019 as both companies will continue to expand capacity to meet growing domestic demand in IGBT and MOSFET. In terms of capex scale relative to global peer, we expect CR Micro's capex to grow from US\$87mn (5% of Infineon's capex) in 2019 to US\$219m (15% of Infineon's capex) in 2022E.

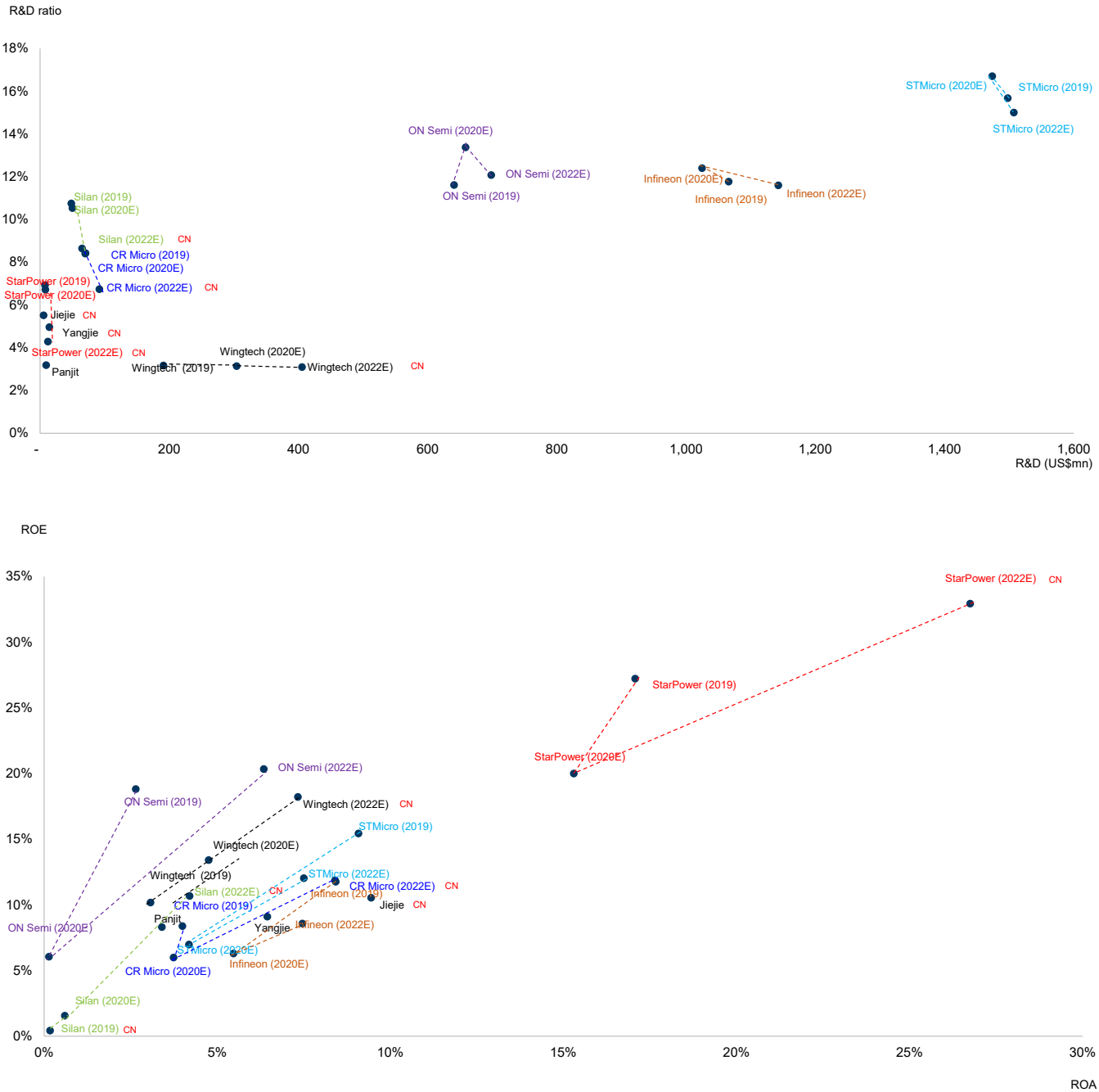
Exhibit 118: Power semi OPM and rev, EBITDA margin and EBITDA scatter chart



Note: CN indicates that the company is from China

Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

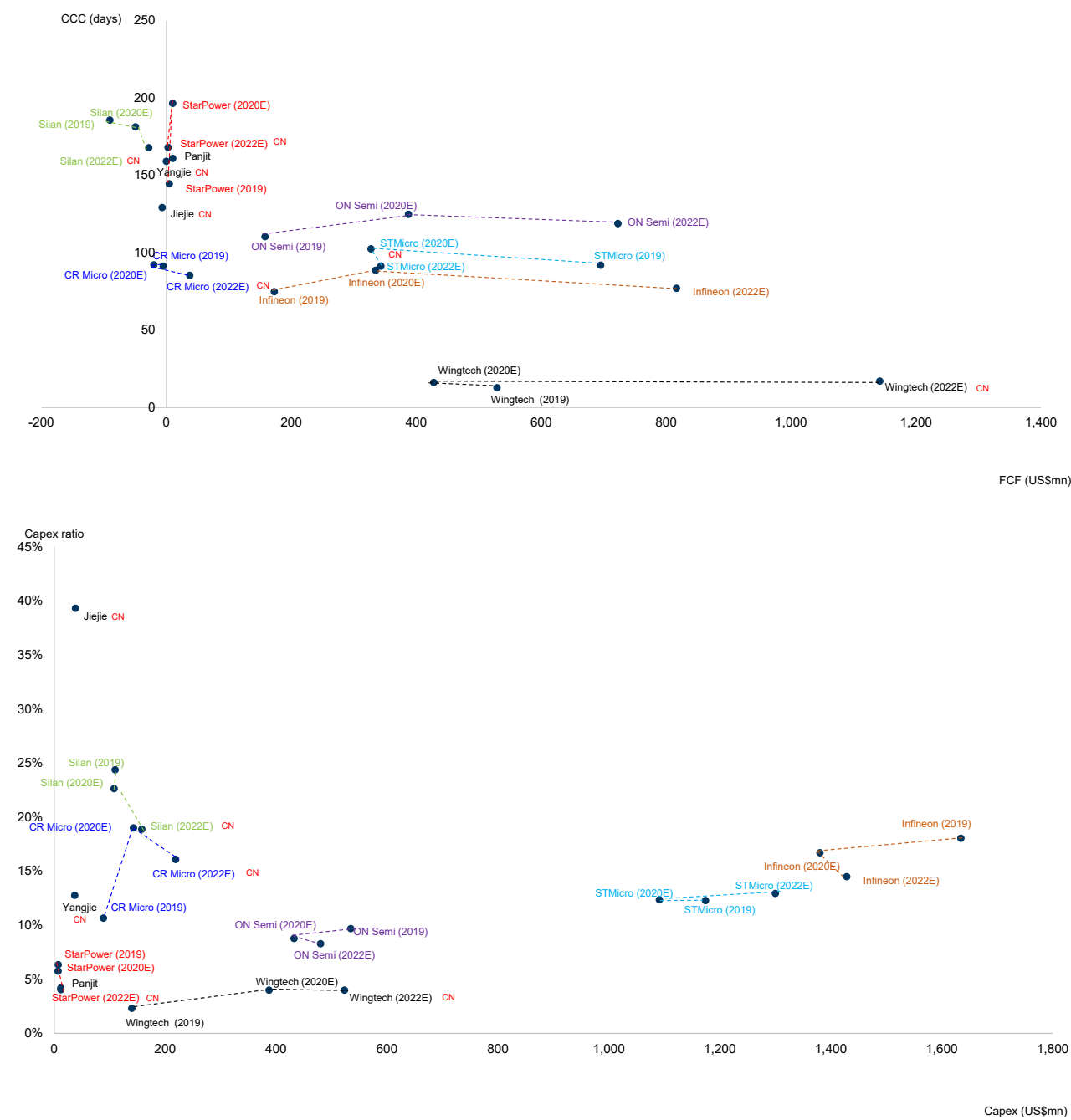
Exhibit 119: Power semi R&D ratio and R&D, ROE and ROA scatter chart



Note: CN indicates that the company is from China

Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 120: Power semi CCC days and FCF, capex ratio and capex scatter chart



Note: CN indicates that the company is from China

Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Power Semi stock idea: Hua Hong, what are its advantages?

We maintain our constructive on Hua Hong and its power semiconductor business, and we believe Hua Hong will also be a key beneficiary of the growing IGBT / MOSFET market in China (43% of Hua Hong's revenue to come from IGBT and MOSFET in 2020E). While there are rising power semi players in China, we maintain our positive view on Hua Hong's power semiconductor business given its advantages of: 1) leading technology capability among domestic peers, 2) pure-play foundry position, 3) first mover in power semis on 12" wafer fab, 4) the largest power semiconductor capacity scale in China, and 5) diversified and comprehensive customer base.

Technology: Hua Hong has better capability in IGBT voltage range and backside thinning process

Hua Hong's IGBT technologies cover 600V-750V FS, 1200V NPT/FS, and 1700V NPT/FS for applications such as home appliances, EVs, induction heaters, motor drivers, UPS, welding, power trains, smart grid, wind power, solar inverter, etc. Its MOSFET technologies cover from low-voltage MOSFET, Trench HV MOSFET (400-700V), to Super Junction MOSFET (600-700V). Its MOSFET products are used in applications such as SMPS (switch mode power supply), AC/DC, adapters, chargers, ELD lighting, etc. Hua Hong has also been gradually upgrading its power discrete product portfolio, with IGBT and Super Junction MOSFET (the higher-end MOSFET) contributing ~50% of its power discrete revenue in 2019. In comparison, CR Micro can cover a wider range of MOSFET voltages (up to 1500V), but can only do 600V and 1200V IGBT. Silan can cover MOSFET voltage up to 900V, but can only do 600V and 1200V IGBT as well.

Hua Hong has better capability in IGBT backside thinning process than domestic peers: Backside thinning process is a key manufacturing process for IGBT, and makes wafers thinner to reduce power consumption and improve the switching speed. On this technology, Hua Hong is the leader among Chinese peers with the capability to reduce the thickness of wafer to 60um — which still lags behind global leaders (can reduce wafer thickness to 40um), but is ahead of other domestic peers which can only reduce wafer thickness to 100um or above.

Pure-play foundry: well-positioned to serve all customers without conflicts of interest

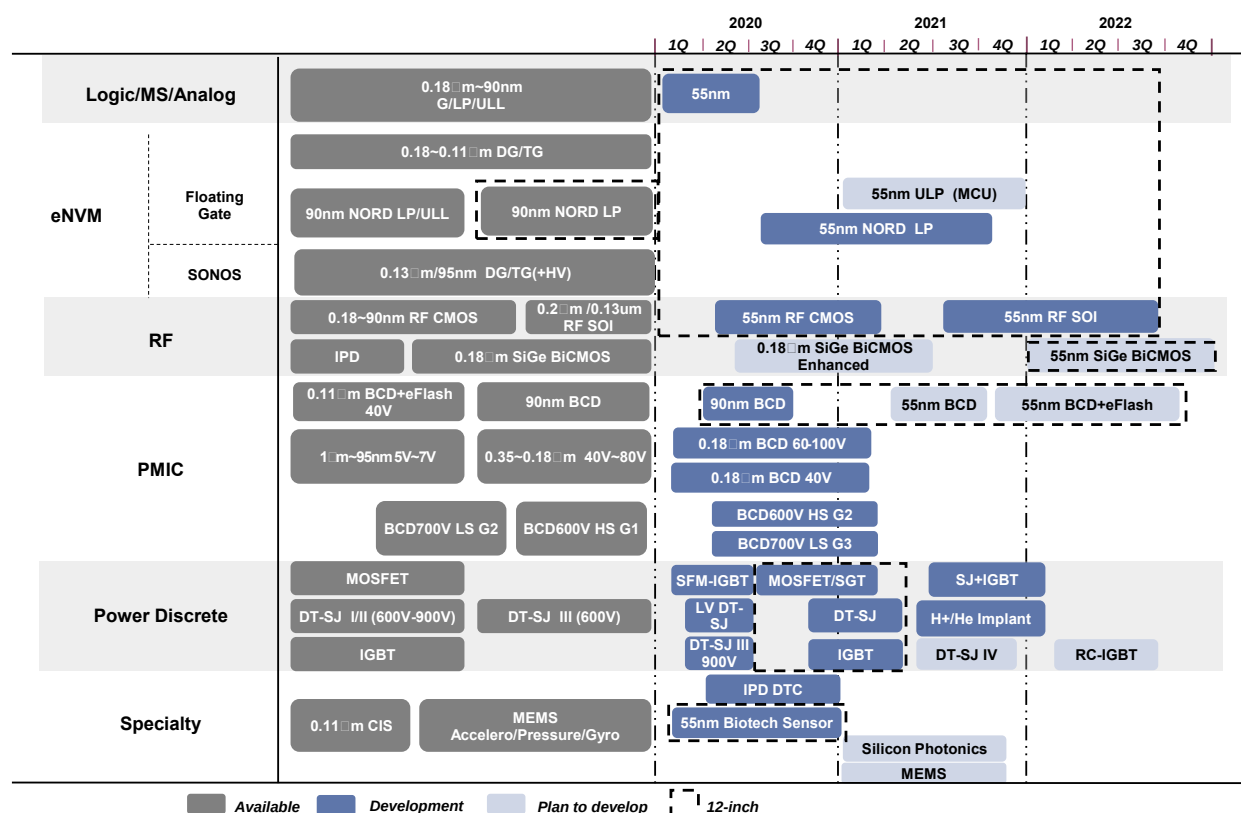
Most emerging power semi players in China run IDMs or fabless business models, and Hua Hong is the leading power semi foundry player in China in terms of capacity and technology capability, making Hua Hong the go-to foundry for fabless customers and system customers who can design their own power semi solutions. One of the benefits of the foundry business model is that it doesn't compete with its customers directly, so there's no conflicts of interest. We also expect domestic system customers to work with Hua Hong to design their own power discrete solutions to better fit their product requirement and enhance supply chain stability. In contrast, fabless and system customers may be less willing to outsource their product manufacturing to IDM peers as there could be potential conflicts.

12" fab power semi: providing 20-30% cost saving vs 8" fabs

Hua Hong is the first in China to migrate power discretes to 12" wafer fab in 2020,

which saves unit cost by 20-30% once the yield rate ramps up. The cost saving comes from larger wafer size (a 12" wafer is 2.25X the size of an 8" wafer), while equipment cost is only 1.7X that of the 8" wafer fab, and personnel cost is only 0.8X. Hua Hong plans to migrate power discrete to 12" fab, with SGT MOSFET ready in 3Q20, Super Junction and IGBT ready in 4Q20. Hua Hong plans to build 10k wafers/months capacity for Power Discretes at its Wuxi 12" fab in 2H20, with another 10k capacity in 2021-22.

Exhibit 121: Hua Hong technology roadmap - migrating power discrete to 12" fab from 2H20



Source: Company data

Capacity: Hua Hong has the largest power semi capacity scale compared with domestic peers

Hua Hong has 85k wpm capacity on 8" wafer fab for power discrete in 2019, which accounted ~6% of global demand and is the largest power discrete foundry in China in terms of capacity scale.

Customers: Hua Hong has diversified and comprehensive customer base

Hua Hong has more than 100 customers across several applications such as consumer electronics, industrial control, computing, servers, automotive electronics, networking, and communications. By customer mix, ~70% of Hua Hong's power discrete revenue is from customers in Greater China (mainly fabless and system customers), and the remaining ~30% is from foreign customers (mainly IDMs). Most power device suppliers in Greater China are Hua Hong's customers, and its products are gradually migrating from mid- to low-voltage power devices for consumer/computing applications to high-end power devices for industrial control, servers, and automotive/EV applications.

Its power discrete customers include StarPower, NCE Power, Oriental Semiconductor, Sinopower, Diodes, Alpha Omega, Fuji, etc. Below are Hua Hong's key power discrete customers in China:

- **StarPower** is Hua Hong's key customer in IGBT and contributed ~50% of Hua Hong's IGBT revenue in 2019. Hua Hong has ~75% order allocation in StarPower, while the remaining ~25% allocation is taken up by ASMC/GTA Semiconductors. StarPower also purchases IGBT chips from other chipmakers per its customers' requests. However, StarPower has been increasing the ratio of in-house design chips from 20% in 2016 to ~60% in 2019, and targets to further increase the ratio in the coming year, which will benefit Hua Hong.
- **NCE Power** is Hua Hong's key customer in MOSFET and contributed 5% of Hua Hong's revenue in 1H19. Hua Hong has ~80% order allocation in NCE Power, and CR Micro has ~20% allocation. NCE Power's major products include Trench MOSFET (12V-250V), Super Junction MOSFET (500V-900V), Shielded Gate MOSFET (30V-300V), and 600V-1350V IGBT. Its products are used in consumer electronics, automotive electronics, industrial electronics, NEV and charging systems, IoT, solar, etc.
- **Oriental Semiconductor** is Hua Hong's customer for both IGBT and MOSFET, and its products are used in fast charging, EV charging systems, switch power supply, DC motor drives, solar inverters, etc. According to the company, it is the first domestic player to penetrate into power devices for NEV charging systems.

Who are Hua Hong's key domestic competitors in power semi foundry space?

As most power semi suppliers in China run IDM business models, they pose limited direct competition to Hua Hong in the power semi foundry space. However, some IDMs (e.g., CR Micro) also have a certain portion of their capacity serving external customers, which compete with Hua Hong directly. Also, Hua Hong's IC design customers compete with the IDMs, which would impact Hua Hong's business if their IC design customers gain or lose market share from IDM peers. Below we listed Hua Hong's major competitors in the power semi foundry space in China:

- **CR Micro** is a leading power semiconductor IDM and it also has a Manufacturing Service business that provides foundry and OSAT service to external customers. CR Micro's foundry business is smaller than those of SMIC and Hua Hong in terms of revenue scales and capacity. However, CR Micro mainly focuses on power semis and can provide OSAT service as well, which could be attractive to customers who are looking for a one-stop-shop with a proven track record in power semi devices. CR Micro's foundry business has capacity of 65k wafers/month on 8" wafer fab and 210k on 6" wafer fab in Wuxi, with technologies of 1.0-0.11um process nodes and platforms of silicon-based/SOI-based BCD (bipolar-CMOS-DMOS, a key technology for power ICs), mixed-signal, high-V CMOS, RF CMOS, bipolar, BiCMOS, eNVM, IGBT, MEMS, silicon-based GaN, SiC, etc.
- **SMEC (SMIC's JV):** Semiconductor Manufacturing Electronics (Shaoxing) Corporation (SMEC; a JV and 23.5% owned by SMIC), was founded in 2018 and started production in November 2019, with a planned capacity of 43k 8"

wafers/month. Its products include IGBT, MOSFET, MEMS, RF, etc. For IGBT, SMEC focuses on the Trench +FS (field stop) IGBT structure, and can provide a whole set of advanced backside IGBT processes, which include temporary bonding and debonding, wafer thinning process, wet etch, ion implant, laser anneal, and backside metal processes. The company can provide 600V~1200V IGBT device general processes with device structure customization support. In February 2020, SMEC and Yangjie announced an agreement to collaborate on IGBT and high-end MOS for R&D and capacity support ([report link](#)).

Hua Hong valuation and risks

Valuation: We are Buy rated. Our 12-month target price of HK\$38.0 is based on discounted P/E. We apply a 25x P/E multiple to Hua Hong's 2025E EPS and discount it back to 2022E at a COE of 9.5%. Our target multiple of 25x is derived from a global semiconductor peers' P/E vs earnings growth correlation. We use 2025E EPS as that is the year when we expect Hua Hong to migrate to 28nm and for its GM to recover back to 28%, and we expect stabilizing growth after 2025E. Our target price implies 2022E P/E of 41x and 2022E P/B of 2.5x.

Downside risks to our investment thesis are:

1) US-China trade negotiations: The development of trade negotiations between the US and China could be a potential risk, as Hua Hong derived 16% of revenue (in 2019) from US-headquartered customers for products such as MCUs, PMICs, and power discrete. However, as demand from domestic customers is growing faster than that from overseas clients, we believe domestic customers could fill any demand gaps in the long term.

2) Slower-than-expected 12" fab ramp-up: If the 12" fab ramp-up is delayed, the high depreciation cost in the absence of offsetting revenue could impact Hua Hong's profitability. Potential risks that may impact 12" fab ramp-up and profitability include customers' demand for MCUs and smart card ICs, changes in government subsidies and funding support.

3) Weaker than expected IGBT market growth: We forecast 7% China IGBT market CAGR in 2020-25E, mainly driven by EV and home appliance applications. If the penetration of EV and inverter-base home appliances is slower than our forecast, or if the usage of IGBT in EV/inverter-base home appliances are lower than our expectations, IGBT market growth could be weaker than our current forecast.

4) Slower than expected MOSFET market growth: We forecast 5% China MOSFET market CAGR in 2020-25E, mainly driven by automotive and EV charging. If the penetration of EVs is slower than our forecast, or if the usage of MOSFET in automotive and EV charging systems is lower than our expectation, MOSFET market growth could be weaker than our current forecast.

5) Potential impact from COVID-19: Hua Hong's revenue is mainly from the domestic market (~60% of revenue) but its customers' end products could be sold globally, we thus believe Hua Hong could be impacted by the macro economic slowdown globally in 2020.

Exhibit 122: Hua Hong P&L

(US\$m)	1Q19	2Q19	3Q19	4Q19	1Q20	2Q20E	3Q20E	4Q20E	2016	2017	2018	2019	2020E	2021E	2022E
Revenue	221	230	239	243	203	220	227	258	721	808	930	933	907	1,062	1,281
Gross profit	71	71	74	66	43	50	50	58	220	267	311	282	200	253	325
Operating expense	(32)	(35)	(40)	(71)	(71)	(46)	(38)	(57)	(104)	(116)	(130)	(179)	(213)	(182)	(204)
Operating income	39	36	34	(5)	(29)	4	12	1	116	151	181	104	(12)	71	121
Pre tax profit	45	61	57	19	(9)	19	26	16	153	172	221	182	52	113	162
Net income	47	43	45	26	20	17	26	20	129	145	183	162	84	120	155
EPS (US\$)	0.04	0.03	0.04	0.02	0.02	0.01	0.02	0.02	0.12	0.14	0.17	0.13	0.06	0.09	0.12
Margins / ratio															
Gross margin	32.2%	31.0%	31.0%	27.2%	21.1%	22.8%	21.9%	22.5%	30.5%	33.1%	33.4%	30.3%	22.1%	23.8%	25.4%
Opex ratio	-14.4%	-15.4%	-16.8%	-29.4%	-35.2%	-20.9%	-16.8%	-22.1%	-14.4%	-14.3%	-14.0%	-19.2%	-23.4%	-17.1%	-15.9%
Operating margin	17.8%	15.7%	14.2%	-2.2%	-14.2%	1.9%	5.1%	0.3%	16.1%	18.7%	19.5%	11.1%	-1.4%	6.7%	9.4%
Net margin	21.5%	18.8%	18.9%	10.8%	10.0%	7.7%	11.6%	7.8%	17.9%	18.0%	19.7%	17.4%	9.2%	11.3%	12.1%
QoQ															
Revenue	-11%	4%	4%	2%	-16%	8%	3%	14%							
Gross profit	-16%	1%	4%	-11%	-35%	17%	-1%	17%							
Operating income	-14%	-8%	-6%	nm	nm	nm	180%	-93%							
Pre tax profit	-22%	36%	-6%	-67%	nm	nm	39%	-39%							
Net income	-3%	-9%	4%	-42%	-22%	-16%	55%	-23%							
EPS (US\$)	-12%	-9%	4%	-42%	-23%	-16%	55%	-23%							
YoY															
Revenue	5%	0%	-1%	-3%	-8%	-4%	-5%	6%	11%	12%	15%	0%	-3%	17%	21%
Gross profit	5%	-8%	-10%	-22%	-40%	-30%	-33%	-12%	9%	21%	16%	-9%	-29%	26%	29%
Operating income	-6%	-17%	-33%	nm	nm	-89%	-66%	nm	30%	30%	20%	-43%	nm	nm	70%
Pre tax profit	12%	2%	-11%	-67%	nm	-69%	-54%	-15%	23%	12%	28%	-18%	-71%	115%	44%
Net income	18%	-5%	-6%	-47%	-57%	-61%	-42%	-23%	14%	13%	26%	-11%	-48%	43%	29%
EPS (US\$)	-4%	-23%	-24%	-52%	-57%	-61%	-42%	-23%	14%	13%	22%	-26%	-49%	43%	29%

Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Power Amplifiers (PA): Intro, TAM, Competitive Landscape, Stock Ideas



Global Power Amplifier
TAM: US\$11.6bn by 2025E,
11% 2020-25E CAGR

China Power Amplifier
TAM: US\$3.9bn by
2025E, 6% 2020-25E
CAGR

Bottom line: We are positive on the burgeoning Power Amplifier (PA) market driven by applications in rapidly growing 5G smartphones and base stations; we estimate the TAM for PA will grow at an 11% CAGR in 2020-25E. **Buy Sanan, an emerging player in China's PA foundry market best placed to capitalize on strong underlying growth.**

PA introduction

What is RF PA?

RF PA (radio frequency power amplifier) is a semiconductor device that converts a low-power RF signal into a higher power signal, and is widely adopted in wireless communication networks such as base stations, smartphones and WiFi routers. In a smartphone RF front-end module, the PA receives the signals from the modem and the RF transceiver, amplifies the signal, and sends it out to an antenna through other components including a filter, switch, duplexer and antenna tuner.

Material comparison: GaAs vs GaN vs Si LDMOS; GaN to replace Si LDMOS in 5G base stations

GaAs, GaN, and silicon are three major materials used in RF PAs, each with different properties in power and frequency. GaAs accounted for 40% of the global PA market in 2019 and is mainly used in smartphones, routers and small cells. GaN accounted for 35% and is mainly used in 5G base stations and small cells; LDMOS (Si) accounted for 25% in 2019 and is mainly used in smartphones and 4G base stations. In the coming years, GaN will gradually replace LDMOS in base stations as 5G penetration rises. By 2025E, accounting for 45% of the global PA market, followed by GaAs (40%) and LDMOS (15%).

This is because of GaN PA's high power density and high frequency, which is suitable for 5G base stations. Among these three materials, GaN has the best power density at more than 30W/mm, while GaAs is at 0.5W/mm and silicon is at 0.2W/mm. In terms of cut-off frequency, GaN and GaAs are both at 150GHz, while silicon is at 20GHz.

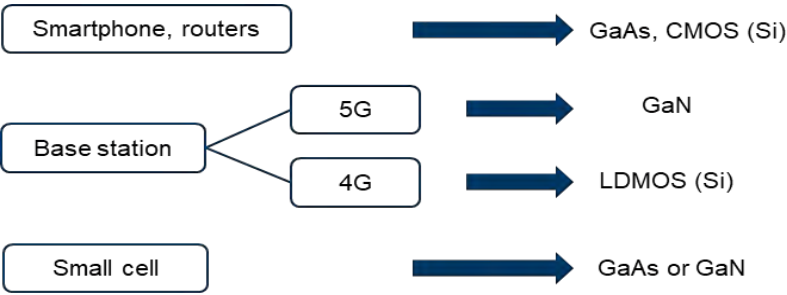
GaN: Gallium nitride

GaAs: Gallium arsenide

Si LDMOS: Silicon
laterally-diffused
metal-oxide semiconductor

CMOS: Complementary
Metal Oxide
Semiconductor

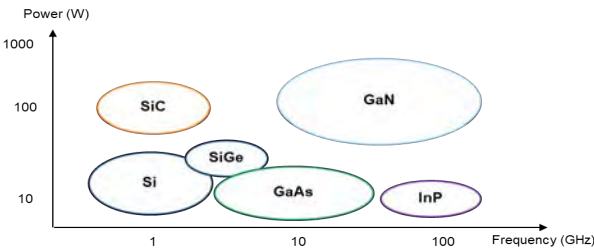
Exhibit 123: 5G smartphone PAs continue to be based on GaAs technology while 5G base stations will migrate from LDMOS to GaN



Source: Goldman Sachs Global Investment Research

Exhibit 124: GaN best supports high frequency and high power applications

Comparison of power and frequency of major PA materials



GaN = Gallium Nitride, GaAs = Gallium Arsenide, Si = Silicon, SiGe = Silicon-Germanium, SiC = Silicon Carbide, InP = Indium Phosphide

Source: Microsemi, Data compiled by Goldman Sachs Global Investment Research

Exhibit 125: GaN has high frequency and power but costs more to manufacture than other materials

Ranking of key features for major PA materials

	GaN	GaAs	Si	SiC
Frequency	High	Medium	Low	Low
Power	High	Low	Medium	Medium
Costs of manufacturing	High	Medium	Low	High
Thermal conductivity	Low	Low	Medium	High
Stage of development	Developing	Mature	Mature	Developing

Source: Freescale, Data compiled by Goldman Sachs Global Investment Research

Material comparison: GaN-on-Si vs GaN-on-SiC; GaN-on-SiC better performance but higher material cost

GaN devices can be grown on different materials, including SiC (Silicon Carbide), silicon, sapphire, diamond, GaN and others. In terms of RF applications, there is considerable debate about the merits of GaN-on-Si vs GaN-on-SiC. GaN-on-SiC has three times the thermal conductivity of GaN-on-Si, which enables devices to function at a much higher voltage and higher power density. GaN and SiC are lattice-matched, which means the manufacturing yield rate should be better and the chip size smaller. In contrast, for GaN to grow on Si, a more complicated epi-structure is required to keep the wafer from warping, impacting time, cost and performance of the device. The cost to grow the GaN epitaxy on silicon is also higher than the cost to grow GaN epitaxy on SiC. On the other hand, the key advantages of GaN-on-Si is its lower material cost of silicon and compatibility with the CMOS process.

Manufacturing technology comparison: HBT vs HEMT; HBT used in smartphone PAs, HEMT used in base station PAs

HBT (Heterojunction Bipolar Transistor) and HEMT (High Electron Mobility Transistor) are the major manufacturing technologies for RF PA. HBT utilizes diffusing semiconductor materials for Base and Emitter parts to create heterojunction, typically using GaAs, InP (Indium phosphide) or InGaAs (Indium Gallium Arsenide) materials. HBT is capable of handling high frequency signals in several 100GHz ranges and its main application is mobile phone PAs, fast switching RF circuits, and high power efficient devices used in mobile phones.

HEMT is a FET (Field Effect Transistor) which incorporates a junction between materials with different gaps (i.e. a heterojunction). Major materials of HEMT include GaAs, GaN, AlGaAs (Aluminium Gallium Arsenide), and InGaAs. HEMT is usually used at very high frequencies such as mmWave bands, on-off digital switches and satellite receivers. Compared to HBT, HEMT has lower noise at low frequency (<100MHz) and at high frequency (10GHz), making it more suitable for base station PAs.

Exhibit 126: HBT is more suitable for smartphones while HEMT is more suitable for base stations

	HBT	HEMT
Power supply	Single polarity	Positive and negative
Size	Small	Large
Linearity	Good linearity	Poor linearity
Noise		
Low frequency (<100MHz)	Moderate	Low
Radio frequency 2GHz	Low	Low
Radio frequency 10GHz	Moderate	Low
Power performance	High power density, high efficiency	Lower power density and efficiency
Suitable for digital circuits	Highly suitable	Less suitable
Applications	Smartphone, router etc.	Base station, radar etc.

Source: Company data, Goldman Sachs Global Investment Research

Exhibit 127: Technology migration from LDMOS to GaAs to GaN

	Si LDMOS	GaAs pHEMT	GaAs HBT	GaN HEMT
Costs	Low	Medium	Medium	High
Power density	Low	Medium	High	Very high
Supply voltage	26V	8-12V	8-26V	48V
Linearity	Good	Good	Medium	Good
Frequency	<3GHz	>2GHz	>2Ghz	>12GHz

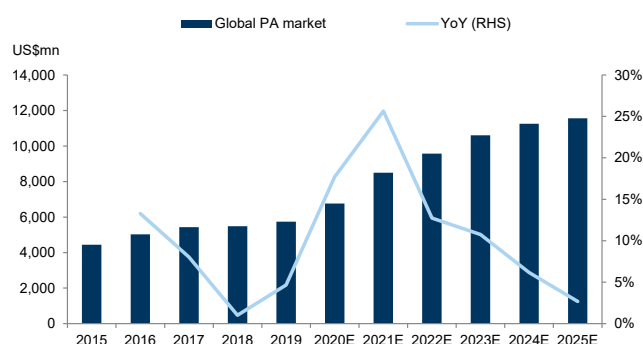
Source: Company data, Goldman Sachs Global Investment Research

PA TAM: US\$11bn globally by 2025E (~US\$4bn in China)

We forecast the global and China PA markets will grow at 19% and 31% CAGRs in 2019-22E, respectively, as 5G will drive significant PA content growth in both base stations and smartphones. PA market growth will then slowdown in 2023-25E as unit shipment growth of 5G base stations and smartphones tapers.

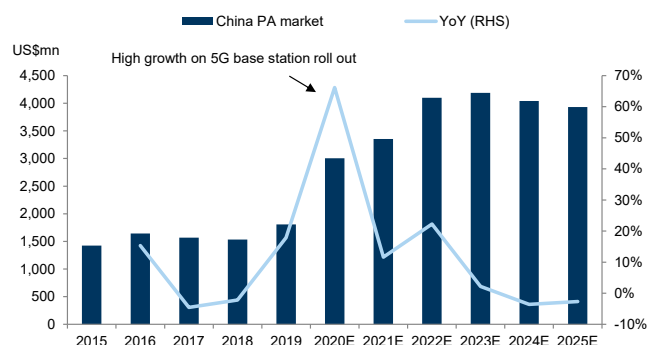
Mobile phones are the major application of PAs (59%/47% of global/China PA market revenue in 2020E) and will enjoy the strongest growth of +16%/+17% CAGR in 2020-25E in global/China on the back of rising 5G smartphone penetration. Base stations and small cells will account for 25%/44% of global/China PA markets in 2020E, and we model +46%/+47% CAGR in 2019-22E on 5G infrastructure builds. We expect routers to account for 18%/9% of global/China PA markets in 2020E, and we forecast +7% CAGR for both in 2019-22E on the back of WiFi 6 adoption (from 6% in 2019 to 90% in 2022E).

Exhibit 128: Global PA TAM to reach US\$11bn by 2025E; growth to peak in 2021E



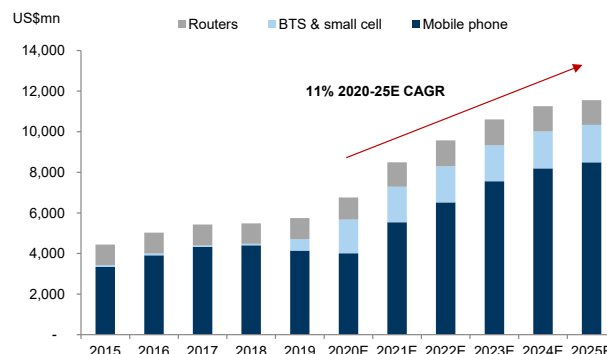
Source: IDC, Gartner, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 130: China PA TAM to reach US\$4bn by 2022E, driven by 5G base station roll out and 5G smartphone upgrade



Source: IDC, Gartner, Goldman Sachs Global Investment Research

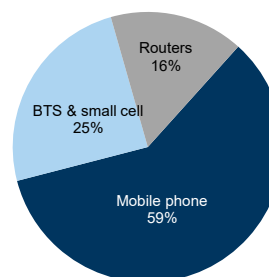
Exhibit 129: Global PA market to grow by 11% p.a. in 2020-25E driven by 5G smartphones and base stations



Source: IDC, Gartner, Goldman Sachs Global Investment Research

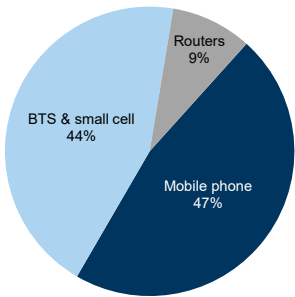
Exhibit 131: Mobile phone PAs comprise 59% of the global PA market

Global PA TAM by application (2020E)



Source: IDC, Gartner, Goldman Sachs Global Investment Research

Exhibit 132: Mobile phone PAs the largest application, comprising 47% of the China PA market
China PA market by application (2020E)

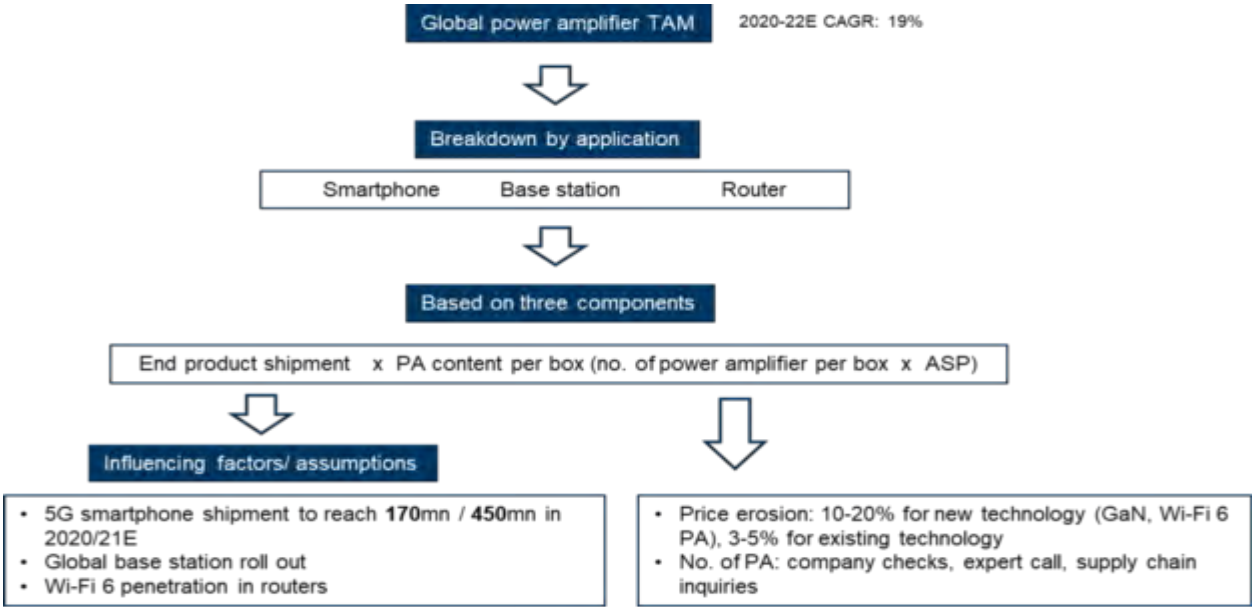


Source: IDC, Gartner, Goldman Sachs Global Investment Research

PA TAM methodology

We derive our PA TAM model based on three key components: device shipments, PA ASP, and PA units per device. **Device shipments** are further divided into three applications (mobile phones, base stations/small cells, and routers) with 11 types of end products including 2G-5G smartphones, 4G/5G base stations and WiFi5/6 routers. We also incorporate supply chain checks and leverage our global technology team in certain areas such as 5G smartphone penetration and WiFi6 penetration in routers. Our **PA ASPs** and **units per device** assumptions are based on supply chain checks with PA device/foundry suppliers and customers.

Exhibit 133: Our PA TAM analysis



Source: Goldman Sachs Global Investment Research

PA TAM by applications: 5G smartphones and base stations key drivers

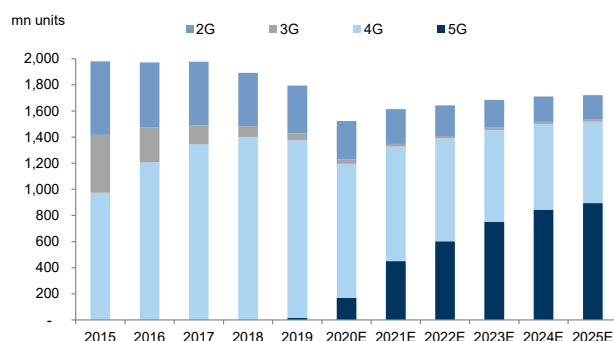
Mobile phones: +16% CAGR in 2019-22E; 5G phone require >2x the PA content of 4G phones

We forecast mobile phones will account for 59% of global PA market revenues in 2020E and grow at a +16% CAGR (from US\$4.1bn in 2019 to US\$6.5bn in 2022E) thanks to rising 5G smartphone penetration. In China's PA market, we expect mobile phones to comprise 47% of revenues in 2020E and we model a +30% CAGR (from US\$1.2bn in 2019 to US\$2.6bn in 2022E).

5G smartphones need US\$7-8 of PA content per phone (vs. US\$3 for a 4G smartphone and <US\$1 for a 3G/2G smartphone), as 5G smartphones require higher power, higher frequency, and better efficiency. In 4G smartphones, PAs are mainly made by CMOS and GaAs process, followed by SOI and SiGe (Silicon-Germanium) process. In 5G smartphones, GaAs will become the mainstream for PA as the electron mobility of GaAs is higher than other materials (e.g. 5x-6x that of silicon), enabling higher frequency of operation. We expect 5G smartphone penetration rate to increase from 11% in 2020E to 28%/37% in 2021/22E.

Exhibit 134: 5G smartphone penetration rising to 52% globally in 2025 (vs. 11% in 2020)

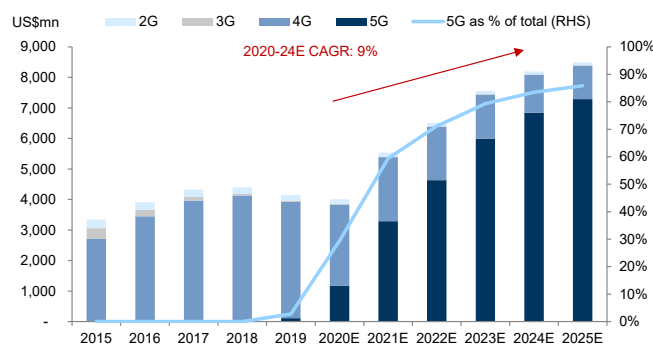
Global smartphone shipment by technology



Source: Gartner, Goldman Sachs Global Investment Research

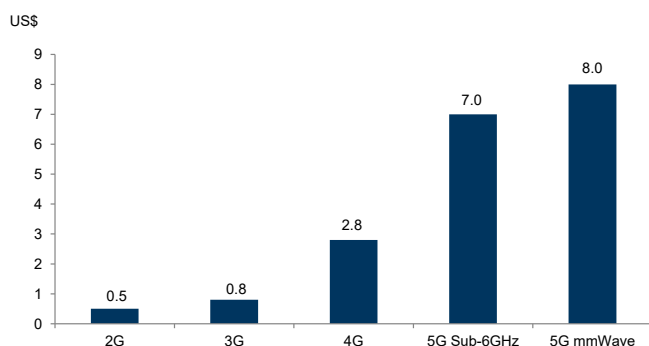
Exhibit 135: 5G smartphone PAs to grow to 86% of total market by 2025E

Global mobile phone PA market by technology



Source: Gartner, Goldman Sachs Global Investment Research

Exhibit 136: PA content to grow from US\$2.8 in 4G to US\$7-8 in 5G



Source: Goldman Sachs Global Investment Research

Exhibit 137: 5G requires an increase in both volume and specs in smartphone PAs

	4G LTE	5G	Requirements
Signal output	23dB	26dB	Better power efficiency
QAM	16	256	Higher data transmission speed
Spectrum range	700MHz-2.7GHz	450MHz-6GHz, 24.25-52.6GHz	Higher frequency
No. of frequency band	15	30+	More PA to cover different bands
No. of PA	6-7	8-12	

Source: Company data, Gartner

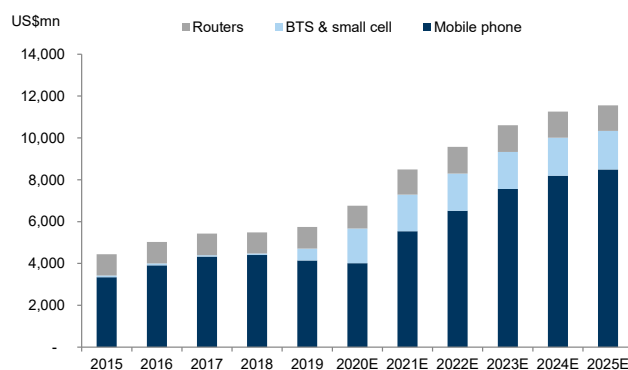
Base stations: +45% CAGR in 2019-22E; 5G base stations require up to 16x the PA content vs. 4G base stations

We forecast base stations and small cells to comprise 25% of global PA revenues in 2020E, growing at a +46% CAGR (from US\$568m in 2019 to US\$1.8bn in 2022E) driven by 5G infrastructure builds. In the China PA market, we expect base stations and small cells to account for 44% of revenues in 2020E and we model a +47% CAGR (from US\$384m in 2019 to US\$1.2bn in 2022E). 5G base stations will drive PA usage due to the adoption of MIMO antennas (8TR/16TR/32T/64TR). Each TR requires one PA and each base station has three antennas, meaning that one 5G base station with 64TR MIMO needs 192 units of PA. This is a significant increase compared to a 4G base station, which only requires 12 units of PA (4TR multiplied by three antennas).

There are three stage PAs for 5G base stations, with GaN to mainly be used in stage 3 (vs. GaAs/LDMOS for stage 1 and LDMOS for stage 2), given its superior properties in terms of wider bandwidth, larger power density, and smaller form-factor. We forecast 5G base station shipments of 0.75/0.9/1m units in China in 2020-22E, of which 60%/45%/35% will be 64TR MIMO, underpinning 5G base station PA demand growth.

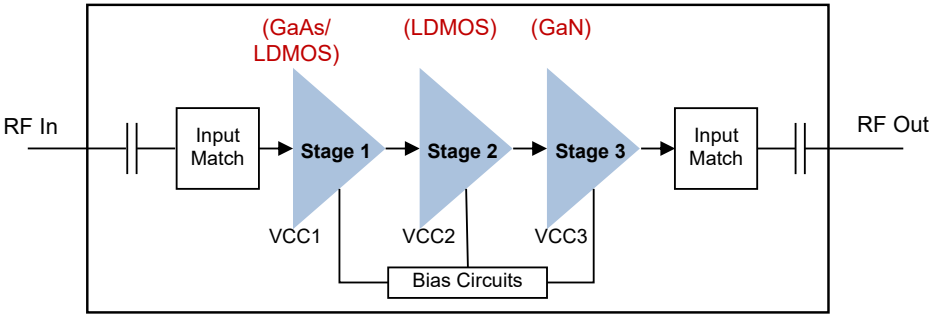
Exhibit 138: Base station PAs the key growth driver for the PA market

Global PA market by application



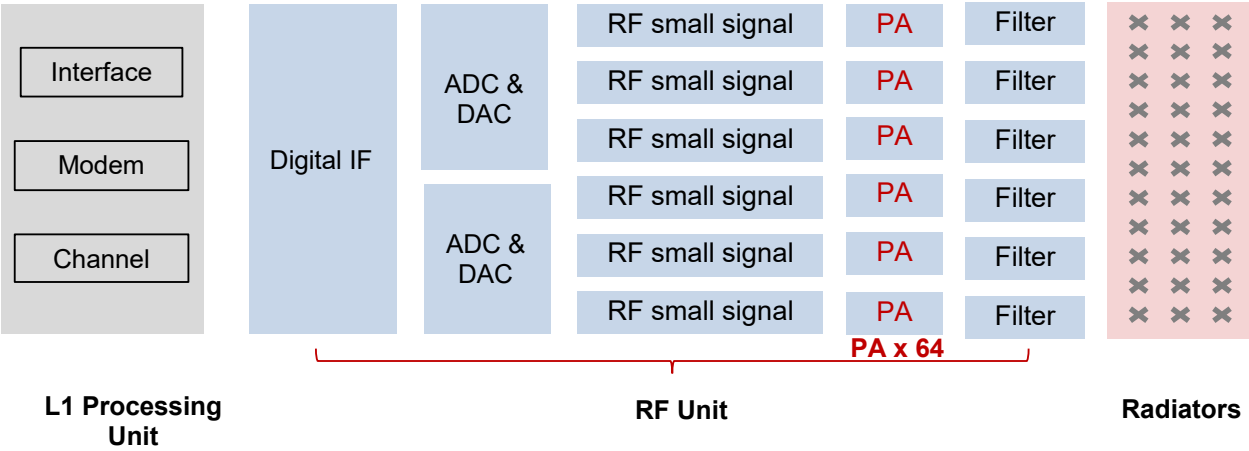
Source: IDC, Gartner, Goldman Sachs Global Investment Research

Exhibit 139: 3-stage PA for a 5G base station: GaN mainly used in stage 3
Structure of PA in base station



Source: Company data

Exhibit 140: A 5G base station uses 192 PAs vs. only 12 for a 4G base station
Internal structure of a massive MIMO AAU in 5G base station



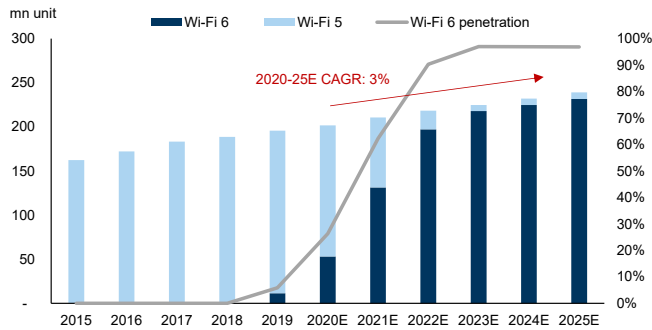
Source: Company data, Goldman Sachs Global Investment Research

Routers: +7% CAGR in 2019-22E; WiFi 6 penetration driving higher PA content

We expect routers to account for 16% of global PA revenues in 2020E, growing at a +7% CAGR (from US\$1bn in 2019 to US\$1.3bn in 2022E) on the back of rising WiFi 6 penetration. In the China PA market, we forecast routers to account for 9% of revenues in 2020E and we model +7% CAGR from US\$257m in 2019 to US\$318m in 2022E. The key growth driver for this segment is rising WiFi 6 penetration in routers, which we expect to grow from 6% in 2019 to 26%/62%/90% in 2020-22E. In terms of PA content, a WiFi 6 router needs c.US\$8 of PA, which is 1.5x that of a WiFi 5 router (PA content of c.US\$5). In terms of unit shipments of routers, we model +3%/+4%/+4% YoY for 2020-22E.

Exhibit 141: Wi-Fi 6 routers will account for 90% of router shipments by 2022E

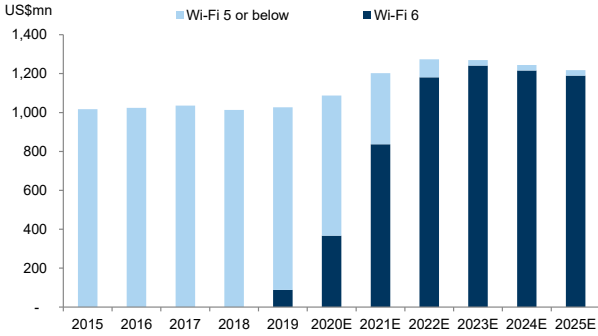
Global router shipment by technology



Source: IDC, Goldman Sachs Global Investment Research

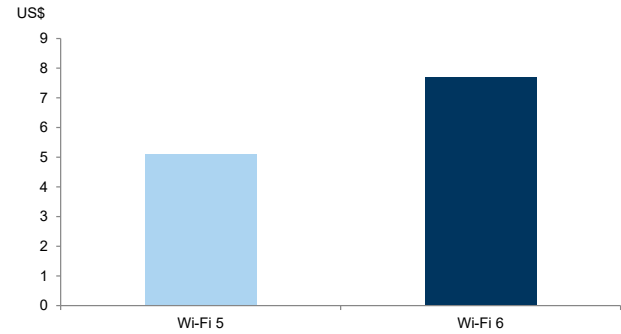
Exhibit 142: Accordingly, we expect Wi-Fi 6 PAs to reach 92% of the router PA market in 2022E

Router PA market by technology



Source: IDC, Goldman Sachs Global Investment Research

Exhibit 143: Wi-Fi 6 content per router is 1.5x that of Wi-Fi 5



Source: Goldman Sachs Global Investment Research

PA Competitive Landscape

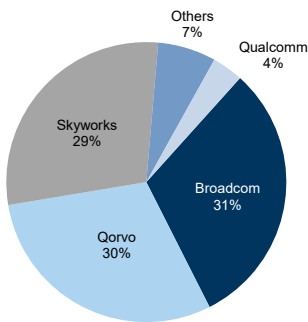
Global and China market share

The global PA market is dominated by a few players in the US and Japan, including Skyworks, Qorvo, Broadcom, Murata, and Qualcomm, while Chinese players are still in the early stages. The three largest PA suppliers (Skyworks, Qorvo and Broadcom) commanded 90% market share in global mobile phone PAs.

In the GaAs PA foundry market, Win Semi is the largest global player with a 76% market share in 2019, followed by Advanced Wireless Semiconductor Company (AWSC) at 8%, Global Communication Semiconductor (GCS) at 6%, and others at 10%. Although in the early stages of its technology ramp and capacity build, Sanan is the largest PA foundry in China (in 2019 we estimate it had a 3% global market share) after only starting its PA foundry business in 2014.

Exhibit 144: Broadcom is the largest player in mobile phone PAs with a 31% share

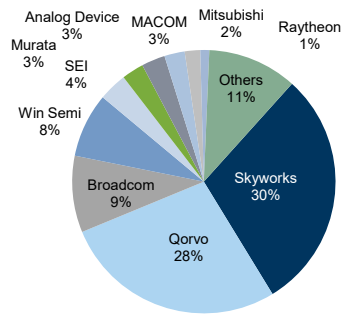
Global mobile phone PA market share



Source: IDC

Exhibit 145: Skyworks and Qorvo are the global leaders in GaAs devices

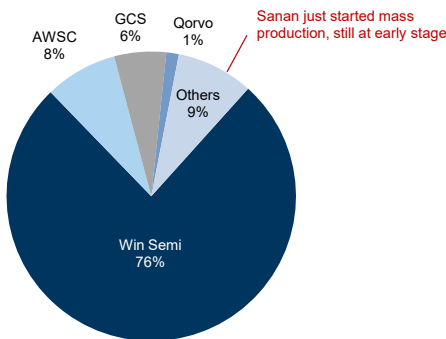
Global GaAs device market share (2019)



Source: Company data

Exhibit 146: Win Semi has 76% of the global GaAs foundry

Global GaAs foundry market share (2019)



Source: Company data

China suppliers' technology gap vs peers

GaN PA mass production - Chinese suppliers lag by 12 years: On GaN PA, Cree (covered by Goldman Sachs US Clean Energy analyst Brian Lee) was the first company

to develop GaN HEMT PA with mass production in 2006, followed by Qorvo's (RFMD) GaN products in 2009. Between 2011-2017, several suppliers started mass production of GaN PA (substrate, epi, foundry, devices, etc), including HRL, Sumitomo, Macom, TI, Win Semi, TSMC and Analog Devices. In comparison, Chinese players only started mass production of GaN PA in 2018-20, including Sanan (which started its GaN PA foundry service in 2018), HiWafer (GaN-on-Si in small volume production in 2020), and Dynax (mass production of GaN on 3" wafer fab in 2015).

Manufacturing technology portfolio - Chinese suppliers are less comprehensive in HEMT:

In terms of manufacturing technology, Sanan's RF portfolio includes GaAs HBT, InGaP HBT, GaAs-pHEMT, E/D pHEMT, GaAs Bi-HEMT, and GaAs-IPD. While not as comprehensive as Win Semi and Qorvo, it is more comprehensive than domestic peer HiWafer. In particular, for HEMT technologies, Win Semi, Qorvo, and Skyworks have PINHEMT and HFET, which Chinese suppliers still lack. In addition, for the same technology, Chinese suppliers still lag global leaders in terms of technology capability; e.g. for the pHEMT process, Sanan only covers 0.15um-0.5um processes while Win Semi covers 0.1um-0.5um processes.

Exhibit 147: Sanan compound semi foundry technology vs peers

Sanan GaN mass product started in 2020

Category	Technology	Sanan	HiWafer	Win Semi	AWSC	GCS	Qorvo	Skyworks
HBT	GaAs HBT	✓	✓	✓	✓		✓	✓
	InGaP HBT	✓	✓	✓	✓	✓	✓	✓
	GaN HEMT	✓	✓	✓		✓	✓	✓
HEMT	Switch pHEMT	✓	✓	✓	✓	✓	✓	✓
	E/D pHEMT	✓		✓	✓	✓	✓	✓
	Bi-HEMT	✓	✓	✓	✓		✓	✓
	PINHEMT			✓			✓	✓
	HFET					✓	✓	✓
IPD	IPD	✓		✓	✓	✓	✓	✓

GaAs HBT = gallium arsenide heterojunction bipolar transistor, InGaP HBT: Indium phosphide heterojunction bipolar transistor, GaN HEMT = gallium nitride/gallium nitride high electron mobility transistor, pHEMT = pseudomorphic high electron mobility transistor, E/D pHEMT = E/D mode pseudomorphic high electron mobility transistor, HFET = heterojunction field effect transistor, IPD = integrated passive device

Source: Company data

Key Chinese PA foundry/IDM suppliers

Sanan started its compound semiconductor foundry business in 2014, focusing on GaAs and GaN for RF PA. We expect Sanan to expand its GaAs capacity from 4.5k wafers/month in end-2019 to 9k/13k/18k by end-2020E/21E/22E. Sanan's customers in PA are mainly Chinese IC design houses such as HiSilicon, UniSoC, Lansus, and Creotech. Its GaAs wafers for 2G-4G smartphone PAs are in volume shipments and GaAs wafers for 5G smartphone PAs are targeted to start volume shipments in 2020. We model Sanan's PA foundry business revenue to grow from Rmb613m in 2020E to Rmb2,080m in 2023E, a 50% CAGR.

HiWafer is a foundry focusing on GaAs and GaN process for RF applications. In April 2020, the company announced it has started production of GaN-on-SiC wafer using the HEMT process, targeting 5G base station RF applications. Its GaN-on-Si products are also in small volume mass production. HiWafer's GaAs technology process includes LN PHEMT, power PHEMT, InGaP HBT, and switch pHEMT.

GaAs HBT: gallium arsenide heterojunction bipolar transistor

InGaP HBT: Indium phosphide heterojunction bipolar transistor

GaAs-pHEMT: gallium arsenide pseudomorphic high electron mobility transistor

E/D pHEMT: E/D mode pseudomorphic high electron mobility transistor

GaAs Bi-HEMT: Gallium arsenide bipolar high electron mobility transistor

GaAs IPD: gallium arsenide integrated passive device

Dynax is an IDM company focusing on GaN for RF and power devices. The company started mass production of GaN on 3" wafer fab in 2015, converting the production line to a 4" wafer fab starting 2017. Its 4" GaN wafer fab construction was completed in mid-2019 with design capacity of 17k wafers per year.

Innoscience is an IDM focusing on GaN-on-Si on 8" wafers for both RF devices and power devices. It was founded in 2015 and is based in Zhuhai. The company established China's first mass production line of GaN-on-Si power device on 8" wafer. Its GaN FET are in mass production and it also plans to develop GaN RF products, targeting applications of 5G communications, LiDAR (Light Detection and Ranging), wireless charging, fast charging, data centers, and EV.

Financial comparison among Chinese and global players

Revenue

Sanan's RF PA business is still in the early stages and its RF PA revenues are only at 4% the scale of RF PA foundry leader Win Semi's revenue in 2019. We expect Sanan's RF PA revenue to grow at a 113% CAGR in 2019-22E, reaching 20% the scale of Win Semi's revenue in 2022E, driven by capacity expansion and growing demand from domestic customers for 5G smartphones and base stations.

OPM

Sanan's OPM was 17% in 2019, at the low end of RF PA foundry and IDM peers at 17-31%, as its LED business suffered from a weak pricing environment in 2019. We expect Sanan's OPM to expand to 25% in 2022E (vs. peers at 31-35%), driven by an improving product mix toward RF PA (13%/14% revenue/gross profit in 2022E) and mini-LED (14%/14% of revenue/gross profit in 2022E).

R&D and R&D ratio

Sanan's R&D expense ratio was only 3% in 2019, much lower than RF PA foundry peers at 6-10% and IDM peers at 13-15%, mainly due to a higher % of Sanan's R&D investment that is capitalized (71% in 2019, vs peers at 0%). Including capitalized R&D investment, Sanan's total R&D investment was 9% of revenue in 2019, similar to RF PA foundry peers at 6-10%. We expect Sanan to maintain total R&D investment (including the capitalized component) to revenue ratio at 5-8% in 2020-22E, and total R&D investment to increase from US\$95mn in 2019 to US\$98mn in 2022E.

ROE and ROA

Sanan's ROE was at 6% in 2019, lower than foundry peers at 8-16% but and IDM peers at 16-24% in 2019 as ROE was mainly dragged down by its weak LED business. ROA was at 4% in 2019, lower than foundry peers (7-11%) and IDM peers (5-18%). We expect Sanan's ROE to improve to 12% in 2022E (vs. peers at 25-29% in 2022E), thanks to improving profitability on better a product mix.

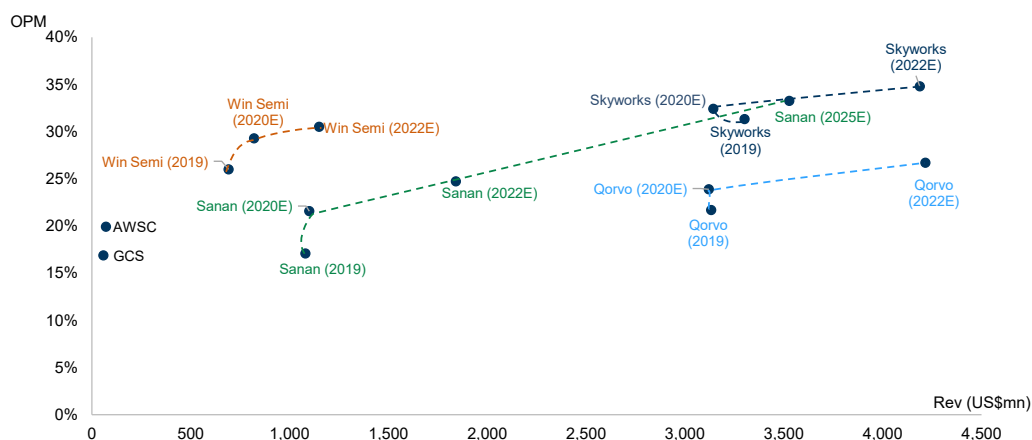
Cash Conversion Cycle (CCC)

Sanan's CCC was 274 days in 2019, longer than peers at 66-175 days, mainly due to its longer accounts receivable days (221 days vs. global peers at 30-58 days) and longer inventory days (202 days vs peers at 54-122 days); account payable days is also longer than peers (149 days vs peers at 43-90 days).

Capex and capex ratio

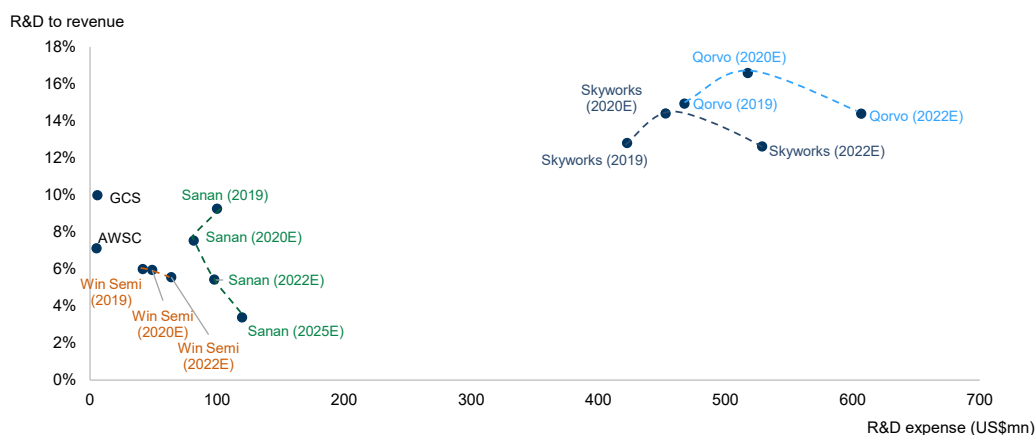
Sanan's capex-to-sales ratio was 40% in 2019, higher than RF PA foundry peers at 7-17% in 2019. We expect Sanan's capex-to-sales ratio to gradually decline from 40% in 2019 to 32% in 2022E (vs. Win Semi at 15% in 2022E) due to stronger revenue growth driven by Sanan's RF PA business. In terms of capex scale relative to global peers, we expect Sanan's total capex at US\$381mn/450mn/573mn in 2020/2021/2022E.

Exhibit 148: Revenue and OPM of major PA peers



Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

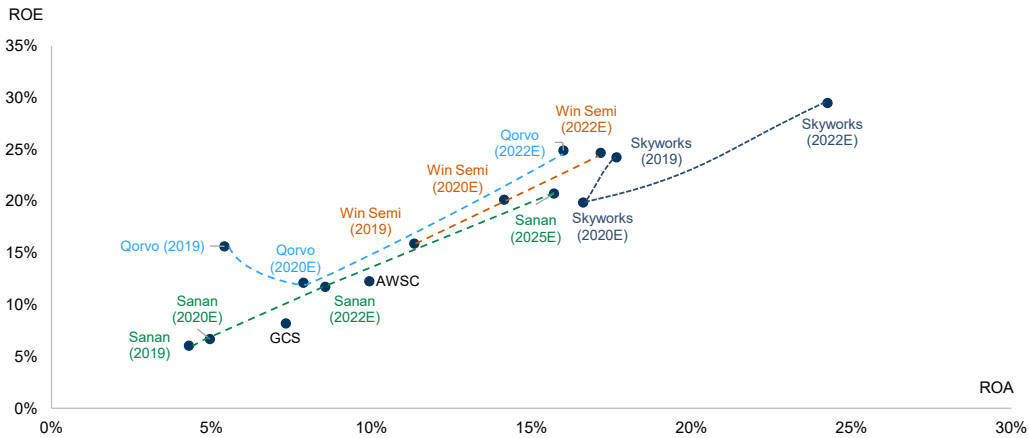
Exhibit 149: R&D and R&D to revenue of major PA peers



Sanan's R&D includes capitalized R&D

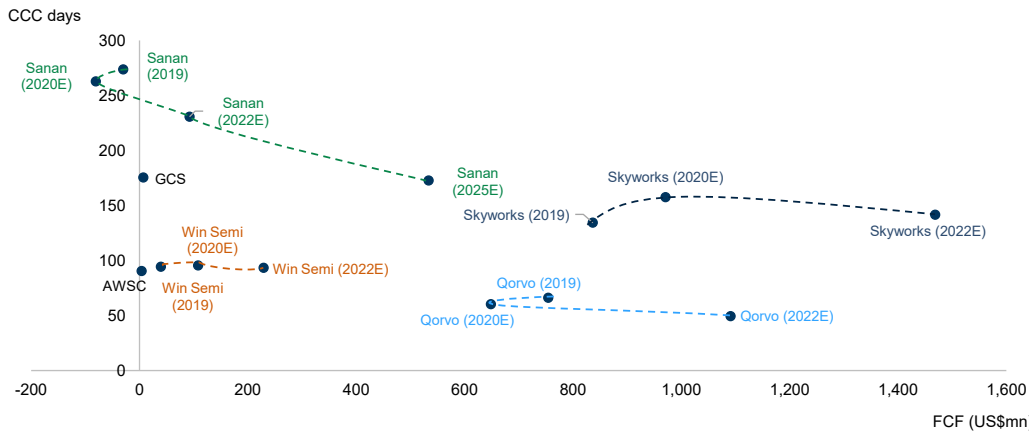
Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 150: ROE and ROA of major PA peers



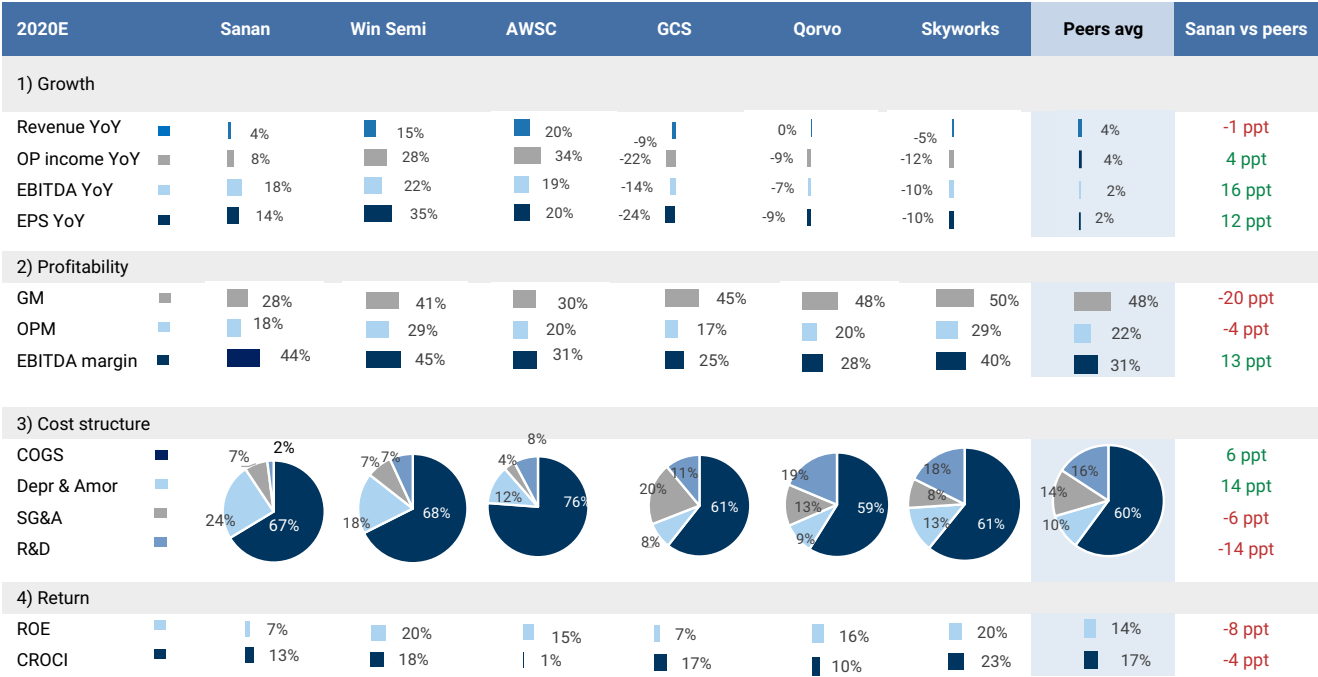
Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 151: FCF and Cash Conversion Cycle of major PA peers



Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 152: Sanan has higher growth than global peers but lower profitability and returns
Sanan financials vs peers



AWSC, GCS are Not Covered, earnings estimates are from Bloomberg

Source: Company data, Goldman Sachs Global Investment Research, Bloomberg, Gao Hua Securities Research

PA stock ideas

In the PA space, we are positive on Sanan (Buy), the PA foundry leader among domestic suppliers, as it is benefiting from PA market growth driven by increased 5G content in both smartphones and base stations, as well as market share gains (off a low base) as domestic customers seek to diversify their supply chains.

Sanan's PA technologies, customers, and growth drivers

Technology

Sanan's technology portfolio in RF includes GaAs HBT, InGaP HBT, GaAs-pHEMT, E/D pHEMT, GaAs Bi-HEMT, and GaAs-IPD. While not as comprehensive as Win Semi and Qorvo, it is similar to AWSC. For pHEMT, Sanan covers 0.15um-0.5um processes, while Win Semi covers 0.1um-0.5um processes.

Customers

Sanan's PA customers are mainly Chinese IC design houses such as UniSoC, Lansus, GSR Microelectronics, and Creotech, and it has been doing tape-out and small volume shipments with customers in Taiwan, Japan, Korea, and the US. On compound semi power devices, the company is working with customers such as Sungrow (inverter), Nari Group (grid), Xuji Electric (grid), Winline (charging pile), King Long (automotive), Kehua Hengsheng (datacenter power supply), and Midea Group (home appliances). Sanan's 3D sensing VCSEL wafers are sampling with customers such as Philips and Samsung.

Growth drivers

1. 5G smartphones PA content to double vs. 4G phones

Mobile phones are the major application of PAs (59%/47% of global/China PA market revenue in 2020E) and will enjoy the strongest growth of +16%/+17% CAGR in 2020-25E in global/China on the back of growing 5G smartphone penetration. 5G smartphones need US\$7-8 of PA content per phone (vs. US\$2-5 for a 4G smartphone and <US\$1 for a 3G smartphone), as 5G smartphones require higher power, higher frequency, and better efficiency. In 4G smartphones, PAs are mainly made by CMOS and GaAs processes, followed by SOI and SiGe processes. In 5G smartphones, GaAs will become the mainstream for PAs as the electron mobility of GaAs is higher than other materials (e.g. 5x-6x that of silicon), enabling a higher frequency of operation. We expect the 5G smartphone penetration rate to increase from 11% in 2020E to 45% in 2023E, driving smartphone PA market growth.

2. 5G base stations - up to 16x the PA content vs. a 4G base station

We forecast base stations and small to cells account for 25%/44% of global/China PA markets in 2020E, and we model +46%/+47% CAGR in 2019-22E on 5G infrastructure builds. 5G base stations will drive PA usage due to the adoption of MIMO antennas (8TR/16TR/32T/64TR). Each TR requires one PA and each base station has three antennas, meaning one 5G base station of 64TR MIMO needs 192 units of PA. This is a significant increase compared to a 4G base station, which only requires 12 units of PA (4TR multiplied by three antennas). In addition, GaN will replace LDMOS as the

mainstream technology for PAs in base stations given GaN's advantages of wider bandwidth, larger power density, and smaller form-factor.

3. Domestic customers actively seeking to diversify their supply chains

While Sanan's RF PA technology and production yield rate still lag behind global leaders, domestic customers have been willing to work with Sanan to improve their joint capability; as domestic customers are actively seeking to diversify their supply chains by building a comprehensive domestic supply chain. As the first mover in RF PA foundry in China, Sanan is best positioned among Chinese foundries to partner with domestic customers.

Sanan investment thesis: Early mover gets the growth; initiate at Buy

We are positive on Sanan's expansion into RF PA/compound semi businesses from LED, and forecast net income to grow at 40% CAGR in 2020-23E, driven by:

- **RF PAs driven by 5G content growth:** As an early mover in GaAs and GaN technologies for RF PAs in China, we expect RF PA to be a key growth driver for Sanan given: 1) 5G will drive PA content growth in smartphones/base stations, and 2) there is significant market share upside for Sanan (off a low base) as domestic customers are actively seeking to diversify their supply chains. We model Sanan's RF PA revenues to grow at a 50% CAGR in 2020-23E, accounting for 13% of revenue by 2023E (vs 8% in 2020E).
- **Mini-LEDs and Micro-LEDs:** Sanan's Mini-LED and Micro-LED products were both in small volume shipments in 2019, and we expect Mini-LED revenue to pick up first this year for high-end TV backlight applications, followed by Mini-LED display for NB/PC monitors in 2021, and Micro-LED display for automotive, wearables, display walls in 2022-25. We expect revenues from Mini-LEDs and Micro-LEDs to grow at a 92% CAGR in 2020-23E, contributing 24% of revenues by 2023E (vs. 7% in 2020E).

Sanan valuation and risks

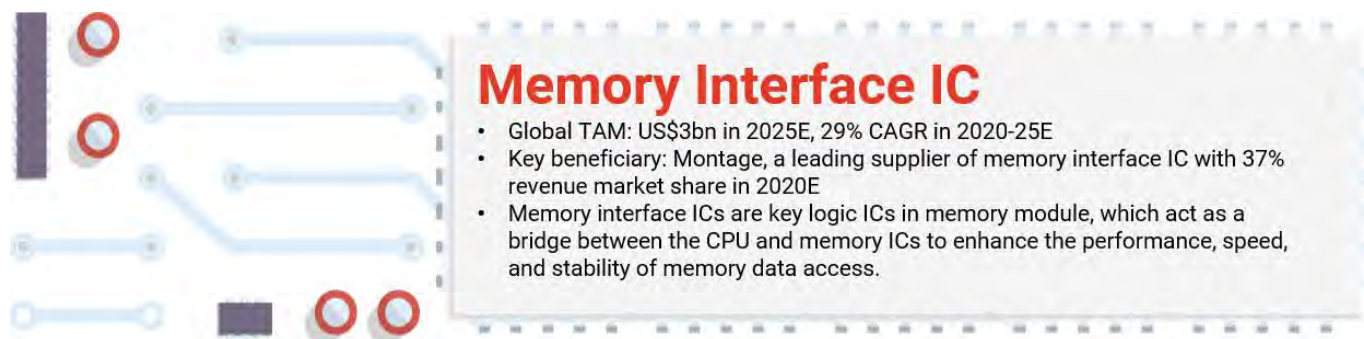
Valuation: Our 12-month target price of Rmb40 (which implies a 55x 2022E P/E) is based on a discounted P/E, as we believe Sanan's compound semi business is still at an early stages of its technology ramp and capacity build compared to global leaders. In our view, discounted P/E captures Sanan's long-term business opportunity which justifies its current higher-than-peer P/E multiple. We apply a 29x target P/E multiple to Sanan's 2025E EPS and discount it back at a COE of 9% (1.0 Beta, 3% risk-free rate, and 6% market risk premium). The 29x target P/E multiple is derived from the sector P/E-EPS YoY correlation; our regression analysis shows that the market has generally rewarded higher EPS growth companies in the semiconductor industry.

Our target price implies 55x 2022E P/E, or a PEG of 1.4x based on average 2023-24E EPS YoY growth (40%). Our valuation cross-check (DCF) derives a similar value of Rmb40.9, or 56x 2022E P/E. The stock currently trades at 39x our 2022E EPS and 1.0x our PEG based on average 2023-24E EPS YoY growth, which we believe is attractive given its strong earnings growth (+40% CAGR in 2020-23E).

Downside risks

1. **Weaker than expected PA market growth:** We forecast the global and China PA market to grow at 19% and 31% CAGRs in 2019-22E, respectively, as 5G will drive significant PA content growth in both base stations and smartphones. If the penetration of 5G or PA content growth is slower than our expectations, growth in the PA market could be weaker than our current forecast.
2. **Slower than expected new order win and market share gains:** We model a 50% revenue CAGR in 2020-23E for Sanan's RF PA business, driven by market growth, new orders wins, and market share gains. If Sanan's new order wins or market share gains are slower than our expectations, there could be downside risk to our earnings estimates.
3. **Slower than expected development progress in new technology (compound semis, mini/micro-LEDs):** We model compound semi (power devices, optical communication devices, filters) to contribute 2%/5%/11% of revenues in 2020-22E, and mini/micro-LED to contribute 7%/15%/20% of revenues in 2020-22E. If progress in R&D or customer adoption/qualification of these products is slower than our expectations, it could result in slower earnings growth than our current forecast.
4. **More severe competition in the LED market:** Given LED is a mature market, if more suppliers expand capacity or if demand is weaker than expected, there could be price pressure across the industry. We model Sanan's revenue from traditional LED to decline from 58% of revenues in 2020E to 47%/36% in 2021E/22E. In addition, if other domestic competitors have faster R&D/new design-wins in mini/micro-LED, there could be downside to our earnings estimates.
5. **Potential impact from COVID-19:** The lion's share of Sanan's revenue comes from the domestic market (~85% of revenue) but its customers' end products are sold globally, thus Sanan could be impacted by the global macro slowdown in 2020. Sanan's revenue declined 3% YoY in 1Q20 (vs +8% YoY in 4Q19) due to COVID-19.

Memory Interface IC: Intro, TAM, Competitive Landscape, Stock Ideas



Bottom line: We believe the memory interface IC market is well positioned within the power semi space driven by DRAM content growth in servers and new generation DDR5, and expect TAM growing at 29% CAGR in 2020-25E to US\$3.0bn. **Buy Montage**, the leader in memory interface IC with 37% global revenue market share in 2020E.

What are memory interface ICs?

Memory interface ICs are key logic ICs in memory module, which act as a bridge between the CPU and memory ICs to enhance the performance, speed, and stability of memory data access. On PC/mobile DRAM, memory controller (inside the CPU or a separated chip) sends all commands directly to DRAM dies in the module. However, in a server DRAM module, given the requirement of higher speeds and higher capacity to process the data, RCD (register clock driver) and DB (data buffer) chips are added into DRAM module, to buffer the control signals, so that the module can handle higher speeds and higher DRAM capacity with better stability. RCD chip adds a clock cycle to handle heavier electrical loads placed on high-speed, high-density DRAM modules, reducing the load on the memory controller.

Migration to DDR5 from DDR4

DDR5 has double the speed of DDR4 with better power efficiency: DDR (double data rate) is a technology to double the output data rate for DRAM module, which have become the mainstream standard for DRAM since early-2000s. DDR4 is the mainstream standard currently and the industry has been developing DDR5 interface IC since 2017. Compared with DDR4, DDR5 interface IC can support faster speeds at lower voltages, enabling faster data transmission speed with better power efficiency. Below are the key specs of DDR5 and DDR4:

- **DDR5:** speed at 3200-6400MT/s, clock rate at 1.6-3.2GHz, IO voltage at 1.1V, and DRAM size support at 32Gb
- **DDR4:** speed at 1600-3200MT/s, clock rate at 0.8-1.6GHz, IO voltage at 1.2V, and DRAM size support at 16Gb

DDR5 mass adoption likely in 2021, depends on interface IC, DRAM, and server CPU suppliers' progress: Key memory interface IC suppliers already have DDR5

products ready or plan to complete the development by end-2020. However, as the interface ICs are used in server DRAM modules, the timing of DDR5 adoption will also depend on DRAM makers' DDR5 DRAM mass production schedule and server CPU suppliers' product roadmap. Based on companies' announcement and our supply chain checks, DRAM makers may start mass production of DDR5 DRAM in 2020-21 with some of them already in sampling; server CPU suppliers could launch the new platforms that support DDR5 in 2021-22. As a result, we believe the earliest timing for the industry to see a significant adoption of DDR5 could be 2021.

TAM to grow at 29% CAGR to US\$3.0bn by 2025E

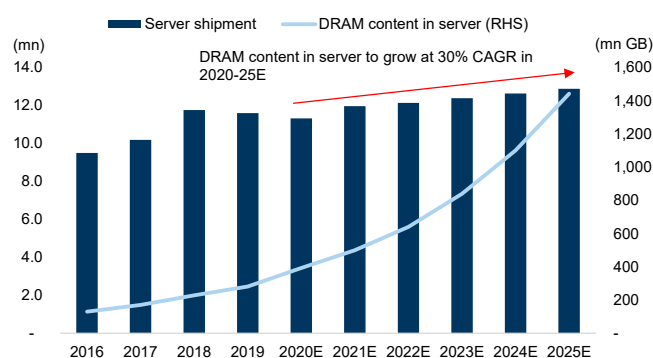
DRAM content growth in servers to drive memory interface IC market growth

We model memory interface IC market to grow from US\$840m in 2020E to US\$3.0bn in 2025E, or 29% CAGR, driven by DRAM content growth in servers,

despite our expectations of a largely flat server market growth. We forecast global server market volume to remain stable at 11.3m/12.0m/12.1m units in 2020-22E, and DRAM content per server growing from 393GB in 2020E to 500/640GB in 2021E/22E, driving server DRAM units growing from 4.5bn GB in 2020E to 6.0/7.8bn GB in 2021E/22E, or +37%/+34% YoY in 2021E/22E. The growing DRAM content in server is driven by increasing adoption of cloud and AI computing and rising demand for better performing and higher density DRAMs. The memory interface IC market growth is mainly driven by shipments of DRAM, while the price has remained relatively stable compared with DRAM price.

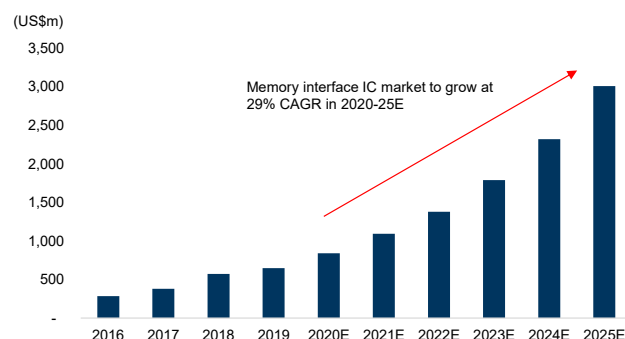
Exhibit 153: DRAM content in servers to grow at 30% CAGR in 2020-25E

Global server unit shipments and DRAM content in server



Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 154: Memory interface IC market to grow at 29% CAGR in 2020-25E



Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Competitive landscape

Industry consolidation

There are 3 main memory interface IC suppliers globally: Montage, IDT (acquired by Renesas, covered by Daiki Takayama), and **Rambus** (not covered). The memory interface IC market has consolidated over the past 10+ years with the number of key players reducing from 6 in DDR2 generation (R&D in 2004-2008), to 5 in DDR3 generation (R&D

in 2008-2014), and further down to 3 in DDR4 and DDR5 generations. We believe this is due the increasing complexity of the technology (achieving faster speeds, lower power consumption, etc.) and high entry barriers. Below we list the tech specs and key players in the market for each generation of DDR interface IC:

DDR2 (R&D in 2004-2008)

- Tech specs: lowest voltage support at 1.5V
- Key suppliers: TI, Intel, Siemens, Inphi, Montage, IDT

DDR3 (R&D in 2008-2014)

- Tech specs: lowest voltage support at 1.25V; highest speed at 1866MT/s
- Key suppliers: Inphi, IDT, Montage, Rambus, TI

DDR4 (R&D in 2013-2017)

- Tech specs: lowest voltage support at 1.2V; highest speed at 3200MT/s
- Key suppliers: Montage, IDT, Rambus

DDR5 (R&D in 2017-now)

- Tech specs: lowest voltage support at 1.1V; highest speed at 4800MT/s; 5600MT/s and 6400MT/s are under development
- Key suppliers: Montage, IDT, Rambus

Key entry barriers

- **Accumulated Technology:** As the new DDR standards are usually established and enhanced on top of the previous generation, it could be more difficult for a new entrant to step into this market without accumulated technology of previous generations.
- **Strict qualification by DRAM makers, CPU suppliers, and server OEMs:** The memory interface ICs need to support DRAM makers' DRAM dies and need to be qualified by server CPU suppliers, DRAM makers, and server OEMs. This is a more complicated process than most consumer appliance/smartphone chips that only need to be qualified by end customers and/or assemblers. The qualification process is strict on stability, speed, and power consumption of the memory interface ICs.

Memory interface IC suppliers' DDR5 progress

- **Montage's** DDR5 interface ICs are currently under R&D, its first engineering version tape-out was in 2019, and its first mass production version is targeted to be complete by end-2020, and mass production expected to commence in 2021.
- **IDT (Renesas):** DDR5 RCD sampling in Jan 2018, production since Jan 2020
- **Rambus:** first prototype announced in Sep 2017, mass production version under R&D (as of 2Q20)

Montage catches up to competition in DDR4 generation

In DDR3 generation, Montage only had 12 memory buffer chips and only four of its register buffer chips passed Intel's validation, while IDT and Rambus (including Inphi memory interface chip business that Rambus acquired in 2016) had 136-143 solutions for DDR3 interface ICs. In DDR4 generation, Montage had 206 of its products pass Intel's validations, which was close to with IDT's 228 validations and better than Rambus' 108 validations. Montage's invention of "1+9" structure for DDR4 interface ICs was one of the key factor that helped Montage catch up with its peers, in our view.

Exhibit 155: Memory interface IC suppliers' numbers of validations by Intel

	Montage	IDT/Renesas	Rambus (Inphi)
DDR4-2666 DB	17	17	0
DDR4-2666 RCD	109	122	68
DDR4-2400 RCD	80	89	40
DDR3 memory buffer	12	0	12
DDR3 register buffer	4	136	131

Source: Company data

Montage's "1+9" structure

In DDR4 generation, Montage invented the "1+9" structure, which was adopted as global standard for DDR4 LRDIMM by JEDEC (Joint Electronic Device Engineering Council, a semiconductor engineering standardization body). The "1+9" structure is a Registering Clock Driver (RCD) with 9 Data Buffers (DB), shortening the signal transmission distance, lowering data latency, providing better signal integrity and faster speed up to 3200MT/s (vs conventional structure at 1866MT/s), with larger capacity up to 128GB (vs. 64GB in the conventional structure), and lower power consumption. This structure reduces the load between CPU and DRAM dies, lowering the signal transmission loss, and solving the conflict between large capacity and high speed in a DRAM system.

Exhibit 156: "1+9" structure doubles the speed and capacity vs. conventional structure

Comparison between "1+9" structure and conventional structure of memory interface ICs

	Conventional structure	"1+9" structure
Speed	up to 1866MT/s	up to 3200MT/s
Max capacity	64GB	128GB
Power consumption	higher	lower
Latency	higher	lower
Data integrity	worse	better

Source: Company data

Stock idea: Montage

We initiate coverage on Montage with a Buy rating and 12MTP of Rmb161.

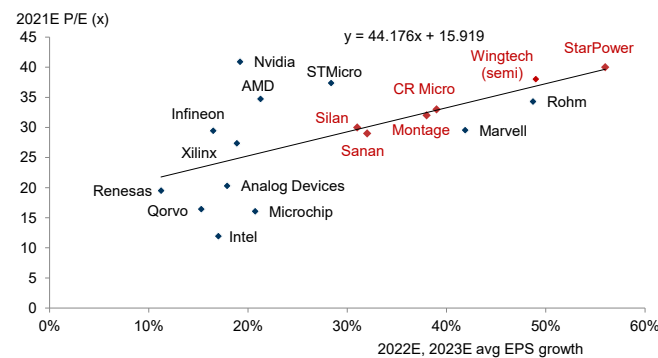
Montage is a leading supplier of memory interface IC with 37% revenue market share in 2020E, serving all major DRAM makers (Samsung, SK Hynix, Micron, etc) in the server market. We forecast Montage's memory interface IC revenue growth of 29% CAGR in 2020-25E driven by DRAM content growth in servers and standard upgrade from DDR4 to DDR5.

We model Montage net income growth of +43% CAGR in 2020-25E, with revenues growing at +42% CAGR and operating income at +46% CAGR. We forecast the revenue growth will mainly be driven by server DRAM content growth and DDR5 penetration. We expect Montage's DDR5 interface IC to contribute 20%/53%/65% of its interface IC revenue in 2021E/22E/23E, driving Montage's interface IC revenue growth at +38%/+39%/+33% YoY in 2021-23E. We also expect Jintide server platform to grow from 1% of revenue in 2020E to 3%/6%/10% of revenue in 2021/22/23. We model the GM to decline from 73.9% in 2020E to 73.6%/72.7%/70.7% in 2021-23E due to increased share of Jintide server platform in the product mix and margin contraction of older generation DDR interface ICs. By products, Jintide server platforms carry lower GM (7% in 2020E vs. corporate average at 74%) and the increasing revenue contribution will weigh on overall margins. For interface ICs, we also model mild margin contraction per year as the technology becomes mature over time.

Our 12M target price of Rmb161 (implying a 68x 2022E P/E) is derived from

discounted P/E. We expect Montage to enjoy stronger growth than its global peers. We believe the discounted P/E method captures the company's long-term business opportunity to justify its current higher-than-peers' P/E multiple. We apply 32x target P/E multiple to Montage's 2025E EPS and discount back at COE of 9% (1.0 Beta, 3% risk-free rate, and 6% market risk premium) in line with our China semiconductor coverage. The 32x target P/E multiple is derived from the sector P/E-EPS YoY correlation, as the market has generally rewarded higher EPS growth companies in the semiconductor industry based on our regression analysis (See [Exhibit 157](#) for details). Our target price implies 68x 2022E P/E, or PEG at 1.6x based on average 2023-24E EPS YoY growth (41% vs. peer average at 30%). Our valuation crosscheck using the DCF method also shows an in-line theoretical share value of Rmb166, or 70x 2022E P/E. The stock currently trades at 75x/50x our 2021/22E EPS and at 1.6x/1.2x PEG based on average 2022-23E/2023-24E EPS YoY growth of 47%/41% (global semi peers 2021E average P/E at 26x), which we believe is attractive considering its strong earnings growth at a +43% CAGR in 2020-23E vs. 30% for global semi peers 2020-23E.

Exhibit 157: Global semi peers P/E vs. EPS YoY scatter chart



Names in red are 2025E target multiples and 2025E EPS YoY

Source: Bloomberg, Goldman Sachs Global Investment Research, Gao Hua Securities Research

WiFi / Bluetooth: Intro, TAM, Competitive Landscape, Stock Ideas



Global Wi-Fi TAM:
US\$5.1bn by 2025E, 3%
2020-25E CAGR

China Wi-Fi TAM: US\$1.5bn
by 2025E, 4% 2020-25E
CAGR

Global Bluetooth TAM:
US\$3.7bn by 2025E, 3%
2020-25E CAGR

China Bluetooth TAM:
US\$1.1bn by 2025E, 5%
2020-25E CAGR

Bottom line: We expect rising connectivity (IoT), driven by the 5G and wireless trend, to benefit SMIC (Buy, on CL) and Maxscend (Buy). Connectivity ICs are key products on SMIC's 40nm and 55nm process nodes; while Maxscend provides BLE MCU and is expanding to WiFi PA.

WiFi / Bluetooth intro

WiFi and Bluetooth are the two major wireless connectivity technologies for connecting devices: WiFi connects devices to the internet and Bluetooth connects between devices for data transfer in a short range. As 5G brings faster data speed and broadens applications, we expect a rising number of connected devices and increasing data traffic to drive semiconductor demand for WiFi and Bluetooth. Other than device unit growth, the new standards of WiFi (WiFi 6) and Bluetooth (BLE) will also drive semiconductor content growth (higher ASP for chips) within connected devices.

WiFi vs Bluetooth: Complement to each other; combo IC a typical solution for various applications

WiFi typically has higher bandwidth than Bluetooth and can also transmit to a longer range (100m vs Bluetooth at 10m) than Bluetooth, but WiFi also has higher power consumption and higher chip cost. In contrast, Bluetooth can transfer data in a shorter range and has lower power consumption and lower chip cost. Given the complementary nature of their functions, both WiFi and Bluetooth are widely adopted in various electronic products including smartphones, PC, tablets, smart watches, smart home devices, etc., and many products are using WiFi and Bluetooth combo IC solutions.

- **WiFi is a wireless technology that uses radio waves to provide wireless high-speed internet and network connections.** WiFi devices usually connect to the Internet through a WiFi router, which takes the internet signal from a modem and transforms it into a radio signal. WiFi devices receive the radio signal and transform it back into internet signal.
- **Bluetooth is a wireless technology that uses radio signals to send data between devices over short distances** using short-wavelength ultra high frequency radio waves ranging from 2.402 GHz to 2.480 GHz. The use cases of Bluetooth are expanding from audio streaming and low-power data transfers, to location services and large-scale device network solutions.

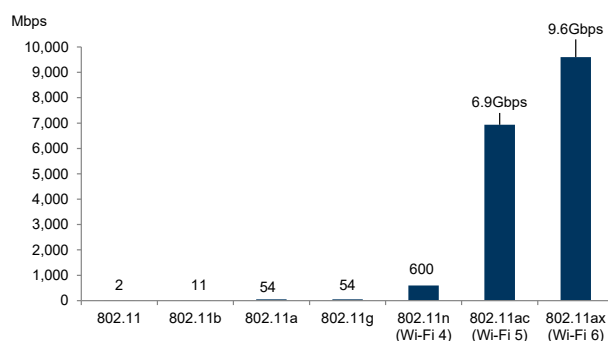
WiFi technology trend: WiFi 6 vs WiFi 5

WiFi was introduced in 1998 and there have been new generations of WiFi technologies introduced every 4-6 years since then. The latest generation is WiFi 6 (as known as 802.11ax), which was established in 2018. Compared to the previous generation, WiFi 5, WiFi 6 has 40% faster data speed and 20% higher signal coverage. WiFi 6 adopts 4 key new technologies to enable faster speed and higher transmission efficiency: MU-MIMO, BSS coloring, OFDMA, and TWT.

- **MU-MIMO** (multi-user massive input massive output) allows multiple users to access the wireless network at the same time by breaking up the available bandwidth into separate streams with the same bandwidth.
- **BSS (best service set) coloring** allows signals on multiple channels to transmit at the same time.
- **OFDMA** (orthogonal frequency-division multiple access) is the simultaneous transmission of data on the same channel. In contrast, WiFi 5 uses OFDM (orthogonal frequency-division multiplexing), which has an exclusive channel regardless of traffic size.
- **Target Wait Time** (TWT) arranges sleep and awake time for devices so that a device is awake only when transferring data. This can save battery life by increasing sleep time.

Exhibit 158: WiFi 6 maximum speed is 40% faster than WiFi 5

Maximum data speed of different Wi-Fi technologies



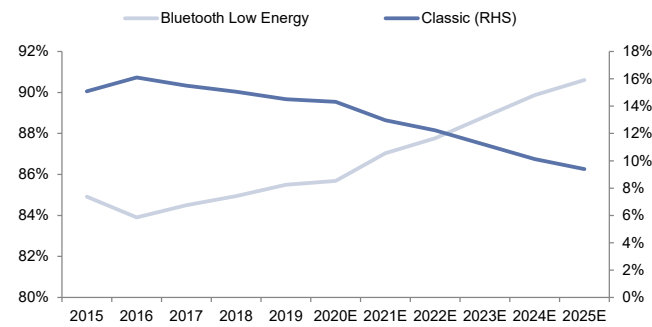
Source: Wi-Fi Alliance, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Bluetooth technology trend: Bluetooth Low Energy vs classic Bluetooth

Bluetooth was introduced in 1999 and there have been new generations of Bluetooth technologies introduced every 5-6 years since then. The latest generation is Bluetooth 5.0, which was established in 2016. Bluetooth Low Energy (BLE) was first introduced in 2010 as a subset of Bluetooth 4.0 to provide lower power consumption and lower cost while maintaining a similar communication range with Classic Bluetooth. The penetration of Bluetooth Low Energy reached 85% in 2019, and we expect a further increase in coming years as low-power consumption is a key requirement for mobile devices.

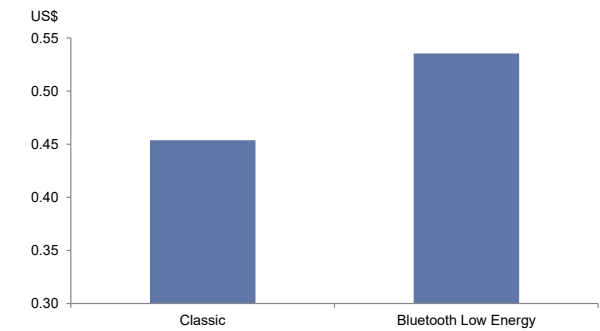
- **Bluetooth Low Energy** has lower latency at 30ms, shorter time lag at 3ms, lower power consumption at 0.01-0.5W, and lower peak current consumption at <15mA. However, Bluetooth Low Energy has a lower data rate at 1Mbps. Key applications include smart homes, wearables, smartphones, tablets, etc.
- **Classic Bluetooth** has a higher data rate at 1-3Mbps, but it also has higher latency at 100ms, a longer time lag at 100ms, higher power consumption at 1Q, and higher peak current consumption at <30mA. Typical applications include PCs, TVs, printers, etc.

Exhibit 159: Bluetooth Low Energy the mainstream (85% in 2019), penetration still on the rise
Bluetooth market by technology



Source: IDC, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 160: BLE ASP c.20% higher than classic Bluetooth
Comparison of classic Bluetooth and BLE chip ASP

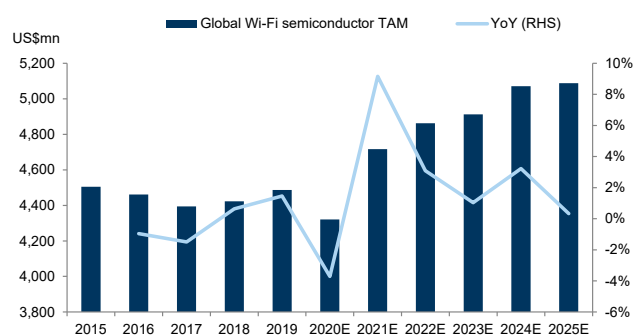


Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

WiFi / Bluetooth IC TAM

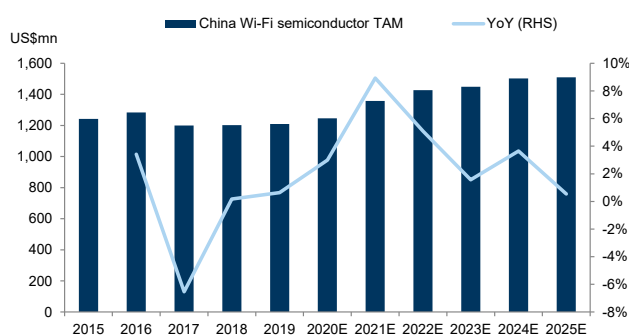
We forecast the global and China WiFi IC markets to grow at 4% and 5% CAGRs in 2020-23E, respectively. By application, we expect smart home will enjoy the strongest growth in both the global (16% CAGR) and China (18% CAGR) markets, thanks to growing device shipments and rising WiFi penetration. We forecast WiFi IC for smartphones will also enjoy 5%/4% CAGRs in the global/China markets in 2020-23E, driven by WiFi 6 upgrades. In terms of revenue mix, smartphone is the largest application, and we expect it will contribute 47% of the global WiFi IC market in 2020E, followed by PCs (10%), smart home (8%), routers equipment (6%), wearables (3%), and others.

Exhibit 161: Global Wi-Fi semiconductor market to reach US\$5.1bn by 2025E



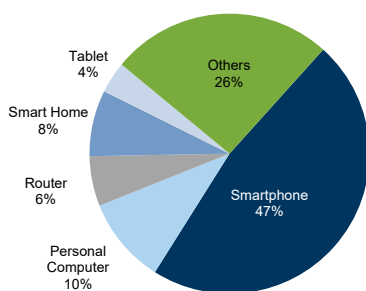
Source: IDC, Goldman Sachs Global Investment Research, Gao Hua Securities Research, Gao Hua Securities Research

Exhibit 162: China Wi-Fi semiconductor market to reach US\$1.5bn by 2025E, 30% of global



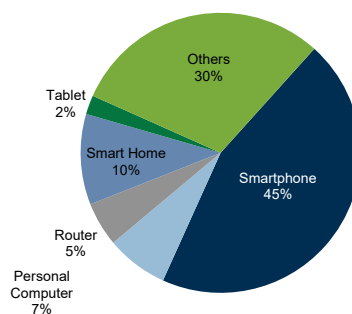
Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research, Gao Hua Securities Research

Exhibit 163: Smartphone Wi-Fi largest at 47% of Wi-Fi market
Global Wi-Fi semiconductor market by application (2020E)



Source: Goldman Sachs Global Investment Research, Gao Hua Securities Research, Gao Hua Securities Research

Exhibit 164: Smartphone at 45% of China Wi-Fi semiconductor market
China Wi-Fi semiconductor TAM by application (2020E)

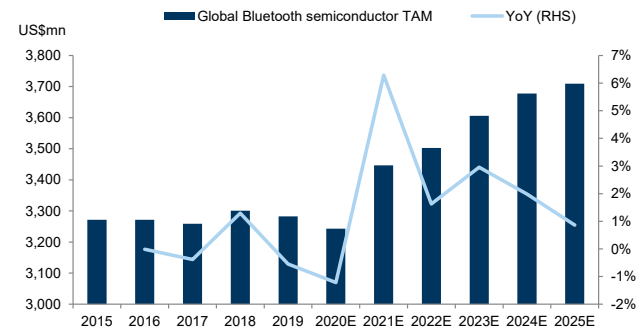


Source: Goldman Sachs Global Investment Research, Gao Hua Securities Research, Gao Hua Securities Research

On Bluetooth IC, we forecast global and China markets to grow at 4% and 6% CAGRs in 2020-23E, respectively. By application, we expect smart home will enjoy the strongest growth in both the global (21% CAGR) and China (23% CAGR) markets, thanks to growing device shipments and rising Bluetooth penetration. Bluetooth IC for TWS will also enjoy 7%/8% CAGRs in global/China markets in 2020-23E, driven by TWS

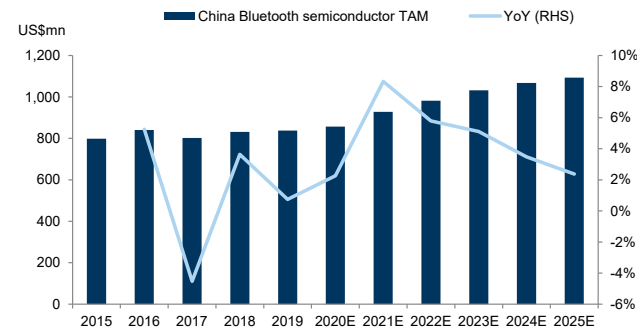
shipment growth. In terms of revenue mix, smartphone is the largest application and contributes 37% of the global Bluetooth IC market in 2020E, followed by TWS (19%), smart home (6%), PC (6%), wearables (5%), and others.

Exhibit 165: Global Bluetooth semiconductor market to reach US\$3.7bn by 2025E



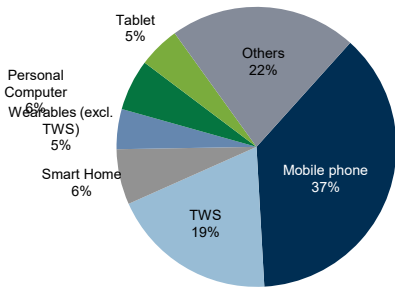
Source: IDC, Goldman Sachs Global Investment Research, Gao Hua Securities Research, Gao Hua Securities Research

Exhibit 166: China Bluetooth semiconductor market to reach US\$1.1bn by 2025E



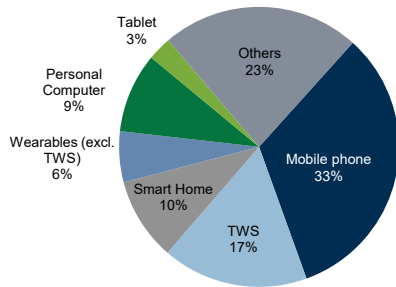
Source: IDC, Goldman Sachs Global Investment Research, Gao Hua Securities Research, Gao Hua Securities Research

Exhibit 167: Mobile phone and TWS the largest two applications for Bluetooth semiconductors
Global Bluetooth market by application (2020E)



Source: Goldman Sachs Global Investment Research, Gao Hua Securities Research, Gao Hua Securities Research

Exhibit 168: Mobile phone at 33% of China Bluetooth semiconductor market
China Bluetooth semiconductor market by application (2020E)

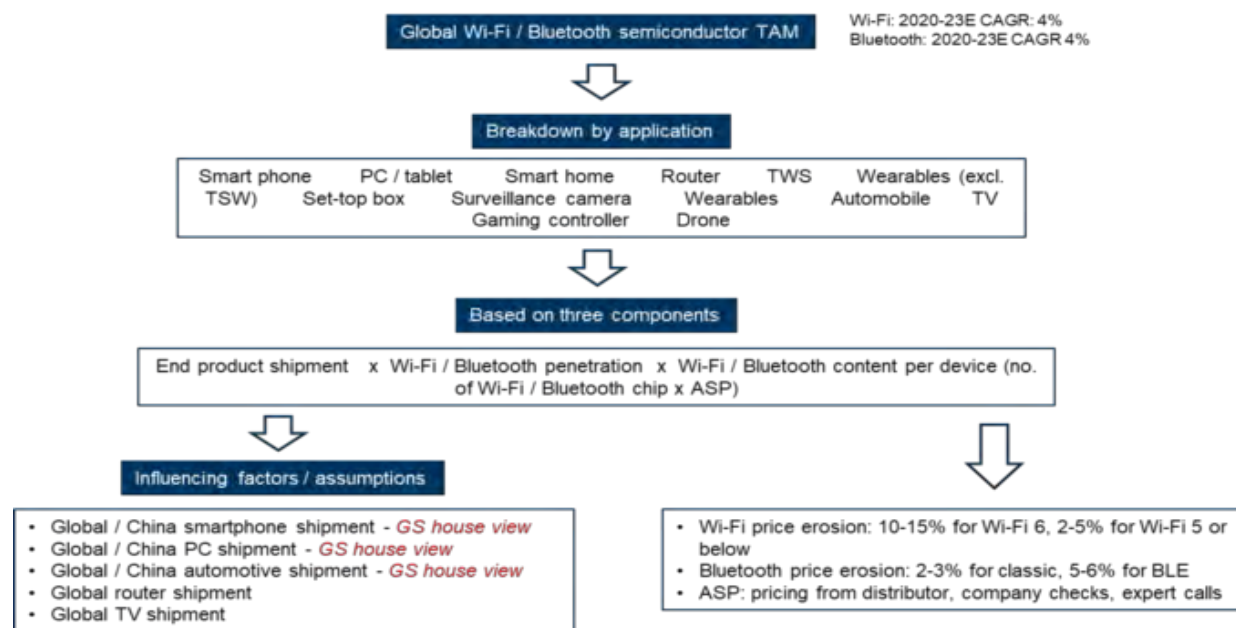


Source: Goldman Sachs Global Investment Research, Gao Hua Securities Research, Gao Hua Securities Research

WiFi / Bluetooth TAM methodology

We form our WiFi and Bluetooth TAM model based on three key components: device shipments, WiFi / Bluetooth penetration, and WiFi / Bluetooth content per device (chip ASP and units). On device shipments, we break them down into 15 applications (smartphone, PC / tablet, smart home, router, set-top box, surveillance, etc). We base our assumptions of device shipments on supply chain checks and by referring to our house view for certain areas such as smartphone/PC shipments, automotive shipments, router shipments, etc. On WiFi / Bluetooth chip ASP and units per device, we base our assumptions on our supply chain checks with chip suppliers, distributors, and customers.

Exhibit 169: Our Wi-Fi / Bluetooth TAM analysis approach

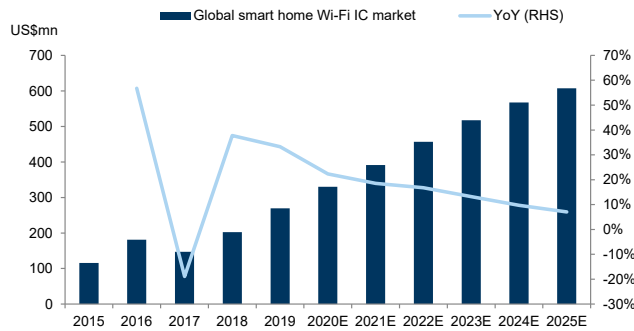


Source: Goldman Sachs Global Investment Research, Gao Hua Securities Research, Gao Hua Securities Research

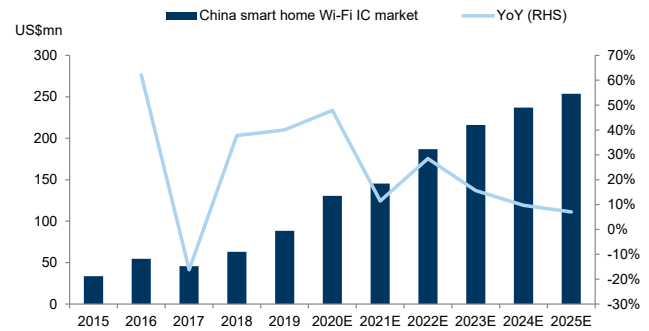
WiFi IC market growth by applications

Smart home: +16% CAGR in 2020-23E driven by unit growth and WiFi penetration

We expect Smart home to contribute 8% of global WiFi market revenue in 2020E, and we expect it to grow at a +16% CAGR from US\$330m in 2020E to US\$517m in 2023E, which is the strongest growth among all major applications in the WiFi market. In China's WiFi market, we expect smart home will account for 10% of revenue in 2020E, and we model a +18% CAGR from US\$130m in 2020E to US\$216m in 2023E. We believe the key growth driver in this segment is device unit growth (+21% CAGR in 2020-23E) and rising WiFi penetration (from 76% in 2020E to 82% in 2023E). Smart home devices include light controllers, sweeping robots, smoke detectors, door locks, home appliances, etc.

Exhibit 170: We model the global smart home Wi-Fi IC market to have a 13% 2020-25E CAGR

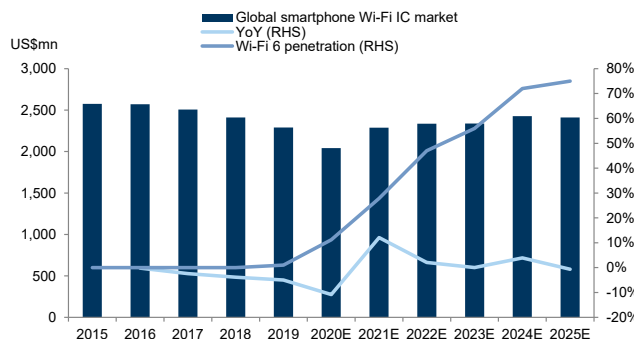
Source: IDC, Goldman Sachs Global Investment Research, Gao Hua Securities Research, Gao Hua Securities Research

Exhibit 171: China smart home Wi-Fi IC to have 14% 2020-25E CAGR

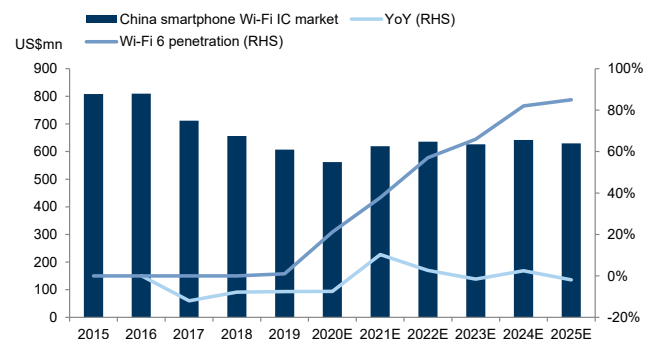
Source: IDC, Goldman Sachs Global Investment Research, Gao Hua Securities Research, Gao Hua Securities Research

Smartphone: +5% CAGR in 2020-23E driven by rising WiFi 6 penetration

We expect smartphone to contribute 47% of global WiFi market revenue in 2020E, and we expect smartphone will grow at a +5% CAGR from US\$2.0bn in 2020E to US\$2.3bn in 2023E, which is the largest revenue contributor among all applications in the WiFi market. In China's WiFi market, we estimate smartphone will account for 45% of revenue in 2020E, and we model a +5% CAGR from US\$562m in 2020E to US\$626m in 2023E. We believe the key growth driver in this segment is the rising penetration of WiFi 6 as the ASP of WiFi 6 chips for smartphones is ~2x of the ASP of WiFi 5 chips. We also expect WiFi 6 penetration to increase from 11% in 2020% to 28%/47%/56% in 2021-23E in the global smartphone market, and from 21% in 2020E to 38%/57%/66% in 2021-23E in China's smartphone market. While some smartphones have WiFi chips integrated into AP/SoC, our TAM model market size includes the theoretical WiFi chip value inside those integrated ones.

Exhibit 172: Global smartphone Wi-Fi IC to reach US\$2.4bn by 2025E, 75% Wi-Fi 6 penetration

Source: IDC, Goldman Sachs Global Investment Research, Gao Hua Securities Research, Gao Hua Securities Research

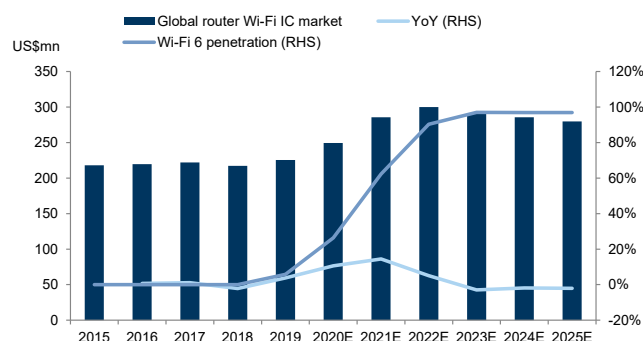
Exhibit 173: China smartphone Wi-Fi IC at US\$630mn, 85%+ Wi-Fi 5 penetration

Source: IDC, Goldman Sachs Global Investment Research, Gao Hua Securities Research, Gao Hua Securities Research

Routers: +5% CAGR in 2020-23E driven by rising WiFi 6 penetration

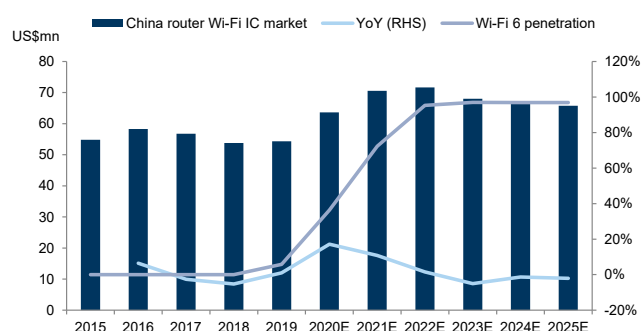
We expect routers to contribute 5% of global WiFi market revenue in 2020E, and we expect routers to grow at a +5% CAGR from US\$249m in 2020E to US\$291m in 2023E. In China's WiFi market, we expect routers account for 5% of revenue in 2020E, and we model a +2% CAGR from US\$64m in 2020E to US\$68m in 2023E. We believe the key growth driver in this segment is the rising penetration of WiFi 6 as the ASP of WiFi 6 chips for routers is ~1.8x of the ASP of WiFi 5 chips. We expect WiFi 6 penetration in routers to increase from 26% in 2020% to 62%/90%/97% in 2021-23E in the global market, and from 36% in 2020E to 72%/95%/97% in 2021-23E in China market.

Exhibit 174: Global router Wi-Fi IC market at c.US\$300mn by 2025E, 97% Wi-Fi 6 penetration



Source: IDC, Goldman Sachs Global Investment Research, Gao Hua Securities Research, Gao Hua Securities Research

Exhibit 175: China router Wi-Fi IC market at c.US\$70mn by 2025E, 97% Wi-Fi 6 penetration

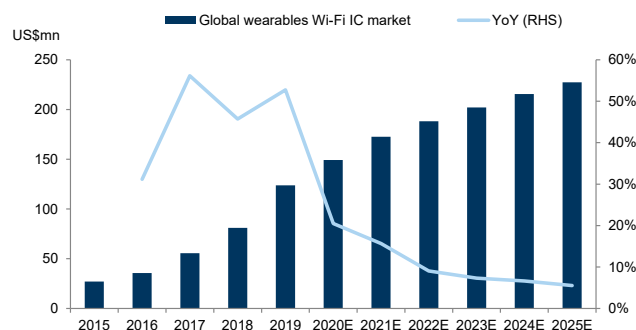


Source: IDC, Goldman Sachs Global Investment Research, Gao Hua Securities Research, Gao Hua Securities Research

Wearables: +11% CAGR in 2020-23E driven by unit growth and WiFi penetration

We expect wearables to contribute 3% of global WiFi market revenue in 2020E and we expect wearables to grow at an +11% CAGR from US\$149m in 2020E to US\$202m in 2023E. In China's WiFi market, we expect wearables to account for 4% of revenue in 2020E and we model an +11% CAGR from US\$50m in 2020E to US\$68m in 2023E. We believe the key growth driver in this segment is device unit growth (+9% CAGR in 2020-23E) and rising WiFi penetration (from 36% in 2020E to 42% in 2023E).

Exhibit 176: Global wearables Wi-Fi market to grow at an 11% 2020-23E CAGR



Source: IDC, Goldman Sachs Global Investment Research, Gao Hua Securities Research, Gao Hua Securities Research

Exhibit 177: China wearables Wi-Fi IC to reach US\$76mn by 2025E



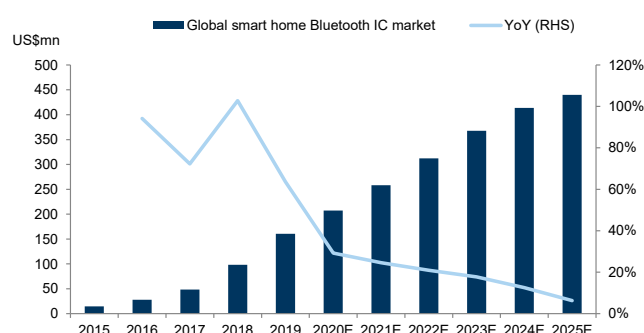
Source: IDC, Goldman Sachs Global Investment Research, Gao Hua Securities Research, Gao Hua Securities Research

Bluetooth IC market growth by applications

Smart home: +21% CAGR in 2020-23E driven by unit growth and Bluetooth penetration

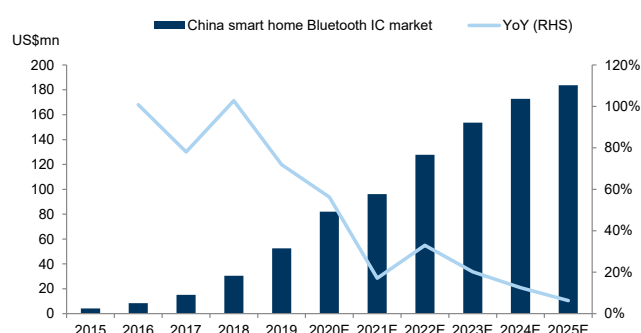
We expect smart home to contribute 6% of the global Bluetooth IC market revenue in 2020E, and we expect it to grow at a +21% CAGR from US\$207m in 2020E to US\$368m in 2023E, which is the strongest growth among all major applications in Bluetooth IC market. In China's Bluetooth IC market, we estimate smart home will account for 10% of revenue in 2020E, and we model a +23% CAGR from US\$82m in 2020E to US\$154m in 2023E. We believe the key growth driver in this segment is device unit growth (+18% CAGR in 2020-23E) and rising Bluetooth penetration (from 70% in 2020E to 85% in 2023E).

Exhibit 178: Global smart home Bluetooth IC to grow at a 21% 2020-23E CAGR



Source: IDC, Goldman Sachs Global Investment Research, Gao Hua Securities Research, Gao Hua Securities Research

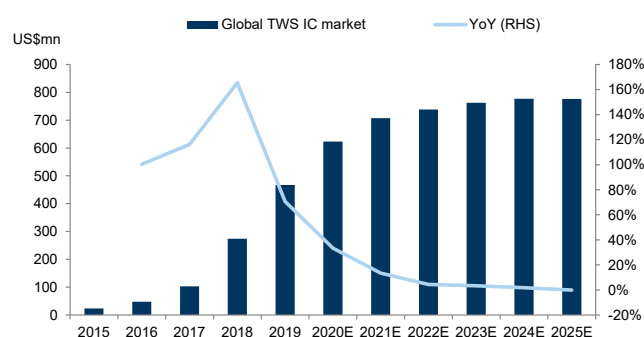
Exhibit 179: China smart home Bluetooth IC market to grow at a 23% 2020-23E CAGR



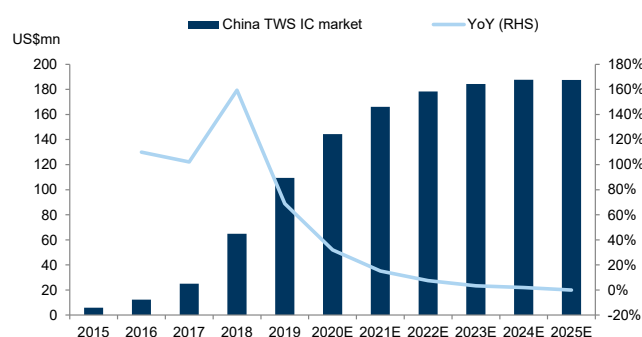
Source: IDC, Goldman Sachs Global Investment Research, Gao Hua Securities Research, Gao Hua Securities Research

TWS: +7% CAGR in 2020-23E driven by device unit growth

We expect TWS to contribute 19% of global Bluetooth IC market revenue in 2020E, and we expect TWS to grow at a +7% CAGR from US\$623m in 2020E to US\$763m in 2023E, which is the second-largest revenue growth contributor in the Bluetooth IC market. In China's Bluetooth IC market, we estimate TWS will account for 17% of revenue in 2020E, and we model a +8% CAGR from US\$144m in 2020E to US\$184m in 2023E. We expect the key growth driver in this segment will be device unit growth (+13% CAGR in 2020-23E), partly offset by ASP erosion of c.5% per year.

Exhibit 180: Global TWS IC market to reach US\$776mn by 2025E

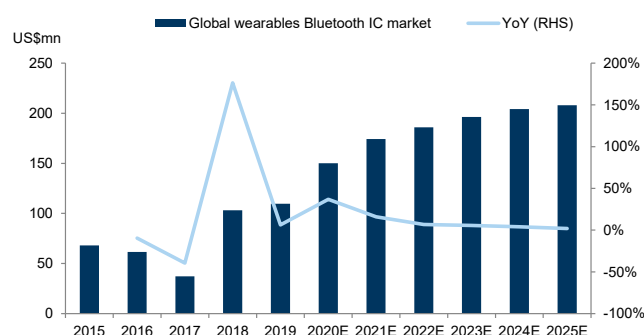
Source: IDC, Goldman Sachs Global Investment Research, Gao Hua Securities Research, Gao Hua Securities Research

Exhibit 181: China TWS market to grow by 8% 2020-23E CAGR

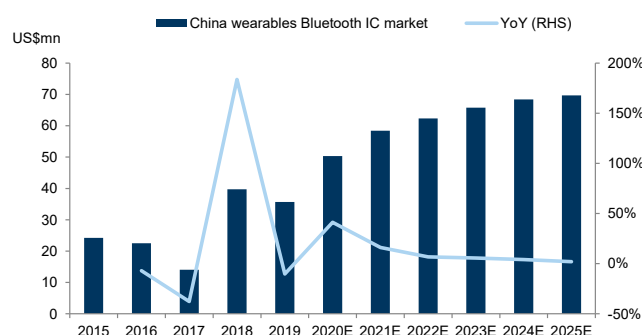
Source: IDC, Goldman Sachs Global Investment Research, Gao Hua Securities Research, Gao Hua Securities Research

Wearables: +9% CAGR in 2020-23E driven by device unit growth

We forecast wearables (excluding TWS) will contribute 5% of global Bluetooth IC market revenue in 2020E, and we expect wearables to grow at a +7% CAGR from US\$150m in 2020E to US\$196m in 2023E. In China's Bluetooth IC market, we estimate wearables (excluding TWS) will account for 6% of revenue in 2020E, and we model a +9% CAGR from US\$50m in 2020E to US\$66m in 2023E. We believe the growth driver in this segment is device unit growth (+12% CAGR in 2020-23E), and increasing Bluetooth penetration (from 89% in 2020E to 95% in 2023E), partly offset by ASP erosion of c.5% per year.

Exhibit 182: Global wearables Bluetooth IC market

Source: IDC, Goldman Sachs Global Investment Research, Gao Hua Securities Research, Gao Hua Securities Research

Exhibit 183: China wearables Bluetooth IC market to grow by 9% 2020-23E CAGR

Source: IDC, Goldman Sachs Global Investment Research, Gao Hua Securities Research, Gao Hua Securities Research

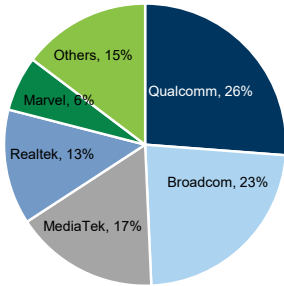
WiFi / Bluetooth competition landscape

WiFi IC market dominated by a few players; Bluetooth IC market more fragmented

The global WiFi IC market is more concentrated with the top 5 players having 85% of aggregate market share; while the Bluetooth IC market is more fragmented with the top-five players’ aggregate market share at 59%. In the WiFi IC market, Qualcomm, Broadcom, MediaTek, Realtek, and Marvell were the five largest suppliers with aggregate market share at 85% in 2019, according to Gartner. In the Bluetooth IC market, Qualcomm, Apple, Nordic, Cypress, and Dialog were the top five players with aggregate market share at 59% in 2019. In China, Espressif and Beken are two key players focusing on WiFi and Bluetooth ICs; All Winner and Rockchip are smart device SoC design houses that integrate WiFi/ Bluetooth into SoC and also develop discrete WiFi/ Bluetooth chips.

Exhibit 184: Top 5 WiFi IC suppliers have 85% aggregate market share

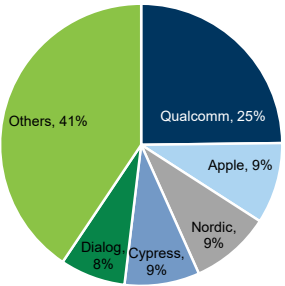
Global WiFi IC market share in 2019



Source: Gartner

Exhibit 185: Top 5 Bluetooth IC have 59% aggregate market share

Global Bluetooth IC market share in 2019



Source: Gartner

Chinese suppliers’ technology gap vs global peers

- **Product offerings - global leaders have more comprehensive product lines:** On WiFi technologies, global leaders such as Broadcom and Qualcomm are usually earlier in adopting new technologies. For the latest WiFi technology, WiFi 6 (or 802.11 ax), global leaders launched their products in 2018, while Chinese suppliers’ WiFi 6 solutions are still under development. In terms of WiFi frequency coverage, global leaders can cover 2.4Ghz, 5GHz, and 6GHz; Chinese supplier Beken can cover 900MHz, 2.4GHz, 5GHz, while Espressif can only cover 2.4GHz for WiFi. On Bluetooth, global leaders’ products can cover from Bluetooth 2.1 generation to Bluetooth 5.1 generation, while Chinese suppliers’ Bluetooth 5.0 products are still under development.

Exhibit 186: Global WiFi/ Bluetooth leaders have more comprehensive product lines

WiFi / Bluetooth product offerings comparison

Category	Technology	Beken	Espressif	Mediatek	Realtek	Broadcom	Qualcomm
Wi-Fi (by standard)	802.11 a	√		√		√	√
	802.11 b	√	√	√	√	√	√
	802.11 g	√	√	√	√	√	√
	802.11 n (Wi-Fi 4)	√	√	√	√	√	√
	802.11 ac (Wi-Fi 5)		√	√	√	√	√
	802.11 ax (Wi-Fi 6)			√		√	√
Wi-Fi (by frequency band)	900MHz	√					
	2.4GHz	√	√	√	√	√	√
	5GHz	√		√	√	√	√
	6GHz					√	√
Bluetooth (by product type)	BLE	√	√	√	√	√	√
	Basic Rate (BR)	√	√	√	√	√	√
	Enhanced Data Rate (EDR)	√	√	√	√	√	√
Bluetooth (by generation)	Bluetooth 2.1	√		√	√	√	√
	Bluetooth 3.0	√		√	√	√	√
	Bluetooth 4.0	√		√	√	√	√
	Bluetooth 4.1	√				√	√
	Bluetooth 4.2		√	√	√	√	√
	Bluetooth 5.0			√	√	√	√
	Bluetooth 5.1					√	√

Source: Company data

- **Process nodes - global leaders in more advanced nodes with WiFi/ Bluetooth integrated in SoCs:** As WiFi/ Bluetooth ICs are usually integrated into SoCs in smartphones, the global leaders are using advanced nodes like 7nm for the SoC. For discrete WiFi / Bluetooth chip solutions, Broadcom has a WiFi 6 / Bluetooth 5 combo chipset based on 16nm technology, which supports 6GHz band, Bluetooth 5 with MIMO radio, 160MHz channels, enabling 2Gbps speed for smartphones. In comparison, Chinese suppliers are mainly in 28nm and 40nm and some of them are moving to 22nm and more advanced nodes for products such as Bluetooth audio chips for TWS.

Exhibit 187: WiFi/ Bluetooth IC suppliers' process node comparison

Including the WiFi/ Bluetooth functions integrated in smartphone SoCs

Company	Process nodes
Qualcomm	7nm, 8nm, 10nm, 14nm, 20nm, 28nm
Broadcom	16nm, 28nm, 40nm
MediaTek	7nm, 10nm, 12nm, 16nm, 20nm, 28nm
Realtek	16nm, 28nm, 40nm
HiSilicon	7nm, 10nm, 14nm, 28nm, 40nm
Espressif	40nm
Beken	28nm, 40nm, 55nm
Bestechnic	28nm, 22nm under development
Allwinner	28nm, 40nm, 55nm

Source: Company data

Key Chinese suppliers

- **Espressif** is an IC design company focusing on WiFi MCU chips and modules for IoT devices, smart home, smart lighting, smart payment devices, smart wearables, sensors, and industrial control. The company launched WiFi MCU for tablet and STB in 2013, and expanded into WiFi and Bluetooth dual-mode dual-core MCU in 2016. The company's products cover WiFi 802.11b/g/n/ac and BLE4.2, while its WiFi 6 and BLE5.0 products are under development. Its WiFi MCUs are based on 40nm process nodes.

- **Beken** is an IC design company in China focusing on connectivity ICs such as WiFi, Bluetooth, 2.4GHz/5.8GHz general wireless, wireless audio, ETC RF, etc. Its customers include Amazon, Philips, ZTE, Media Group, Huawei, DJI, Motorola, LG, Sharp, etc. Its Bluetooth ICs are used in TWS, home appliances, smart speakers, wearables, PC peripherals, etc.; its WiFi ICs are used in smart home appliances and drones. Its Bluetooth ICs are based on 55nm to 28nm process nodes. It currently has an R&D team of 150 people, >100 product types, and >200 patents.
- **All Winner** is an IC design company focusing on smart device SoC, power management ICs, and wireless connectivity ICs; for applications such as smart home, tablet, IoT, robotics, STB, wireless connectivity modules, smart IoT, etc. Its WiFi MCU products are targeting at an IoT market with low power consumption, and have penetrated into smart watch customers.
- **Rockchip** is an IC design company focusing on SoCs for smart IoT and consumer electronic applications such as AI system platform, smart display, smart retail, surveillance, etc. Some of Rockchip's SoC products integrate Bluetooth function, and the company also announced its WiFi chips recently.

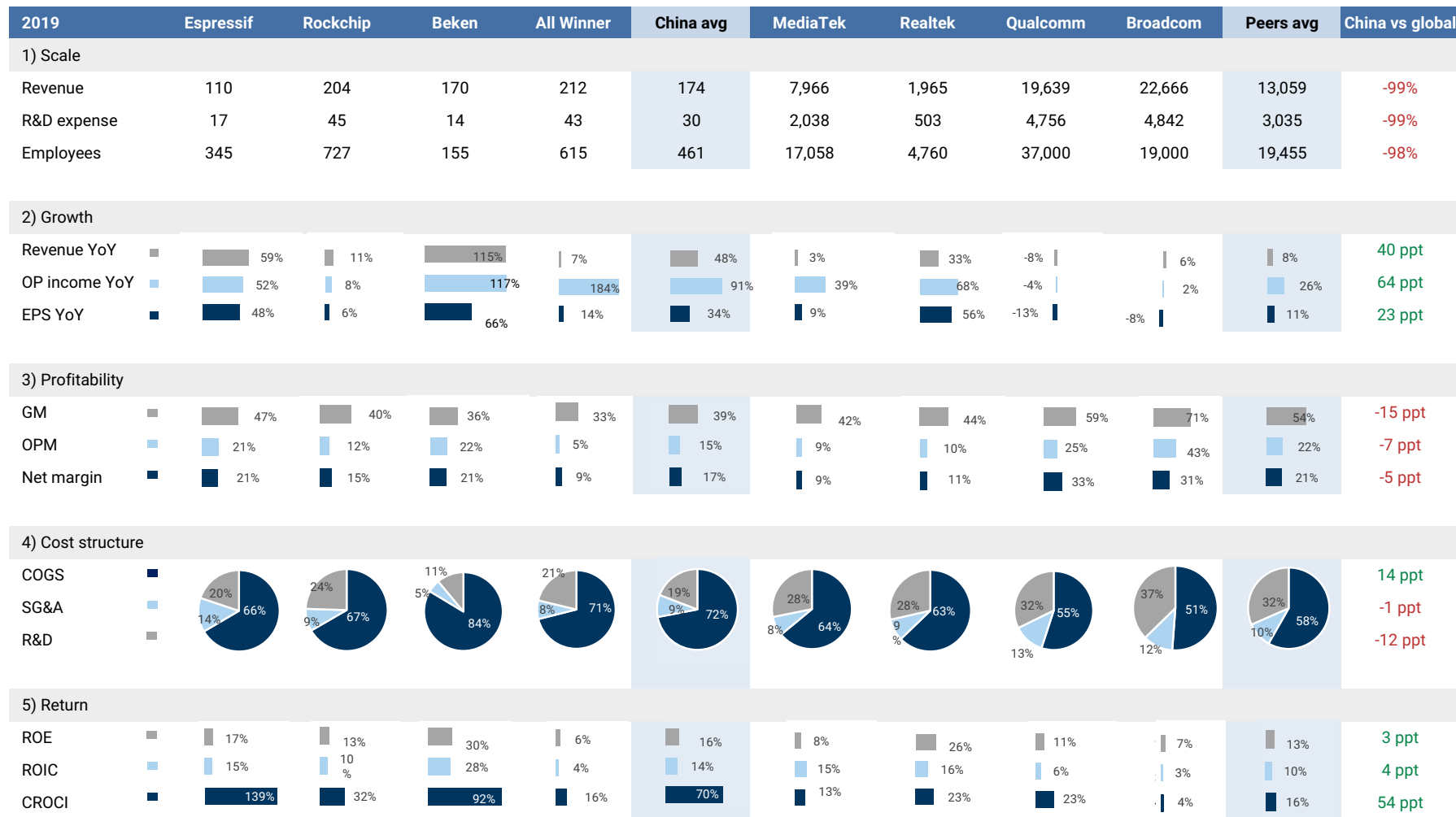
Financial comparison among Chinese and global players

- **Scale - Chinese players' revenue and R&D expense scale only 1% of global leaders:** The leading Chinese players in WiFi and Bluetooth such as Espressif, Beken, Rockchip, and All Winner only had total revenue scale at US\$110~212m in 2019, which was less than 1% of the total revenue scale of global leaders such as Broadcom, Qualcomm, MediaTek, and Realtek. On R&D expenses, Chinese players spent US\$30m in R&D expenses on average in 2019, which were only 1% of global leader's average R&D expenses of US\$3bn. On numbers of employees, Chinese players' average numbers of employees were 461 in 2019, which were only 2% the scale of global players' average numbers of employees of 19k in 2019.
- **Growth - Chinese players' revenue growth was 40ppt higher than global players:** Beken/ Espressif enjoyed strong revenue growth at +115%/ +59% YoY in 2019; while Rockchip / All Winner showed slower revenue growth at +11%/ +7% YoY. Chinese players' revenue growth was +48% YoY in 2019 on average, higher than the global leaders' average revenue growth of +8% YoY. On operating income, Chinese players' average growth was +91% YoY (ranged from +8% to +184%) in 2019, higher than global players' average operating profit growth at +64% YoY. On EPS, Chinese players' average EPS growth was +34% YoY (ranged from +6% to +66%) in 2019, higher than global players' average's growth at +11% YoY.
- **Profitability - Chinese players' GM was 15ppt lower than global players:** The Chinese players' GM ranged from 33% to 47% in 2019 with an average at 39%, which was 15ppt lower than global players' average GM of 54% (ranged from 42% to 71%). On operating margin, the Chinese players' average OPM was 15% (ranged from 5% to 22%) in 2019, which was 7ppt lower than global players' average OPM of 22% (ranged from 9% to 43%). On net margin, the Chinese players' average NM was 17% (ranged from 9% to 21%) in 2019, which was 5ppt lower than global players' average NM of 21% (ranging from 9% to 33%).

- **Cost structure - Chinese players have higher COGS but lower R&D:** The Chinese players' COGS accounted for 72% of total cost on average (ranged from 67% to 84%) in 2019, higher than global peers' average of 58% (ranged from 51% to 64%). On R&D expenses, Chinese players' R&D expenses accounted for 19% of total cost on average (ranged from 11% to 25%) in 2019, which was lower than global players' average of 32% (ranging from 28% to 37%).
- **Return - Chinese players are slightly higher than global peers:** The Chinese players' ROE was at 6-30% in 2019 with average at 16%, which was slightly higher than global players' average of 13% (ranged from 7% to 26%). This was mainly due to Chinese players' higher asset turnover given their smaller scales and fewer product lines. Chinese players' ROIC average of 14% (ranged from 4% to 28%) in 2019 were also slightly higher than global players' average of 10% (ranging from 3% to 16%).

Exhibit 188: Chinese WiFi/ Bluetooth players have stronger growth but weaker profitability

Financial comparison between Chinese and global WiFi/ Bluetooth players



Source: Company data

WiFi / Bluetooth stock ideas; reiterate Buy on SMIC (on CL), Maxscend (Buy)

In the WiFi and Bluetooth space, we are positive on SMIC (Buy, on CL) and Maxscend (Buy). For SMIC, WiFi and Bluetooth are key applications and products on its 40nm and 55nm process nodes, with key customers such as Beken, Jieli, Bestechnic. For Maxscend, although Bluetooth Low Energy MCU was small in 2019 at 1% revenues, we expect a strong growth ahead at 52% CAGR in 2020-25E driven by 5G, IoT trends.

SMIC in WiFi / Bluetooth

Connectivity ICs such WiFi, Bluetooth, and NB-IoT are key applications and products on SMIC's 40nm and 55nm process nodes. SMIC's 65nm / 55nm RF / IoT IP Portfolios support product applications in Wi-Fi, GPS, Bluetooth, NFC, ZigBee and wireless combo. In particular, with eFlash (embedded Flash) and RF technologies, SMIC's 55nm wireless solutions are suitable to meet IoT-related wireless connectivity demands. For the near term, SMIC sees Bluetooth ICs for TWS enjoying strong demand from customers such as Jieli and Beken. As the TWS market is in the early stage with several IC design houses emerging, we believe SMIC is well-positioned in this market given its foundry leader position in China and accumulated production track records. SMIC's key customers in WiFi and Bluetooth include Jieli, Beken, Allwinner, Bestechnic, etc. These customers' products are mainly on 55nm and 40nm currently and will migrate to 28nm and 14nm in coming years.

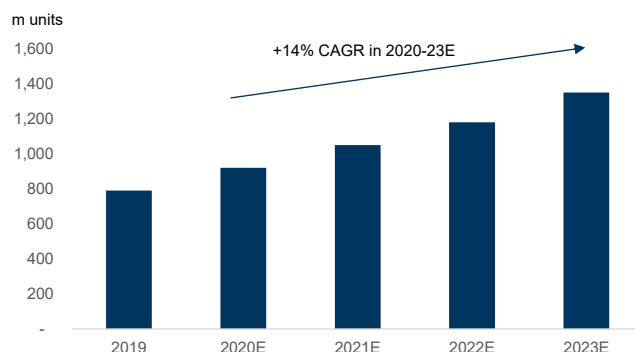
- **Beken:** SMIC mainly manufactures the WiFi IC and TWS Bluetooth ICs for Beken, using SMIC's 55nm, 40nm, and 28nm. Beken offers a wide range of Bluetooth ICs covering from low-end wireless earphones to high-end TWS earphones, with Bluetooth ICs ASP ranging from <US\$0.5 to US\$2. Its TWS customers include ZTE, Walmart, etc. On WiFi IC, Beken is developing WiFi 6 SoC with lower power consumption, higher carrier frequency, and more precise positioning technology. The company targets to have 30-40% of its WiFi IC products to be WiFi 6 compliant in 3 years.
- **Jieli** is an IC design company focusing on SoC for RF smart devices and multi-media smart devices. Its RF smart device SoC integrates Bluetooth, NOR flash, embedded CPU, USB, and FM into one chip, enabling audio/data transmitting/receiving through Bluetooth, for applications such as Bluetooth earphones and Bluetooth speakers. SMIC is one of Jieli's major foundry suppliers with ~50% order allocation.
- **Bestechnic** is a IC design company focusing on smart audio SoCs (including Bluetooth audio chip, smart Bluetooth audio chip, Type-C audio chip) for applications such as smart Bluetooth earphones, Type-C earphones, smart speakers, etc. Its customers include Huawei, Samsung, OPPO, Xiaomi, Moto, etc. Its products are currently based on 40nm and 28nm, and the company also plans to migrate to 22nm. SMIC is one of Bestechnic's major foundry suppliers with ~30% order allocation.

Maxscend in WiFi / Bluetooth

Small but rising market: Maxscend's bluetooth low energy MCU (BLE MCU) started in 2016 and is still small in terms of revenues, at less than 5% in 2019 and 1.5% in 2018.

BLE MCU provides connectivity for end-devices across short distances to realize IoT, for example, in wristbands, blood pressure monitors, weighing scales, toys, surveillance cameras, etc. These can be used in smart home, smart health care, wearables, smart city, environment monitors, smart meters, automotive electronics, etc. Devices using Bluetooth technology to transmit data will grow at a 14% CAGR in 2020-23E to 1,350m units, per Maxscend.

Exhibit 189: Global Bluetooth devices shipments to grow by 14% 2020-23E CAGR



Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research, Gao Hua Securities Research

Main customer is Holtek; upside from Xiaomi and Samsung also rich in IoT

devices: Maxscend's BLE MCU is mainly sold to Holtek, which accounts for around 50% of Maxscend's BLE MCU revenues. BLE MCU ASP is around US\$0.2, and Maxscend's annual shipments amounted to only 5-6m in 2018. Maxscend started shipping BLE MCU to Holtek in 2016, mainly used in IoT smart devices. Holtek is an IC design house in Taiwan, focusing in microcontroller and peripheral component design and marketing. Holtek's products are mainly MCU, across general purpose MCU, BLE MCU, Display MCU, USB MCU, earphone interface bridge MCU, etc. Other major clients for Maxscend include Samsung and Xiaomi, which are also rich in IoT devices, with Xiaomi's IoT and Lifestyle products contributing 30% of Xiaomi's 2019 revenues, providing upside for Maxscend's future BLE MCU business.

Customer, license fee on Bluetooth IP: Apart from selling chips, Maxscend also receives license fees on its Bluetooth IP. For example, **SMIC**, as Maxscend's foundry on BLE MCU (55nm), paid Maxscend on its Bluetooth IP and Bluetooth low energy RF IP. Other key customers include: **UniSoC** (WiFi, Bluetooth, FM, three in one chips), **Cypress** (BLE IP, used in MCU), **MVSilicon** (2.4GHz BT Transceiver and Modern IP, for its Bluetooth audio chips), **Spansion** (Bluetooth RF IP for MCU) **Actions Semi** (Bluetooth RF IP for audio chips), **Sunrise** (2.4GHz BT Transceiver IP for audio chips), etc.

License fee business model: The revenues from IP authorization includes two parts: 1) NRE (non-recurring engineering expense): a one-off R&D services fee, charged based on the project development progress and 2) Royalty: charged based on the authorized product shipments.

Future plan, invest Rmb176m in connectivity MCU for IoT: Maxscend also aims to develop other connectivity with MCU, such as Wifi, which could support larger data transmission, and NB-IoT, which could support a wider area network, realizing smart cities. As disclosed in Maxscend's prospectus, the company plans to invest Rmb176m (US\$25m) to develop chips for IoT connectivity (BLE MCU, Wifi MCU, NB-IoT MCU, etc.). Specifically, the company plans to develop three products by 2023E:

- **High performance BLE MCU:** target to develop new design or manufacturing technique to raise the performance, integrate more components, and lower costs.
- **Low energy IoT MCU:** target to develop the MCU which could applied to wide applications, such as smart city, environment monitoring, smart meters, etc.
- **BLE audio chips:** target to add audio functions on its current BLE chips, which carries features of low Bluetooth power consumption and low background noise.

BLE MCU Technology - CMOS:

Wifi & Connectivity Module: In 2019, Maxscend introduced WiFi & connectivity module, integrated RF switch and LNA via SIP (system in package). The product is based on the WiFi 5 standard and Maxscend is developing modules for WiFi6, to integrate RF switch, LNA, filters and PA. As we highlighted on May 11 ([report link](#)), Maxscend's Wifi PA has just started to produce and promote their Wifi PA to customers, under customer qualification. The company targets routers and high-end smartphones and sees further business opportunities in Samsung and Xiaomi. Foundry at AWSC and UMC's GaAs fab. With new wifi standard (Wifi 6), we are positive on the overall market growth, supporting Maxscend's penetration.

Wifi PA technology - GaAs, a good start from Wifi PA: The PA market can be divided into four parts: (1) Smartphone PA, (2) Wifi PA / FEM, (3) NB-IoT PA, and (4) 5G base station PA. We believe Maxscend's penetration into the PA market via Wifi PA is a good start given that the PA market uses different technology, GaAs, while Maxscend has more experience in CMOS SOI (switch, LNA) and thus needs time to accumulate experience on GaAs. Among the four sub-markets, the NB-IoT PA is gradually integrated into SOC, 5G base station PA has a smaller market with less customers, and smartphone PA is fast due to technology / generation upgrade. And thus we see Wifi PA / FEM as a good start for Maxscend to accumulate experience on GaAs. Wifi PA / FEM is slow in technology / generation migration compared to smartphone PA, with two major products only: 2.4G PA / FEM and 5.8G PA / FEM, and the market growth is being driven by Wifi 6, supporting new suppliers' penetration.

SMIC investment thesis: reiterate Buy (on CL)

Our view on SMIC has been constructive since we upgraded in Aug-2019 ([deep-dive](#)), and we reiterate our positive thesis as we expect:

- A strong rev/ earnings CAGR of 22%/ 42% in 2020-2025 due to the high utilization rate of mature nodes (40nm-65nm) and disciplined expansion of advanced nodes (14/12nm, N+1, N+2);
- Growing IC design houses in China to drive growth, with SMIC the major beneficiary locally.

Why do mature nodes matter? They're profit drivers, driven by a high utilization

rate: We are positive on mature node utilization rate, thanks to stronger orders from key customers such as Will Semi (CIS), GigaDevice (NOR flash, MCU), ZTE Micro (networking IC), and domestic design houses in ASIC, Bluetooth IC, smart devices SoC, etc. SMIC's 40-65nm is the major profit driver (51% of gross profit in 2020E), and we model the utilization rate to improve from 93% in 2020E to 95%/98% in 2021/22E, supporting GM.

Don't advanced nodes dilute profit? Acceptable as long as the speed is

disciplined: We expect SMIC to continue with its technology migration, moving from 14nm to 12nm this year, to N+1 (8nm) in 2022E, N+2 (7nm) in 2023E, and 5nm in 2025E. Although the profitability of advanced nodes is lower in the first few years, we see the key difference as that SMIC will be more disciplined on capacity expansion of advanced nodes, which should limit the profit dilution. We model a 12/14nm capacity to increase from 12k wpm (wafers per month) by end-2020E, to 30k / 36k by end-2021E / 22E. With 12/14nm capacity utilization improving from 38% in 2021E to 80% in 2022E and yield rate ramp-up, we expect the GM of 12/14nm to improve from -25% in 2021E to +24% in 2022E. Key customers at SMIC's 12/14nm are UniSoC and domestic IC design houses in ASIC, FPGA, PC/server CPU, Bluetooth audio IC, DSP, etc.

Exhibit 190: SMIC P&L

(US\$m)	1Q19	2Q19	3Q19	4Q19	1Q20	2Q20E	3Q20E	4Q20E	2016	2017	2018	2019	2020E	2021E	2022E
Revenue	669	791	816	839	905	941	939	720	2,914	3,101	3,360	3,116	3,505	4,374	5,892
Gross profit	122	151	170	199	234	250	236	109	850	741	747	642	829	931	1,351
Operating expense	(98)	(194)	(123)	(179)	(186)	(180)	(194)	(154)	(510)	(616)	(732)	(594)	(714)	(819)	(1,014)
Operating income	24	(43)	47	20	47	70	42	(45)	339	125	15	49	115	112	337
Pre tax profit	31	(24)	89	88	66	95	63	(23)	310	128	92	182	200	189	390
Net income	12	19	115	89	64	92	79	(6)	377	180	134	235	229	229	404
EPS (US\$)	0.00	0.00	0.02	0.02	0.01	0.02	0.02	(0.00)	0.09	0.04	0.03	0.05	0.05	0.04	0.08
Margins / ratio															
Gross margin	18.2%	19.1%	20.8%	23.8%	25.8%	26.6%	25.2%	15.1%	29.2%	23.9%	22.2%	20.6%	23.6%	21.3%	22.9%
Opex ratio	-14.6%	-24.5%	-15.0%	-21.4%	-20.6%	-19.1%	-20.7%	-21.3%	-17.5%	-19.9%	-21.8%	-19.1%	-20.4%	-18.7%	-17.2%
Operating margin	3.7%	-5.4%	5.8%	2.4%	5.2%	7.5%	4.4%	-6.2%	11.6%	4.0%	0.4%	1.6%	3.3%	2.6%	5.7%
Net margin	1.8%	2.3%	14.1%	10.6%	7.1%	9.8%	8.4%	-0.8%	12.9%	5.8%	4.0%	7.5%	6.5%	5.2%	6.9%
QoQ															
Revenue	-15%	18%	3%	3%	8%	4%	0%	-23%							
Gross profit	-9%	24%	12%	17%	17%	7%	-6%	-54%							
Operating income	nm	nm	nm	-57%	135%	49%	-41%	nm							
Pre tax profit	1099%	nm	nm	-1%	-25%	44%	-33%	nm							
Net income	-54%	51%	521%	-23%	-28%	44%	-14%	nm							
EPS (US\$)	-54%	51%	521%	-23%	-28%	44%	-14%	nm							
YoY															
Revenue	-20%	-11%	-4%	7%	35%	19%	15%	-14%	30%	6%	8%	-7%	13%	25%	35%
Gross profit	-45%	-31%	-3%	49%	91%	65%	39%	-45%	24%	-13%	1%	-14%	29%	12%	45%
Operating income	-42%	nm	nm	nm	94%	nm	-11%	nm	53%	-63%	-88%	234%	134%	-2%	200%
Pre tax profit	-29%	nm	638%	3342%	115%	nm	-29%	nm	34%	-59%	-29%	99%	10%	-6%	107%
Net income	-58%	-64%	334%	235%	423%	398%	-31%	nm	49%	-52%	-25%	75%	-2%	0%	77%
EPS (US\$)	-59%	-65%	330%	234%	417%	393%	-32%	nm	48%	-56%	-31%	72%	-3%	0%	77%

Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Maxscend investment thesis: Reiterate Buy

Maxscend

300782.SZ		12m Price Target: Rmb562		Price: Rmb476.61		Upside: 17.9%	
Buy	GS Forecast						
			12/19	12/20E	12/21E	12/22E	
	Market cap: Rmb85.8bn / \$12.2bn	Revenue (Rmb mn)	1,512.4	2,606.2	3,721.7	5,775.2	
	Enterprise value: Rmb84.7bn / \$12.1bn	EBITDA (Rmb mn)	590.2	1,035.6	1,555.3	2,419.0	
	3m ADTV :Rmb1.3bn/ \$185.3mn	EPS (Rmb)	5.68	6.38	7.01	10.84	
	China	P/E (X)	31.3	74.6	68.0	44.0	
	Greater China Technology	P/B (X)	9.1	29.1	28.8	20.7	
		Dividend yield (%)	1.1	0.5	0.6	0.9	
	M&A Rank: 3	Net debt/EBITDA (X)	(0.8)	(1.0)	(0.9)	(0.9)	
		CROCI (%)	47.2	45.3	50.3	55.4	
		FCF yield (%)	(0.3)	1.2	0.8	1.6	
			3/20	6/20E	9/20E	12/20E	
		EPS (Rmb)	1.52	2.01	1.37	1.49	

Source: Company data, Goldman Sachs Research estimates, FactSet. Price as of 10 Jul 2020 close.

Maxscend is a leading RFFE supplier (switch, LNA, SAW filter), penetrated into all leading Android smartphone brands (Samsung, Xiaomi, Huawei, OPPO, Vivo), with growing product lines (Wifi PA, Bluetooth low energy MCU, RFFE for 5G base stations). We model Maxscend's earnings growth at a 50% CAGR in 2020-22E driven by upside in:

- **Product mix upgrade:** We see Maxscend as a 5G beneficiary of dollar content increase in 5G smartphones vs. 4G. In addition, Maxscend's 5G antenna tuning switch priced at US\$0.4-0.5 vs. general switch (on or off) at less than US\$0.1, driving its product mix upgrade.
- **Market share:** We see upside in its home market, China smartphones, due to its low base, especially in OPPO and Vivo, given that these two brands are not under trade tension pressure but also more open to raising new suppliers' allocation to diversify their supply chain. We see RFFE carry higher single country supplier risk, given that dominator, Skyworks, Qorvo, and Broadcom are all US suppliers, with 65% global market share. Amid the current trade tension, we believe brand makers are more willing to diversify their supply chain, providing opportunities to Maxscend.
- **End-markets expansion:** Maxscend is also expanding its end-market exposure, from smartphones to IoT (Bluetooth low energy MCU in wristbands, blood pressure monitors, weighing scales, toys, surveillance cameras, etc), routers (Wifi PA), and 5G base stations (RFFE, including switch, PA, filters), diversifying its end markets exposure.
- **Product lines expansion:** The company's revenues come mainly from switch (80% of revenues), followed by LNA (17%); however, the company continues to expand its product lines, including SAW filters, Bluetooth low energy MCU, Wifi PA, RFFE for 5G base stations, and cellular PA in the long term.

Exhibit 191: Maxscend P&L

Rmb m	1Q19	2Q19	3Q19	4Q19	1Q20	2Q20E	3Q20E	4Q20E	2017	2018	2019	2020E	2021E	2022E
Revenues	181	334	470	528	451	601	739	815	592	560	1,512	2,606	3,722	5,775
GP	96	177	247	273	237	316	387	422	331	290	793	1,363	1,948	2,976
OP	61	119	193	199	173	230	282	306	220	163	571	991	1,436	2,227
Pretax income	49	126	199	189	175	232	284	310	193	180	563	1,000	1,457	2,254
Net income	42	111	170	175	152	201	246	268	170	162	497	867	1,262	1,952
EPS (Rmb)	0.56	1.48	1.70	1.95	1.52	2.01	1.37	1.49	2.27	2.16	5.68	6.38	7.01	10.84
Margins														
GM	52.8%	53.0%	52.7%	51.8%	52.7%	52.5%	52.4%	51.8%	55.9%	51.7%	52.5%	52.3%	52.3%	51.5%
OPM	33.4%	35.6%	41.1%	37.7%	38.4%	38.2%	38.1%	37.5%	37.1%	29.2%	37.8%	38.0%	38.6%	38.6%
NM	23.0%	33.3%	36.2%	33.1%	33.7%	33.4%	33.3%	32.9%	28.7%	29.0%	32.9%	33.3%	33.9%	33.8%
Ratios														
Opex ratio	19.4%	17.4%	11.6%	14.2%	14.3%	14.3%	14.3%	14.3%	18.8%	22.6%	14.7%	14.3%	13.8%	13.0%
Tax rate	15.8%	12.1%	15.1%	8.1%	13.5%	13.5%	13.5%	13.5%	12.2%	10.7%	12.1%	13.5%	13.5%	13.5%
YoY														
Revenues	42%	155%	159%	339%	149%	80%	57%	55%	54%	-5%	170%	72%	43%	55%
GP	40%	167%	163%	348%	148%	78%	57%	54%	38%	-12%	174%	72%	43%	53%
OP	46%	213%	217%	764%	186%	94%	46%	54%	127%	-26%	250%	73%	45%	55%
Net income	73%	144%	151%	597%	263%	81%	45%	54%	102%	-4%	206%	74%	46%	55%
QoQ														
Revenues	51%	84%	41%	12%	-15%	33%	23%	10%						
GP	57%	85%	40%	11%	-13%	33%	23%	9%						
OP	163%	96%	62%	3%	-13%	33%	23%	8%						
Net income	67%	166%	53%	3%	-13%	32%	22%	9%						

Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

SMIC valuation and downside risks

0981.HK		12m Price Target: HK\$42		Price: HK\$41.25		Upside: 1.8%	
Buy - CL		GS Forecast					
			12/19	12/20E	12/21E	12/22E	
Market cap: HK\$207.9bn / \$26.8bn		Revenue (\$ mn)	3,115.7	3,505.4	4,374.2	5,891.9	
Enterprise value: HK\$255.2bn / \$32.9bn		EBITDA (\$ mn)	1,176.7	1,593.5	2,055.6	2,731.5	
3m ADTV :HK\$3.0bn/ \$389.9mn		EPS (\$)	0.05	0.05	0.04	0.08	
China		P/E (X)	24.4	118.2	118.6	67.2	
Greater China Technology		P/B (X)	0.9	4.2	4.1	3.8	
		Dividend yield (%)	0.0	0.0	0.0	0.0	
M&A Rank: 3		Net debt/EBITDA (X)	0.7	0.6	0.8	0.9	
Asia ex. Japan Conviction List		CROCI (%)	3.3	7.0	7.9	8.9	
		FCF yield (%)	(10.4)	(7.8)	(7.3)	(6.7)	
			3/20	6/20E	9/20E	12/20E	
		EPS (\$)	0.01	0.02	0.02	(0.00)	

Source: Company data, Goldman Sachs Research estimates, FactSet. Price as of 10 Jul 2020 close.

Valuation:

PE methodology as earnings growth matters, visibility is better: We used a PB valuation previously due to 1) SMIC's volatile earnings (EPS +33%/+48%/-56%/-31% in 2015-18), 2) operating loss in 3Q18-4Q18, and 3) if excluding government subsidy, SMIC's operating level would be loss making in 2018-21E. However, we believe it's more appropriate to value the stock on a PE approach now given: 1) Improving profitability; we model OPM to improve from 0.4%/1.6% in 2018/19 to 3.3%/2.6%/5.7% in 2020-22E (the lower OPM in 2021E is due to the Huawei impact, for which we assume zero revenue contribution starting 4Q20E), 2) if excluding government subsidy, SMIC's operating level would turn positive from 2022E, 3) strong earnings growth ahead: we model +77%/+66% in 2022/23E (vs -3%/0% in 2020/21E due to COVID-19 and the Huawei impact). Read across: SMIC: raising TP to HK\$42, published on July 2.

Our 12-month target price of HK\$42.0 is based on discounted P/E. We expect SMIC to migrate to 7nm in 2023E and 5nm in 2025E, and GM to recover back to 30% in 2025E due to reduced competition and strong demand from domestic customers. We then apply a 27X P/E multiple to SMIC's 2025E EPS and discount it back to 2022E at a COE of 9%. The 27X P/E multiple is based on global semiconductor peers' PE vs EPS growth correlation. The discounted P/E methodology implies a 2022E P/E of 68X and 2022E P/B of 3.9X.

Exhibit 192: SMIC valuation: discounted PE

(US\$m)	2018	2019	2020E	2021E	2022E	2023E	2024E	2025E	2026E	2027E	2028E
Technology migration	28nm	14nm	12nm		8nm	7nm	7nm+	5nm			
Revenue	3,360	3,116	3,505	4,374	5,892	7,129	8,270	9,593	11,128	12,797	14,461
YoY		-7%	13%	25%	35%	21%	16%	16%	16%	15%	13%
GM	22.2%	20.6%	23.6%	21.3%	22.9%	25.5%	27.8%	30.1%	31.1%	32.1%	32.6%
GP	747	642	829	931	1,351	1,818	2,299	2,887	3,461	4,108	4,714
Opex ratio	21.8%	19.1%	20.4%	18.7%	17.2%	16.4%	16.2%	15.7%	15.1%	14.6%	14.2%
OP	15	49	115	112	337	652	958	1,386	1,779	2,241	2,661
Net profit	134	235	229	229	404	672	932	1,295	1,629	2,022	2,379
EPS (US\$)	0.03	0.05	0.05	0.04	0.08	0.132	0.18	0.25	0.32	0.40	0.47
YoY Growth		72%	-3%	0%	77%	66%	39%	39%	26%	24%	18%
2025E target P/E								27			
Target multiple x EPS								6.9			
Discounted back to 2022; TP (HK\$)					42						
Implied 2022E P/E					68						
Implied 2022E P/B					3.9						
COE assumption											
Beta	1.0										
Risk free	3.0%										
Market risk premium	6.0%										

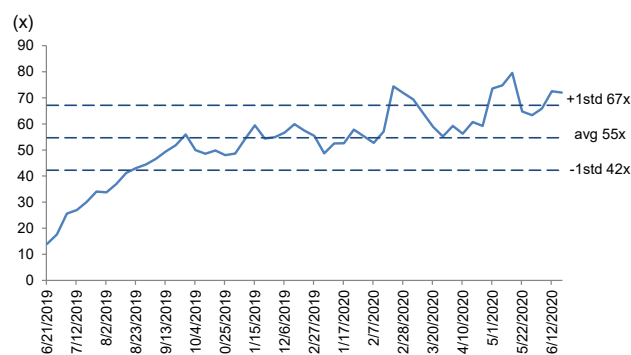
Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Downside risks:

1) US-China trade negotiations could impact demand for its customers' end-products, thus posing potential risks to SMIC. 2) SMIC's execution on advanced technology ramp-up could be a key swing factor for stock price sentiment and for financial performance. 3) Weaker-than-expected demand in smartphones and consumer electronics.

Maxscend valuation and downside risks

Valuation: We value Maxscend via discounted P/E, with a target P/E of 30x (we apply this to 2025E EPS and discount it back to 2021E). Our target P/E of 30x is set in line with the peak P/E of global peers over the past five years. We believe Maxscend still deserves the sector peak P/E by 2025E as we expect 2025E to mark the start of the company's product mix upgrade cycle. Our 12-month target price is at Rmb562, giving implied 2022E PE of 52x.

Exhibit 193: Maxscend 12M P/E ratio

Source: Bloomberg

Downside risks:

Slower-than-expected 5G smartphone roll outs: These potential risk factors could cap Maxscend's opportunities stemming from the 5G trend, and thus bring downside risks to our revenues estimates.

Slower-than-expected mid/low-end smartphone model roll outs: Such potential risk could limit Maxscend's addressable market as in the near term we expect the company's earnings to be primarily driven by market share expansion from a low base in mid / low-end smartphones.

Slower-than-expected market share expansion: If Maxscend does not expand market share, its revenue and earnings growth will be lower than we expect. Global peers are strong in comprehensive product lines and leading technology, which could affect Maxscend's market share expansion.

Slower-than-expected new product development: Currently, Maxscend's products are concentrated in RF switches and LNAs, while SAW filter and BLE MCU shipments are still relatively low volume. The company's long-term growth will depend on its progress in developing new technology and new products such as power amplifiers, 5G switches/LNAs, RF front-end modules, IoT MCUs, etc. Maxscend has a lower number of patents than peers (56 patents in 2018 vs. ~1,300 for Qorvo and ~3,500 for Skyworks), which could make it challenging for new product development. Any delay in technology development or new product launches could limit the company's earnings growth.

Mini/Micro-LED: Intro, TAM, Competitive Landscape, Stock Ideas



In this section, we discuss: (1) introduction of mini-LED and micro-LED, (2) TAM, (3) key suppliers' progress, (4) stock ideas.

Mini/Micro-LED global TAM: US\$1.5bn by 2023E, 50% 2019-23E CAGR

Bottom line: Positive on the new technology within the LED sector, with TAM growing at a 50% CAGR in 2019-23E. **Buy Sanan.**

What is mini/micro-LED?

Mini-LED and micro-LED are next generation LED technologies with a smaller form factor and better performance as well as lower power consumption than traditional LED. Compared with a traditional LED's size of 1000um, mini-LED is only 100-200um, which enables more local dimming zones to improve contrast ratio. For example, a 65" TV with standard LED backlight has 300-400 LEDs, which can be divided into 300-400 dimming zones, but a 65" TV with mini-LED backlight can be divided into ~1000 dimming zones with ~1000 mini-LED chips in the backlight. A micro-LED's size is even smaller at <30um and is self-emitting, with advantages of high luminous efficiency, high brightness, high contrast ratio, high reliability, and short response time. However, the manufacturing process of micro-LED is more complicated than mini-LED with key bottlenecks such as "mass transfer" yet to be solved for mass production. Mini-LEDs typically use flip chip or COB (chip on board) packaging, while traditional LED uses die bond or wire bond packaging. In terms of applications, mini-LED are mainly used in CD backlight, RGB display, automotive, large display; micro-LED are mainly used in commercial display, AR/VR, smartphones, wearables, transparent display.

TAM: 50% CAGR in 2019-23E

We expect both mini-LED and micro-LED to enjoy strong growth in the next few years, but the market size of mini-LED is still much larger than micro-LED given the more mature technologies, supply chain, and lower cost. We model the mini-LED market to grow from US\$200m in 2019 to US\$1bn in 2023E, or 50% CAGR. This is mainly driven by applications of LCD backlight, RGB display, automotive and large display. On micro-LED, we expect revenue to grow from US\$100m in 2019 to US\$500m in 2023E, or a 50% CAGR, driven by commercial display, AR/VR, smartphones, wearables and transparent display.

Competitive landscape

Domestic supply chain progress

- **BMTC** (002429.SZ, not covered): Cooperating with Korean and Taiwan companies on mini-LED used in high-end displays (announced in January 2020)
- **NationStar** (002449.SZ, not covered): Mini-LED IMD-M09T in mass production; launched IMD-M05 with a smaller pitch, launched light source display modules for mini-LED backlight, smart home appliances (April 2020)
- **BOE** (000725.SZ): Mass production of glass-based mini-LED backlight and mini-LED displays in 2H20 (March 2020)
- **Refond** (300241.SZ, not covered): Ready for large-scale production of mini-LED and will expand the production line, based on customer orders (May 2020)
- **Jufei** (300303.SZ, not covered): Mini-LED is a newly developed business with mass-production capability, and is a key investment direction in the future, per the company. Mini-LED modules adopt COB (Chip on Board) or COG (Chip-On-Glass) solutions (May 2020)
- **Mason** (002654.SZ, not covered): Small-volume production of mini-LED (December 2019)
- **Coreach** (002983.SZ, not covered): Mini-LED display technology was selected by the government as a major scientific and technological project in Anhui province, and some technologies have obtained local patents and have entered the customer sampling stage (May 2020)
- **Unilumin** (300232.SZ, not covered): Launched Zhou Ming UMini (mini-LED) in 2020, which adopted full-flip LED chips, mass transfer and integrated packaging technology to achieve high-density and reliable LED display (May 2020)

Stock ideas

In the mini/micro-LED space, we are positive on Sanan (Buy), the LED leader among domestic suppliers, which should benefit from mini/micro-LED market growth.

Sanan is an early mover in China, collaborating with Samsung on micro-LED

Sanan started R&D on mini-LED and micro-LED in 2017 and started small-volume production in 2018. Sanan also collaborates with Samsung on micro-LED, and the two companies signed a prepayment agreement in 2018, in which Samsung agreed to pay US\$16.8m as prepayment for a certain amount of LED chips made by Sanan. Samsung also agreed to purchase a certain amount of LED chips from Sanan during a 3-year period.

Sanan's mini-LED and micro-LED products were both in small-volume shipments in 2019, and we expect mini-LED revenue to pick up first this year for high-end TV backlight applications, followed by mini-LED display for NB/PC monitors in 2021, and micro-LED display for automotive, wearables and display walls in 2022-25. We expect revenue from mini-LED and micro-LED to grow at a 92% CAGR in 2020-23E, contributing 24% to revenue by 2023E (vs. 7% in 2020E).

Capacity expansion in Mini/micro-LED

In November 2019, Sanan announced a private placement to raise funding of up to Rmb7bn for capacity expansion in mini-LED, micro-LED, traditional LED and LED packaging. The capacity expansion plans include: 1) GaN LED wafer annual capacity of 7.7mn units (including 1.6mn of Mini/micro-LED), 2) GaAs LED wafer annual capacity of 1.2mn units (including 176k of Mini/micro-LED) and 3) LED packaging capacity of 8.7bn units per year. Sanan expects this project to take 4 years to construct and 7 years to reach full production, with annual revenue/net profit at Rmb8.2bn/Rmb2.0bn once it reaches full production. We model Sanan's Mini/micro-LED revenue contribution at 7%/15%/20% of total revenue in 2020-22E.

Sanan investment thesis

We are positive on Sanan's expansion into RF PA/compound semi businesses (from LED) and model net income growth at a 40% CAGR in 2020-23E, driven by

- **RF PA driven by 5G content growth:** As an early mover into GaAs and GaN technologies for RF PA in China, we expect RF PA to be a key growth driver for Sanan given 1) 5G is expected to drive PA content growth in smartphones/base stations, and 2) there is a significant opportunity for Sanan to gain share from a low base as domestic customers seek to diversify their supply chain. We model Sanan's RF PA revenue to grow at a 50% CAGR in 2020-23E, contributing 13% to revenue by 2023E (vs 8% in 2020E).
- **Mini-LED and micro-LED:** Sanan's mini-LED and micro-LED products were both in small-volume shipments in 2019, and we expect mini-LED revenue to pick up first this year for high-end TV backlight applications, followed by mini-LED display for NB/PC monitors in 2021, and micro-LED display for automotive, wearables and display walls in 2022-25. We expect revenue from mini-LED and micro-LED to grow at a 92% CAGR in 2020-23E, contributing 24% to revenue by 2023E (vs 7% in 2020E).

Sanan valuation and risks

Valuation: Our 12-month target price of Rmb40 (implies 55x 2022E P/E) is derived from discounted P/E, as we believe Sanan's compound semi business is still at an early stage compared to global leaders. Discounted P/E captures the company's long-term business opportunity to justify its current higher-than-peers' P/E multiple. We apply a 29x target P/E multiple to Sanan's 2025E EPS and discount back at a COE of 9% (1.0 beta, 3% risk-free rate, and 6% market risk premium). The 29x target P/E multiple is derived from the sector P/E-EPS YoY correlation, as the market has generally rewarded higher EPS growth companies in the semiconductor industry based on our regression analysis. Our target price implies 55x 2022E P/E, or PEG at 1.5x based on average 2023-24E EPS YoY growth (37%). Our valuation cross-check using a DCF methodology also shows a similar theoretical share value of Rmb40.9, or 56x 2022E P/E. The stock currently trades at 39x our 2022E EPS and at 1.0x our PEG based on average 2023-24E EPS YoY growth, which we believe is attractive considering its strong earnings growth at a +40% CAGR in 2020-23E.

Downside risks

1. **Weaker than expected PA market growth:** We forecast the global and China PA market to grow at 19% and 31% CAGR in 2019-22E, respectively, as 5G will drive significant PA content growth in both base stations and smartphones. If the penetration of 5G or PA content growth is slower than our expectation, PA market growth could be weaker than our current forecast.
2. **Slower than expected new order-wins and market share gain:** We model a 50% revenue CAGR in 2020-23E for Sanan's RF PA business, driven by market growth, new orders wins, and market share gains. If Sanan's new order-wins or market share gains are slower than our expectation, there could be downside to our earnings estimates.
3. **New technology (compound semi, mini/micro-LED) development progress:** We model compound semi (power devices, optical communication devices, filters) to contribute 2%/5%/11% to revenue in 2020-22E, and mini/micro-LED to contribute 7%/15%/20% to revenue in 2020-22E. If the R&D progress or customer adoption/qualification of these products is slower than our expectation, it could result in slower earnings growth than our current forecast.
4. **Stronger than expected competition in the LED market:** Given LED is a mature market, if more suppliers expand capacity or if demand is weaker than expected, there could be pricing pressure across the industry. We model Sanan's revenue from traditional LED to decline from 58% of revenue in 2020E to 47%/36% in 2021E/22E. Also, if other domestic competitors have faster R&D/new design-wins in mini/micro-LED, there could be downside to our earnings estimates.
5. **Potential impact from COVID-19:** Sanan's revenue is mainly from the domestic market (~85% of revenue) but its customers' end products could be sold globally; we thus believe Sanan could be impacted by the macroeconomic slowdown globally in 2020. Sanan's revenue declined 3% YoY in 1Q20 (vs +8% YoY in 4Q19) due to COVID-19 impacts.

SPE: Product expansion, technology migration riding a multi-year uptrend



China SPE spending to reach US\$38bn by 2025E, 31% 2020-25E CAGR

Our positive stance toward China's SPE makers is supported by two important structural trends:

1. Local SPE makers' product expansion and technology migration in line with local fabs' technology roadmap, which allows them to capture more equipment slots at local customers. Individual equipment segments (e.g., etchers, depositions, lithography, etc.), have corresponding local SPE makers (e.g., NAURA and AMEC in etchers, ACMR in cleaning tools, Piotech in CVD, etc). Although China's SPE makers still trail global leaders in terms of product offerings (especially leading-edge nodes equipment) local SPE makers are expanding products and developing tools for advanced nodes along with local fabs.
2. China's rising investment in the semiconductor industry is growing TAM for local SPE makers. Based on the projects we track, we expect investments in new fabs or capacity expansion will exceed US\$160bn in China over the coming 5-7 years; we expect this will drive an increase in China's SPE spending from US\$6bn/10bn in 2019/20E to US\$38bn in 2025E, with c.60% of the investments going to memory fabs. We believe the expansion of product offerings by local SPEs will result in significant growth opportunities for local SPEs over the coming 5-7 years.

Bottom line: As we are constructive on the local SPE sector, we initiate coverage of AMEC, ACMR, and AccoTest at Buy and maintain Buy on NAURA. Our 12-month target prices are based on our discounted P/E valuation model, which applies a target multiple on 2025E EPS and is discounted back to 2022E using each company's cost of equity. Our 2025E target multiples are based on the correlation of P/E and EPS growth among peers (see Exhibit below).

Exhibit 194: Earnings growth (2017-26E) and valuation summary

Segment	Company	2017	2018	2019	2020E	2021E	2022E	2023E	2024E	2025E	2026E	Target multiple	Rating	TP	Upside
CMP slurry	Anji	7%	13%	46%	53%	101%	86%	66%	72%	49%	31%	30x (2025E)	Buy	647.0	42%
Wafer	NSIG	n.a.	-95%	n.a.	n.a.	n.a.	319%	88%	87%	117%	31%	80x (2025E)	Buy	60.0	25%
SPE	AMEC	n.a.	204%	108%	66%	97%	78%	105%	99%	99%	-18%	30x (2025E)	Buy	382.0	42%
	ACM Research	n.a.	n.a.	187%	21%	111%	57%	53%	48%	53%	-20%	14x (2025E)	Buy*	150.0	84%
	AccoTest	28%	72%	12%	52%	74%	79%	82%	38%	37%	-9%	22x (2025E)	Buy	469.0	48%
	NAURA	35%	86%	32%	64%	108%	96%	79%	72%	65%	-17%	19x (2025E)	Buy	307.0	39%

Upside as of July 10, 2020

Source: Goldman Sachs Global Investment Research

In this section, we discuss the history and future trends of China's SPE industry as well as companies and their product offerings in each equipment category, our TAM analysis by project, and key investment ideas across the local SPE space.

China's SPE industry: History, current standing, and future development

Although China's SPE makers are still in the early stages of their ramp-up in terms of product offerings, revenue scale, and historical track record, we believe they are on a rapid growth trajectory supported by strong capex from local semiconductor firms.

Most of the local SPE makers were founded in the early and mid-2000s. Their initial technological development and commercialization efforts were relatively slow as domestic semiconductor manufacturing also lagged behind global peers during that time (SMIC was founded in 2000). Thanks to the government's support of semiconductor research programs since 2006 and the national strategy to boost the local semiconductor supply chain since 2014, China's SPE makers have made breakthroughs in technology development and product commercialization. As a result, top local SPE makers can supply leading-edge node equipment (14nm, 7nm, 5nm) to local and foreign fabs (SMIC, YMTC, TSMC). Going forward, against the backdrop of China-US trade disputes and the risk of losing access to US equipment, local fabs are working more closely with China's SPE makers to improve the SPE performance and configurations, which should help drive the development of the local SPE makers.

A brief history of China's local SPE development

In 2006, China's government rolled out a **VLSI (Very Large Scale Integrated Circuits) Fabrication Technology Research Program (also called the "02 Project")** to boost the development of local semiconductor technology. The program provided research grants to applicants (local SPE companies) to develop SPE-specific areas (e.g., AMEC in dielectric etcher projects, ACM Research in cleaning tools, Piotech in CVD, NAURA in PVD, etc.). These specific research projects fall under a comprehensive framework aimed at developing all types of equipment to cover the entire semiconductor manufacturing process. As these research projects at individual SPE companies do not overlap with one and another, local SPE companies currently do not compete with each other but collectively cover all equipment categories in the wafer fabrication process. Within each equipment category, local SPE makers' product offerings are currently not as comprehensive or advanced as those of their global counterparts. However, they are working on new tools and new technologies to enlarge their SAM (service addressable market). For example, AMEC is developing a high aspect ratio etcher and a staircase etcher for 128-L 3D NAND manufacturing at YMTC.

Exhibit 195: Local SPE suppliers cover most of the equipment segments but some are still in the early stages of their development**Product portfolio of Chinese SPE suppliers**

Equipment segments	Sub-categories	Equipment by local SPE makers	Commercial status	Global leaders	NAURA 北方华创	AMEC 中微半导体	ACM Research 盛美半导体	SMEE 上海微电子装备	PNC 至纯科技	Kingsemi 沈阳芯源微	Wanye 万业企业	Jingce 精测电子	AccoTest 华峰测控	Changchuan 长川科技	Raintree 上海睿励	Mattson 屹唐半导体	Hwatsing 华海清科	Piotech 沈阳拓荆
Thermal process	Oxidation	√	HVM	TEL	√													
	Diffusion	√	HVM	AMAT	√													
	Annealing	√	HVM	ASM Hitachi	√													
Lithography	DUV/EUV	√		ASML				√										
Etcher	Silicon etch	√	HVM	LAM	√													
	Dielectric etch	√	HVM	TEL		√											√	
	Metal etch	√	HVM	AMAT	√													
Photoresist	Coater	√	HVM	TEL						√								
	Remover	√	HVM	Mattson													√	
CVD	LPCVD	√	Initial orders	AMAT	√													
	PECVD	√	Initial orders	TEL														
	ALD	√	Initial orders	LAM														√
	MOCVD	√	HVM	ASM Int'l AMEC	√		√					√	√	√				√
PVD	Al-pad	√	HVM	AMAT	√													
	Hard mask	√	HVM	Evatec	√													
	CuBS	√	Initial orders		√													
Ion implanter	High energy	√	Qualification								√							
	High current	√	Qualification	AMAT Axcelis							√							
	Low ion current	×																
CMP		√	Repeat orders	AMAT/ Ebara														√
Cleaning tool	Single wafer	√	HVM	SCREEN			√		√									
	Batch	√	HVM	LAM TEL	√		√		√									
Testing	Analog	√	HVM	Teradyne									√	√				
	SoC	√	R&D	Advantest Cohu														
	Memory	√	Initial orders									√						
Metrology		√	Initial orders	KLA/AMAT								√			√			

Source: Company data, data compiled by Goldman Sachs Global Investment Research

In 2014, China rolled out a national strategy to cultivate a comprehensive semiconductor supply chain ranging from materials, equipment, foundry, IC design and packaging and testing. China also began to invest in the construction of new fabs and the support of foundries looking to upgrade their technologies. This strategy has promoted closer cooperation within the local supply chain. Local fabs have increased cooperation with local SPE makers, which also helped boost development of the SPE space as the calibration of SPE based on customers' technology requirements and feedback is an important process in SPE development across the globe. For example, NAURA's 14nm etcher is partnered with SMIC in verification.

From a local SPE commercialization perspective, China still imports the majority of the SPE used in the country from global majors. In some equipment categories with lower technological barriers such as furnace and cleaning tools, NAURA and ACM Research have made significant breakthroughs. **NAURA's** furnace equipment has captured the lion's share of YMTC's public equipment tenders and its CuBS (copper barrier and seed) PVD tools are accepted by YMTC as well. **ACM Research's** cleaning tools have been adopted by global leading semiconductor firms such as SK Hynix. **AMEC's** dielectric etcher is used by TSMC's leading edge (5nm) fab.

A brief history of China's semiconductor and SPE development**Stage 1: Exploration (1956-1978)**

- The Chinese government called for semiconductor research development for the first time in 1956
- Subsequently, China's Academy of Science invited semiconductor scholars back to China and opened semiconductor-focused majors in universities
- In 1950, CoCom began levying export controls against China
- In 1957-1975, China developed transistors, silicon ingots, GaAs wafers, MOS/CMOS circuits, LSI, and 1K DRAM

Stage 2: Initial IC production (1978-2000)

- China's economic reform and opening began in 1978
- **Early phase of semiconductor manufacturing:**
 - In 1980, China's first 3" wafer fab for CMOS watches/clocks began operations
 - In 1982, a 3" wafer TV IC production line and its related technologies were introduced from Toshiba
 - In 1988, a 4" production JV was set up with Bell.
 - In 1990, the "908 Project" started to produce 6" 0.8-1.2um chips but took seven years to complete.
 - in 1999, the "909 Project" was started with NEC and **Hua Hong was founded.**
 - Also in 1999, the first 8" fab was completed.
 - Huada was founded in 1986, the first fabless IC design house among China SPE makers

Stage 3: Technology catch-up (2000-2014)

- The Chinese government put in place policies to increase support for IC industry development.
- **SMIC was founded** in Shanghai in 2000 and began fab construction; in 2004, SMIC's 12" fab in Beijing (the first 12" fab in China) started production.
- Electronics production took off, mobile phone production grew by 34% 2000-2010 CAGR, PC production grew by 43% 2000-2010 CAGR, per National Bureau of Statistics.
- **Huawei's HiSilicon** was founded in 2004; driven by Huawei's smartphones and telecom gears equipment, HiSilicon become the largest fabless firm in China by 2013.
- **China established the VLSI Research Project ("02 Project") in 2006** to support local VLSI manufacturing, equipment and materials development.

Stage 4: Acceleration (2014-present)

- China released its **National IC Industry Development Framework and the China IC Fund** was established in 2014 to cultivate a comprehensive local semiconductor supply chain.
- SMIC started mass production of 28nm and 14nm in 2015 and 2019, respectively.
- China-US trade disputes broke out in 2018; US placed multiple Chinese tech firms (including Huawei, Hikvision, and iFlytek) on its Entity List.
- China's STAR stock market board was established in 2019.
- YMTC/CXMT achieved mass production of NAND and DRAM in 2019.

Local players are gradually rising in the Chinese SPE market. They have progressed through the stages of foreign reliance and self-development, and they are now in the localization stage.

Before 2008: Foreign reliance

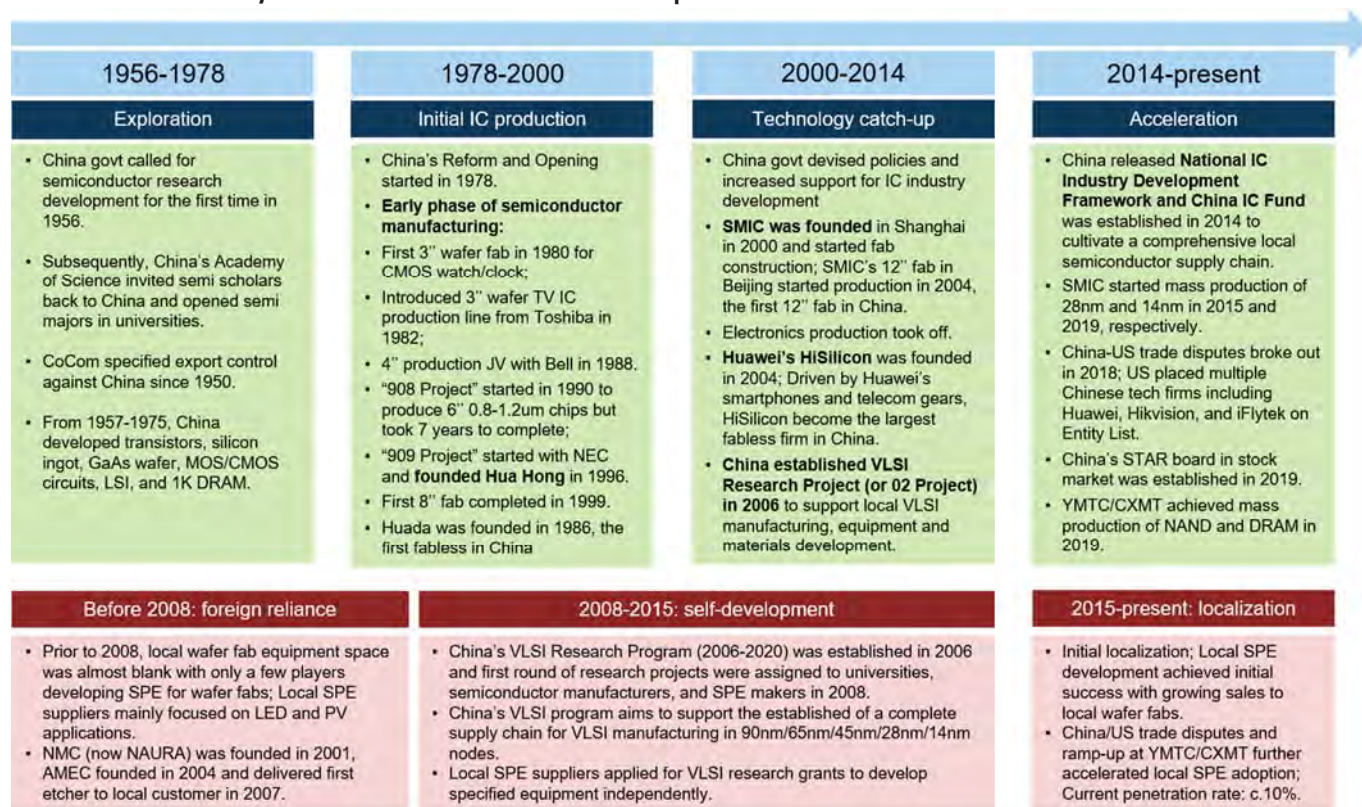
- Prior to 2008, the local wafer fab equipment space was almost blank with only a few players developing SPE for wafer fabs; local SPE suppliers mainly focused on LED and PV applications.
- NMC (now NAURA) was founded in 2001, AMEC was founded in 2004 and delivered its first etcher to a local customer in 2007.

2008-2015: Self-development

- China's VLSI Research Program (2006-2020) was established in 2006 and first round of research projects were assigned to universities, semiconductor manufacturers, and SPE makers in 2008.
- China's VLSI program aims to support the establishment of a complete supply chain for VLSI manufacturing in 90nm/65nm/45nm/28nm/14nm nodes.
- Local SPE suppliers applied for VLSI research grants to develop specified equipment independently.

2015-present: localization

- Initial localization; local SPE development achieved initial success with growing sales to local wafer fabs.
- China/US trade disputes and ramp-up at YMTC/CXMT further accelerated local SPE adoption; current penetration rate: c.10%.

Exhibit 196: A brief history of China's semiconductor and SPE development

Green represents the development of semiconductors; Pink represent SPE development

Source: MIIT, Data compiled by Goldman Sachs Global Investment Research

Further technology migration and product expansion

Going forward, we expect China's SPE companies will continue to focus on expanding their product offerings and migrating their technologies to catch up with industry leaders and local foundries and memory makers' demand. Our checks with SPE companies indicate their current clientele focus remains at the local level but some leading names (AMEC and ACM Research) have already penetrated overseas customers' supply chains (AMEC in TSMC, and ACM Research in SK Hynix). NAURA is developing etchers and deposition equipment for 7nm and 5nm nodes. AMEC's etcher is used in TSMC's 5nm fab and is developing a high aspect ratio etcher and staircase etcher for 128-L 3D NAND manufacturing at YMTC.

Exhibit 197: NAURA develops its etcher along with SMIC's technology roadmap while AMEC progresses along with global development

	1995	1998	1999	2000	2002	2005	2006	2007	2008	2009	2010	2011	2012	2014	2015	2017	2018	2019	2020
Global	0.35um	0.25um	0.18um	0.13um	90nm		65nm		45nm	32nm	28nm	22nm	16/14nm	10nm	7nm	5nm			
SMIC							90nm		65nm		55nm	40nm		28nm		14nm			
NAURA equipment						100nm		90nm			65nm-40nm		28nm		14nm				
AMEC equipment								65-16nm			45-7nm								

Source: Data compiled by Goldman Sachs Global Investment Research

Compared with global SPE majors, local names are lagging in terms of revenue scale but have faster growth and comparable profitability. China's SPE companies are latecomers in the industry and in many cases lag behind in terms of technology and product offerings, so their revenue scale is a small fraction of that of global leaders (see exhibit below) but we expect local SPE companies are well positioned to deliver

better-than-industry growth globally due to: 1) China's strong investment in semiconductor manufacturing in coming years (we forecast an SPE spending CAGR of 31% in 2020-25E); 2) increasing allocations from local fabs' equipment purchases to hedge against their equipment supply risks. Local SPE's gross margin is stable at c.40-45%, which is largely in line with the global average. Typically, the price of locally manufactured SPE is c.20% lower than that of imports, but China's SPE companies enjoy lower labor costs for technicians and engineers.

Exhibit 198: China's local SPE makers vs. global majors; still at early stage with small revenue scale but growing fast

2020E	AMEC	ACMR	AccoTest	NAURA	China avg	AMAT	LAM Research	SCREEN	Tokyo Electron	KLA	Global avg	China vs global
1) Scale												
Revenue (US\$m)	381	157	50	738	332	16,183	10,299	3,011	10,421	5,855	9,154	-96%
Net income (US\$m)	45	23	22	72	40	3,271	2,239	77	1,627	1,327	1,708	-98%
Market cap (US\$m)	20,573	1,545	2,773	15,657	10,137	58,187	48,740	2,507	43,599	31,566	36,920	-73%
Global market share	<1%	<1%	<1%	<1%		21%	15%	3%	15%	7%		
2) Growth (2020-22E CAGR)												
Revenue	56%	51%	60%	54%	55%	10%	13%	3%	10%	4%	8%	47 ppt
OP income	105%	88%	77%	105%	94%	15%	20%	57%	18%	3%	23%	71 ppt
Net income	87%	82%	77%	102%	87%	18%	22%	59%	19%	15%	27%	61 ppt
3) Profitability												
GM	37%	43%	82%	41%	51%	45%	45%	24%	40%	61%	42%	9 ppt
OPM	11%	15%	47%	12%	21%	25%	26%	4%	21%	35%	20%	1 ppt
NM	12%	15%	44%	10%	20%	20%	22%	2%	16%	23%	14%	6 ppt
4) R&D												
R&D to revenue	13%	11%	13%	11%	12%	14%	13%	7%	11%	11%	9%	3 ppt
5) Return												
ROE	8%	21%	13%	8%	12%	9%	11%	3%	22%	16%	13%	-1 ppt
CROCI	8%	15%	14%	15%	13%	7%	8%	7%	29%	7%	14%	-2 ppt

Market cap as of July 10, 2020

Source: Goldman Sachs Global Investment Research, Gao Hua Securities Research, Gartner

Local SPE profiles:

- **AMEC (688012.SS, Buy):** AMEC is a leading Chinese supplier of etching equipment and metal-organic chemical vapor deposition (MOCVD) equipment. The company specializes in dry etch (plasma) systems with products covering IC manufacturing (65nm-5nm process nodes, 3D NAND/DRAM), advanced packaging, LED chip manufacturing and MEMS manufacturing. AMEC is headquartered in Shanghai, with manufacturing sites in Shanghai and Nanchang. Key customers include TSMC, SMIC, Huahong, Huali, and YMTC, etc.
- **ACM Research (ACMR, Buy):** ACM Research is the leading local cleaning tool maker and counts SK Hynix, YMTC, Huali, and SMIC as its key customers. In recent quarters, the company has launched new products such as semi-critical cleaning tools, copper plating equipment, and furnaces. Its products are used in both front-end fabrication and back-end packaging and testing. ACM Research's major operation is based in Shanghai.
- **AccoTest (688200.SS, Buy):** AccoTest provides Automated Test Equipment (ATE) used in the testing of analog and mix-signal IC and is expanding into SoC testing equipment, an area with higher technological barriers but a larger addressable market. The company was established in Beijing in 1999, with manufacturing sites in Tianjin, support centers in 6 cities in mainland China, and sales agents in Taiwan, Singapore, Korea, Japan, US and Italy. AccoTest supplies products to major OSAT companies in China (including JCET, Tongfu and Huatian) and IC design companies such as SG Micro and Hisilicon.
- **NAURA (002371.SZ, Buy):** NAURA's products include thermal process tools (furnaces), PVD, silicon etchers, and CVD. NAURA is by far the local SPE maker with the largest product offerings. Its customers consist of local semiconductor manufacturers, e.g. SMIC, Hua Hong, YMTC, GTA Semiconductors, etc. NAURA is headquartered in Beijing with branches in Shanghai, Taiwan, Shenzhen, the US and Germany.
- **PNC (603690.SS, Not Covered):** PNC is a supplier of high purity process systems for semiconductors, biological medicines, photovoltaic, optical fiber, TFT-LCD, and LED. The company is also ramping up cleaning tools for wafer fabrication with both batch cleaning and single wafer cleaning tools. The customers of PNC include Huali, CSMC (Central Semiconductor Manufacturing Corporation), TSMC, PSMC (Powerchip Semiconductor Manufacturing Corporation), BOE, Everdisplay, Hengtong, Futong, Tongding, HC SemiTek, Focus Lightings, Epitop, NationStar, etc. PCN was established in 2000 and is headquartered in Shanghai.
- **Kingsemi (688037.SS, Not Covered):** Kingsemi is a supplier of semiconductor fabrication equipment covering spin coater/developer, spray coater, scrubber, wet etcher, single-wafer cleaner. The products are adopted in manufacturing of IC, MEMS, LED, OLED, 3D-IC TSV, photovoltaics and advanced packaging. Kingsemi had 174 authorized patents as of 2019 and has applied for 300+ patents.
- **Wanye (600641.SS, Not Covered):** Shanghai Wanye Enterprise was established as a real estate company in 1991 and has expanded into the SPE market since 2017.

The company acquired Kingstone Semiconductor in 2018, a leading supplier of ion implanters in China. In June 2019, Wanye announced plans to set up an Integrated Circuit Equipment Group with the Institute of Microelectronics of the Chinese Academy of Sciences (IME of CSA) and IC Leasing (subsidiary of China IC Fund), with a total investment of Rmb1.5bn (Rmb800mn from Wanye and CSA in aggregate). Integrated Circuit Equipment Group will provide SPE design and manufacturing services, as well as solutions to optimize the IC fabrication process.

- **Jingce Electronics (300567.SZ, Not Covered):** Jingce is a supplier of flat panel display (FPD) inspection system expanding to semiconductor equipment. The company's main products include module inspection systems, panel inspection systems, automatic optical inspection (AOI) systems, OLED inspection systems, touch panel inspection systems and flat panel display automation equipment. Jingce's Wuhan subsidiary specializes in ATE for memory IC. In 2019, Jingce acquired a 61% holding in Wintest, a company providing driver IC testing equipment to further expand its semiconductor equipment portfolio.
- **Changchuan (300604.SZ, Not Covered):** Changchuan is a supplier of testing equipment, test handlers, probers and taping equipment, with customers including JCET, Huatian, Silan, etc. The company acquired Semiconductor Technologies & Instruments (STI) in 2019, expanding into automatic optical inspection (AOI) systems used in IC packaging. Changchuan was established in 2008 and headquartered in Hangzhou, with branches in Beijing, Shanghai, Shenzhen, Changzhou, Taiwan, Japan, and Singapore.
- **Mattson Technology (private):** Mattson is a key global supplier of plasma, rapid thermal processing equipment, and photoresist removing equipment. The company was founded in the US. In May 2016, Mattson was acquired by Beijing's E-Town Capital and maintains its headquarters in the US. In local fabs' public tenders, Mattson has frequently won orders for photoresist removal equipment.
- **Hwatsing (private):** Hwatsing is a supplier of CMP (chemical-mechanical polishing) equipment and CMP foundry services. The key products of Hwatsing include 12" and 8" CMP equipment, thick film lubrication and coefficient of friction tester, etc. Hwatsing was established in 2013 in Tianjin and jointly invested by the Tianjin government and Tsinghua University.
- **Piotech (private):** Piotech supplies 8-12 inch PECVD, ALD (atomic layer deposition), and 3D NAND deposition equipment, which are applied in front end and back end processes in IC manufacturing, 3D-TSV, Wave Guide, LED, 3D NAND flash memory, and OLED display, etc. The company's manufacturing facility is located Shenyang and its service centers are in Beijing, Tianjin, Xiamen, Wuhan, Shenzhen, Hefei, Chongqing, etc.
- **Raintree (private):** Raintree Scientific Instruments is a supplier of process technology testing equipment, with key products covering optical measuring equipment, defect inspection equipment, plasma ashing equipment and parts. The optical thin film measurement equipment has been adopted in the 12" production line of major foundry and 3D NAND of memory IDM.

Exhibit 199: China's local SPE makers by equipment category

Company names	NAURA	AMEC	ACM Research	SMEC	PNC	Kingsemi	Jingce	AccoTest	Changchuan	Wanye	Raintree	Mattson	Hwatsing	Piotech
Chinese names	北方华创	中微半导体	盛美半导体	上海微电子装备	至纯科技	沈阳芯源微	精测电子	华峰测控	长川科技	万业企业	上海睿励	屹唐半导体	华海清科	沈阳拓荆
Ticker	002371.SZ	688012.SS	ACMR.US	Private	603690.SS	688037.SS	300567.SZ	688200.SS	300604.SZ	600641.SS	Private	Private	Private	Private
Thermal process	√													
Lithography				√										
Etcher	√	√										√		
Photoresist						√						√		
CVD	√													√
PVD	√													
Ion implanter										√				
CMP													√	
Cleaning tool	√		√		√									
Metrology							√				√			
ATE							√	√	√					

Source: Company data, Goldman Sachs Global Investment Research

Exhibit 200: China's VLSI program aims to build a comprehensive supply chain for micro-fabrication

Key research projects on SPE in China's VLSI Program

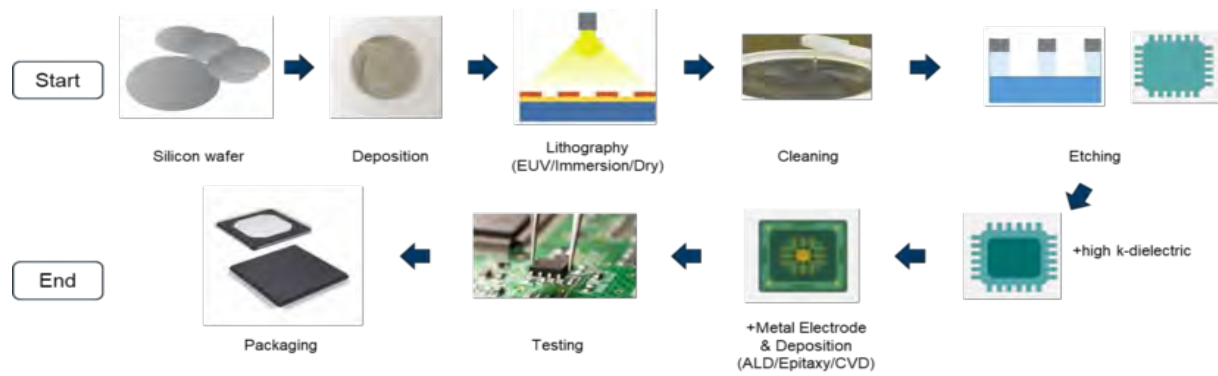
Period	Project name	Period	Project name
2009-12	65nm PVD equipment	2017	High density flip device
	65nm interconnect copper plating equipment		Large field/double sided step lithography machine
	65nm rapid thermal annealing equipment		Testing and sorting machine
	90-65nm uniform glue developing equipment		High-end packaging (TSV) plasma etching machine
	65nm cleaning and chemical processing equipment		High-end packaging (TSV) PVD equipment
	90-65nm automatic optical measuring equipment		WLP solder ball 3D inspection equipment
	CD-SEM process detection equipment		300mm wafer cutting equipment
	RF and digital-analog mixed signal IC testing equipment		Single-chip wet degumming machine
	Advanced packaging equipment		Mask aligner for IC substrate
	Clean and Direct Drive Vacuum Manipulator and Silicon Wafer Transmission System		WLP automatic wafer laser marking machine
	Wafer transmission manipulator under ultra-clean environment		Automatic wafer ball moulder
	Dry pump and vacuum valve		Single wafer glue spraying machine
	Maglev Molecular Pump		High-end analog / hybrid circuit testing system
2011-14	200-300mm SMIF system		High-end digital / hybrid circuit testing system
	32-22nm gate etching machine		High voltage and high current testing system
	45-22nm ultra-low energy injection equipment		SiP automatic testing and sorting machine
	45-22nm interconnection copper plating equipment		High-performance probe card for advanced packaging
	High-performance epitaxial furnace equipment		High density etching lead frame
	45-32nm LPCVD equipment		Bonded copper wire for high-end packaging
	300mm silicon wafer front-end photoresist equipment		45-22 nm single wafer cleaning equipment
	45-22nm OCD detection system and equipment		Testing and sorting machine
	45-22nm testing equipment		
	Advanced mask manufacturing process and equipment		
	Cryogenic vacuum pump		
	Advanced packaging equipment and materials		
	High-end digital / analog / RF product testing equipment		
	Multi-level packaging technologies		
	Fused Silicon Single Wafer and equipment		

Source: Data compiled by Goldman Sachs Global Investment Research

Local SPE by equipment segment: Products and technology development, comparison vs. global majors

In wafer fabrication, key processes and corresponding equipment used include thermal process, lithography, etch, wafer cleaning, deposition, ion implant, CMP (chemical-mechanical polishing) and process control. Local SPE makers typically focus on one type of equipment (except NAURA, whose products cover thermal process, etcher, PVD, and cleaning tools). Within each equipment segment, there are different sub-type equipment used for specific processes or layers within the wafer fabrication. In our view, the key to evaluating local SPE makers' ability to capture market share in the local market is to understand their product offerings, future product/technology development plans and comparison with established global players' products. In this section, we discuss local SPE's standing and development progress in each equipment category.

Exhibit 201: Wafer fabrication process and key equipment used



Source: Goldman Sachs Global Investment Research

Exhibit 202: Global SPE market by equipment segment: US\$61bn in 2019

Equipment segments	Etch and clean		Lithography	Deposition	Process control	Thermal process	Ion implanter	Photoresist processing	Others	Test	Assembly
Market size (US\$ bn)	15.9		11.7	12.0	6.2	1.4	1.2	2.1	2.1	5.5	3
Mix	26%		19%	20%	10%	2%	2%	3%	3%	9%	5%
Key suppliers	Applied Materials LAM Research Tokyo Electron NAURA AMEC	SCREEN LAM Research Tokyo Electron ACM Research NAURA	ASML Cannon Nikon SMEE	Applied Materials LAM Research TEL NAURA Sypiotech	KLA Nanometrics Applied Materials Hitachi Hightech Raintree Scientific	Tokyo Electron Applied Materials Hitachi NAURA Mattson	AMAT Axcelis Nissin Wanye	TEL Mattson Tech Kingsemi		Teradyne Advantest Cohu Accotest Changchuan	ASMPT DISCO BE SEMI K&S CEC institute 45

Green: major suppliers globally; Pink: China local supplier

Source: Goldman Sachs Global Investment Research, Gao Hua Securities Research, Gartner

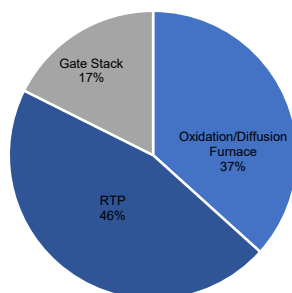
Thermal process/furnace: An area with relatively lower technology barriers; NAURA is the local leader in this space

Thermal processes are used for a variety of high-temperature procedures in wafer fabrications including dopant diffusion, thermal oxidation, annealing and CVD (chemical vapor deposition). Dopant diffusion takes place in the ion implantation process and expands the dopants into the silicon substrate. Oxidation is a process where wafers are put in a high-temperature environment filled with oxygen or wafer vapor to form oxide layers (protective layers). Annealing is a process used to heat wafers in a noble gas environment to reduce crystal defects and damage.

Depending on the heating rates, the wafers are heated by standard furnaces and rapid thermal processing (RTP) equipment that use high-intensity lamps or lasers. Thermal process equipment is a US\$1.5bn market with RTP making up 46% and oxidation and diffusion furnace contributing 37% in 2019, per Gartner.

NAURA makes oxidation and diffusion furnaces and its products have captured a significant share (40-50%) of YMTC’s thermal process equipment purchases, per our channel checks. In RTP, major players include Applied Materials, Tokyo Electron, and Mattson Technology (private).

Exhibit 203: Oxidation/diffusion equipment makes up 37% of the total thermal process equipment market



Source: Gartner

Exhibit 204: Furnace makes up a large portion of NAURA's equipment orders from public tenders by local fabs

NAURA's order wins in public tenders by China's semiconductor fabs

#units	1Q19	2Q19	3Q19	4Q19	1Q20
Etcher	3	-	2	3+	3
Deposition	1	-	-	5	3
Furnace	24	1	1	8	6
Cleaning tools	-	-	6	10	-
Total units	28	1	9	25+	12

Source: Company data, Data compiled by Goldman Sachs Global Investment Research

CVD: NAURA and Shenyang Piotech are key local vendors; Global majors command the lions share

CVD equipment is primarily dominated by foreign vendors in China market, including Tokyo Electron, Lam Research, and Applied Materials, etc. Key local CVD vendors include Shenyang Piotech (Not Covered) and NAURA. Within CVD, there are key subcategories such as low pressure CVD (LPCVD), plasma enhanced CVD (PECVD), and Atomic Layer Deposition (ALD), and each type of CVD could be used for specific deposition layers with specific materials (Shown in Exhibit below).

With respect to local CVD suppliers, we highlight key suppliers Piotech and NAURA. Piotech's products cover PECVD and ALD and its PECVD products have entered commercial phase with repeating orders from key local wafer fabs (e.g. YMTC, SMIC, Huang Hong, etc.). Local suppliers' ALD remain in early stage of commercialization. In Electrochemical deposition, or ECD, (for copper layers in front-end fabrication and back-end packaging), ACM Research launched electrochemical plating tools with initial small volume sales in both front-end and back-end. This space is currently dominated by global majors.

Exhibit 205: PECVD, HDPCVD and ALD are the main categories of CVD systems; Piotech is a key local PECVD vendor

	AMAT	LAM	TEL	Piotech	NAURA	ACM Research	Type of films	Sub-type	CVD type
PECVD	√	√		√			Low-k dielectric	SiO2	PE, AP, LP
HDPCVD	√	√						Si3N4	PE, LP
APCVD					√			Phosphosilicate glass	PE, AP
LPCVD			√		√			Borophosphosilicate glass	PE, AP
ALD	√	√	√	√	√		Metal film	Poly Si	LP
ECD	√	√				√		W	LP
								Wsix (Tungsten silicide)	LP

Source: Company data, Data compiled by Goldman Sachs Global Investment Research

Chemical vapor deposition is a key process in wafer fabrication

Chemical vapor deposition (CVD) is a vacuum deposition method used to produce thin films in semiconductor fabrication. In CVD process, wafer is exposed to one or more volatile precursors, which react or decompose on the substrate surface to produce a

layer of deposit. CVD is used to deposit materials in various forms, including monocrystalline, polycrystalline, amorphous, and epitaxial. By subtypes, there are mainly LPCVD (low pressure), PECVD (plasma enhanced), and ALD. With plasma CVD making up c.50% of the total CVD market, ALD (c.19%) and LPCVD (c.14%), per Gartner.

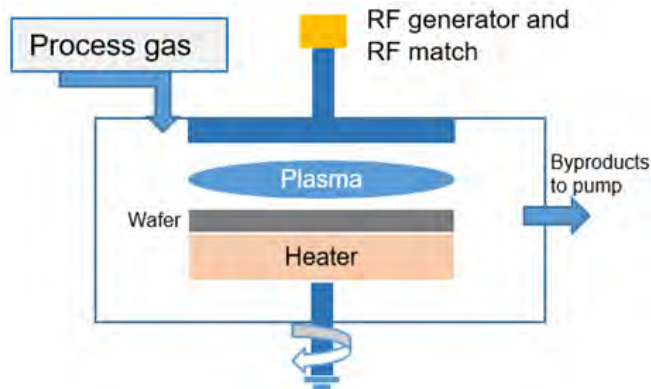
LPCVD: A thermal process that uses heat to initiate a reaction of a precursor gas on the solid substrate. This reaction at the surface is what forms the solid phase material. Low pressure (LP) is used to decrease any unwanted gas phase reactions, and also increases the uniformity across the substrate. The LPCVD process can be done in a cold or hot walled quartz tube reactor. Hot walled furnaces allow batch processing and therefore high throughput. They also provide good thermal uniformity, and thus result in uniform films. A disadvantage of hot wall systems is that deposition also occurs on the furnace walls, which requires more maintenance for cleaning or eventual replacement of the tube to avoid flaking of the deposited material and subsequent particle contamination. Cold wall reactors are lower maintenance, as there is no film deposition on the reactor walls.

PECVD is a process by which thin films of various materials can be deposited on substrates at lower temperature than that of standard Chemical Vapor Deposition (CVD). In PECVD processes, deposition is achieved by introducing reactant gases between parallel electrodes—a grounded electrode and an RF-energized electrode. The capacitive coupling between the electrodes excites the reactant gases into a plasma, which induces a chemical reaction and results in the reaction product being deposited on the wafer. The wafer is typically heated to 250°C to 400°C, depending on the specific film requirements. In contrast to traditional CVD, where higher temperature (600°C to 800°C) is used to cause reactions, in PECVD the plasma provides the energy needed to cause the reaction, which means that it can be done at a lower temperature. The lower deposition temperatures are critical in many applications where CVD temperatures could damage the devices being fabricated.

ALD: a surface-controlled layer-by-layer process that results in the deposition of thin films one atomic layer at a time. Layers are formed during reaction cycles by alternately pulsing precursors and reactants and purging with inert gas in between each pulse (shown in below exhibit). Each atomic layer formed by this sequential process is a result of saturated surface-controlled reactions. For example, a metal precursor pulse of trimethylaluminum ($\text{Al}(\text{CH}_3)_3$) followed by an oxygen reactant pulse (H_2O vapor) results in the formation of a layer of aluminum oxide, a metal oxide compound that can be used as a high-k dielectric. Building devices atom by atom gives wafer fabs very precise control over the process. Because the ALD process is self-limiting, it results in films with a precise thickness and conformality, even over varied surface patterns. It can be applied to produce different oxides, nitrides or other compounds.

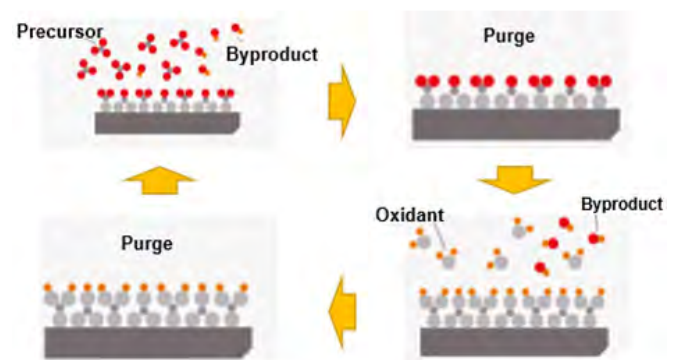
Exhibit 206: LPCVD reaction takes place in a tube via a high temperature process while in PECVD, plasma is used to create energy to cause reaction

Illustrations of PECVD



Source: Goldman Sachs Global Investment Research

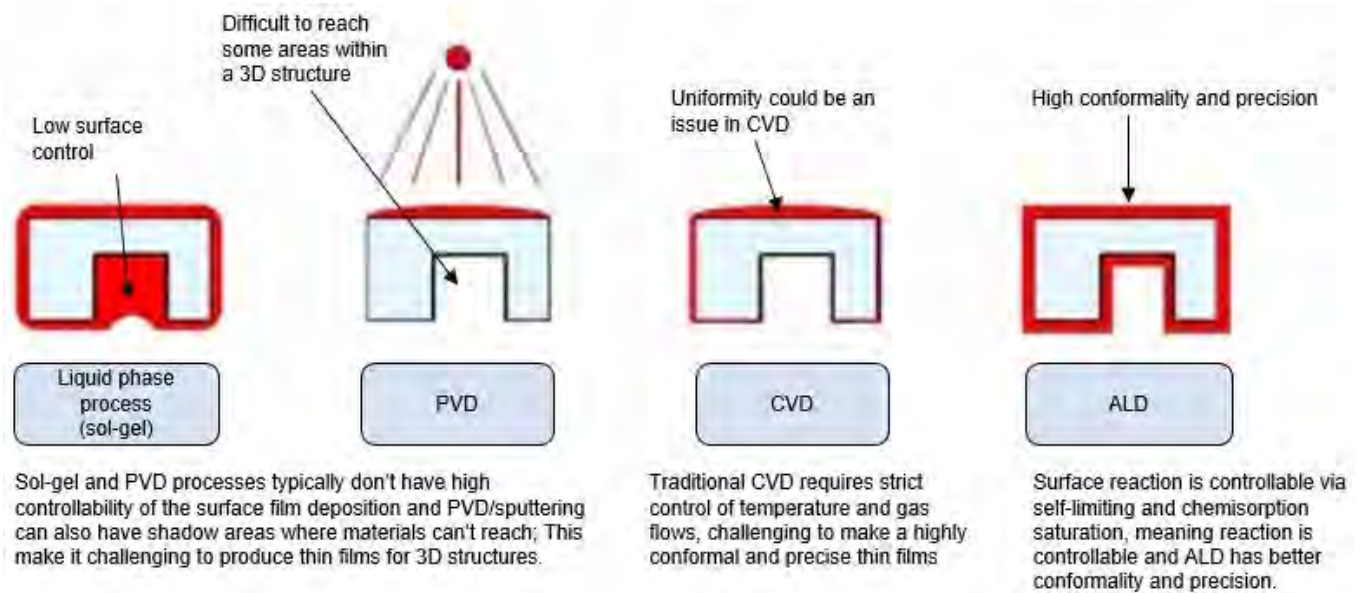
Exhibit 207: The typical cycle of ALD process



Source: Company data

Exhibit 208: ALD has better uniformity, conformality and precision over other traditional deposition processes

Comparison among key deposition techniques



Source: Company data, Data compiled by Goldman Sachs Global Investment Research

Global leaders AMAT, LAM Research and Tokyo Electron have wide offerings of CVD products ranging from PECVD (Plasma-enhanced Chemical Vapor Deposition), Electrochemical Deposition (ECD), LPCVD, and ALD (Atomic layer deposition) etc. Local suppliers such as Piotech and NAURA also have LPCVD, PECVD and ALD products. Piotech is the local leader in this space with PECVD in volume production stage, receiving repeat orders from YMTC, Hua Hong, and SMIC, etc. Based on public tender results, Piotech secured orders of 4 units of PECVD (for SiN, SiO₂) by end-2019 from YMTC, representing 10% of order allocation.

Exhibit 209: CVD global leaders have comprehensive product portfolios

AMAT			LAM			TEL		
Products	Technology	Applications	Products	Technology	Applications	Products	Technology	Applications
CENTURA ULTIMA	HDPCVD	STI, pre-metal dielectric	ALTUS series	CVD/ALD	Tungsten deposition	TELINDY PLUS	LPCVD	Oxidation/Anneal
CENTURA ISPRINT	ALD	Tungsten nucleation layer	SABRE 3D series	ECD	Advanced WLP; TSV	TELFORMLA	LPCVD	Oxide, High-k, Nitride
ENDURA VOLTA	CVD	Cobalt liners; Copper interconnect	SPEED series	HDPCVD	Gap fills; STI, pre-metal, inter-layer, inter-metal, passivation	TELINDY PLUS Irad	PEALD	SIN, SiO2 films
ENDURA VOLTA W	CVD	Enhanced version of VOLTA	STRIKER series	ALD	Patterning spacers, masks, etch stop layers	NT333	ALD	SiO2, SIN, High-k films
PRODUCER APF	PECVD	Advanced patterning films for memory	VECTOR series	PECVD	Hardmask, anti-reflective layers, patterning layers; 3D structures			
PRODUCER AVILA	PECVD	TSV; Advanced packaging						
PRODUCER BLOK	PECVD	Ultra low-k copper barrier and etch stop films						
PRODUCER BLACK	PECVD	Ultra low-k films for 28nm or below						
PRODUCER CELERA	PECVD	Tensile high stress silicon nitride films (45nm and below)						
PRODUCER DARC	PECVD	Dielectric anti-reflective coating film						
PRODUCER ETERNA	Flowable CVD	Transistor isolation						
PRODUCER INVIA/OPTIVA	CVD	TSVs						

Source: Company data

Exhibit 210: Piotech and NAURA are Chinese leaders in CVD equipment

Piotech			NAURA		
Products	Technology	Applications	Products	Technology	Applications
PF-300T	PECVD	SiO2, SIN, SION films for 40-28nm; TSV	HORIS L6371	LPCVD	SiO2, SIN, Poly, BSG, BPSG films for IC, MEMS, Power device
NF-300H	PECVD	SiO2, SIN films for 3D NAND	SES630A	APCVD	Silicon epitaxy for 6"/8"
FT-300T	ALD	SiO2, SIN, Al2O3 films for advanced nodes and TSV packaging	THEORIS 302	LPCVD	SiO2, SIN, Poly films for 28nm and below, MEMS, Power device
			Polaris PE	PE ALD	Isolation, barrier, hardmask, passivation layers for 28-14nm and 3D NAND
			Polaris A	ALD	High-K dielectric, metal gate, barrier, and passivation layers for 28-14nm and 3D NAND

Source: Company data

MOCVD: AMEC has emerged as a key player globally

MOCVD (metal-organic chemical vapor deposition) is technology for depositing atoms onto a semiconductor wafer. MOCVD is the core process technology for manufacturing LED, compound semiconductors (e.g., GaN, GaAs, etc.), lasers, transistors, solar cells and other electronic and opto-electronic devices. With MOCVD technology, nano-layers can be deposited with precision, each layer featuring certain thickness to create a material with specific optical and electrical properties. When manufacturing compound semiconductors, the chemicals are vaporized and transported into the reactor with other gases. Then critical chemical reacts and turns into compound semiconductors. After the deposition process, the wafers are processed into chips. Precision is key to deposition given the thinnest films in an LED structure is <1nm, but the films are usually deposited on 4" substrates. A 4" wafer can produce 4k-120k LED chips.

AMEC has become a leading player in the MOCVD space and captured c.40% global market share in GaN based LED MOCVD systems as of 2018, according to AMEC. AMEC offers three types of MOCVD equipment: 1) MOCVD for LED and power devices (Prismo D-BLUE), 2) MOCVD for high-volume LED production (Prismo A7), and 3) MOCVD for deep UV LED production (Prismo HiT3). AMEC launched its first MOCVD system Prismo D-BLUE in 2013 and added Prismo A7 in 2016, which is the primary MOCVD for AMEC.

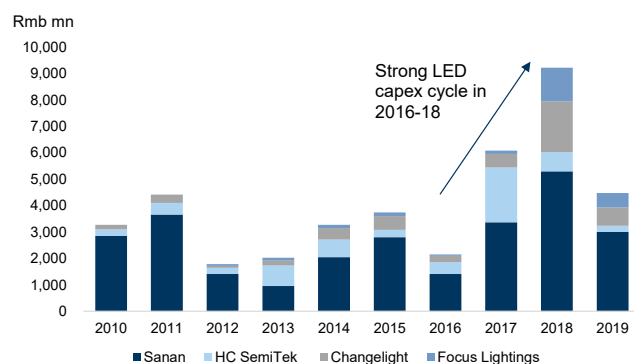
Key players in this space also include **Veeco** (VECO, Not Covered) and **Aixtron** (AIXA, Not Covered). With the rise of AMEC in the MOCVD space, MOCVD supply has largely been localized in China.

Exhibit 211: AMEC MOCVD equipment portfolio**Prismo D-BLUE****Prismo A7****Prismo HiT3**

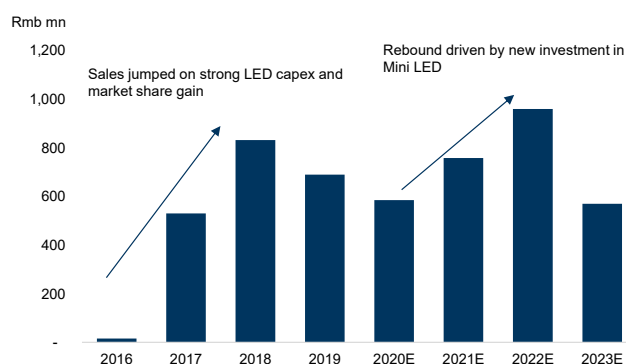
Source: Company data

- **Prismo D-BLUE:** Accommodates up to 4 reactors, and processes up to 232 2-inch wafers or 56 4-inch wafers simultaneously; extendible to 6 and 8-inch wafer production; each reactor is controlled independently, which is an innovative design and enables larger manufacturing flexibility.
- **Prismo A7:** Accommodates up to 4 reactors and processes up to 136 4-inch wafers or 56 6-inch wafers simultaneously; extendible to 8-inch wafer production; each reactor is controlled independently, which is an innovative design and enables larger manufacturing flexibility; precise control of process parameters.
- **Prismo HiT3:** Enables the growth of high-quality aluminum nitride and high-aluminum component materials; maximum reactor chamber temperature at 1400 Celsius degrees; processes up to 18 2-inch epitaxial wafers per run, with extendibility to 4-inch wafers; Complies with highest semiconductor industry standards

The MOCVD market amounts to around US\$400-600mn per year globally based on our channel checks and is mainly driven by LED chip makers' capacity expansion. In 2016-18, China's LED chip makers spent heavily on ramping up their capacities, but in 2019 LED capex dropped significantly as the industry entered into a downturn. AMEC's MOCVD sales jumped from Rmb16mn in 2016 to Rmb832mn (51% of total sales) in 2018, driven by a strong capex cycle in the LED industry. As capex dropped significantly in 2019, LED equipment orders decreased sharply as well based on our checks across the supply chain. Going into 2020, we expect MOCVD sales to remain soft and rebound starting from 2021E driven by new investment by leading LED companies such as Sanan and the expansion of Mini LED production.

Exhibit 212: China LED chip makers' capex: Currently in a capex downtrend after a strong capex cycle in 2016-18

Source: Company data, Wind

Exhibit 213: AMEC's MOCVD sales trend: Trough in 2020E; rebound driven by Mini LED investment

Source: Company data, Goldman Sachs Global Investment Research

Based on our supply chain checks, two-thirds of LED fab capex is spent on equipment, of which c.50% is for MOCVD. AMEC's MOCVD equipment "Prismo A7" can process 220k 2" wafers per year per chamber. Based on Sanan's new capacity projects, we estimate it will need 128 units of MOCVD in the coming 2-3 years. We believe another key driver of MOCVD demand rebound is Mini LED investment. AMEC targets to launch Mini LED MOCVD in 2020, which should allow the company to capture the coming uptrend in Mini LED investment that we expect. A number of key companies have announced plans for Mini LED and have launched Mini LED products.

Exhibit 214: Sanan's LED expansion projects under construction could create new MOCVD demand of 128 units in the coming 2-3 years

Project	Process	Capacity k wpm (4")	Construction start	#MOCVD needed (units)
Quanzhou 1	GaN	160	2019	36
Quanzhou 1	PSS-substratn	192	2019	43
Quanzhou 1	GaAs	26	2019	6
Hubei	GaN	134	2019	30
Hubei	GaAs	63	2019	14

Source: Company data, Goldman Sachs Global Investment Research

Exhibit 215: Mini LED investment gathering momentum; a number of companies are aiming to mass produce Mini LED in 2020

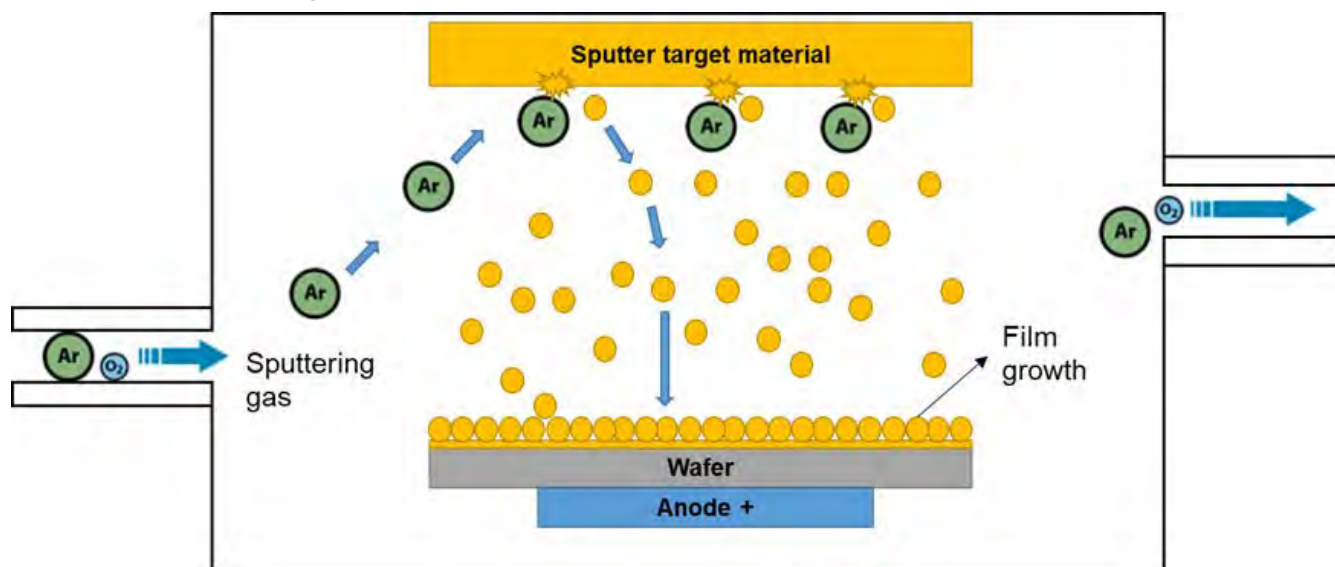
Company	Ticker	Progress	Announced
BMTC	002429.SZ	Cooperating with Korean and Taiwan companies on Mini LED used in high-end displays	Jan, 2020
NationStar	002449.SZ	Mass production of Mini LED IMD-M09T Launched IMD-M05 with a smaller pitch Launched light source display modules for Mini LED backlight, smart home appliances	Apr, 2020
BOE	000725.SZ	Mass production of glass-based Mini LED backlight and Mini LED displays in 2H20	Mar, 2020
Refond	300241.SZ	Ready for massive production of Mini LED and will expand the production line, based on customer orders	May, 2020
Jufei	300303.SZ	Mini LED is a newly-developed business of mass-production capability, and key investment direction in the future. Mini LED modules adopt COB (Chip on Board) or COG (Chip-On-Glass) solutions	May, 2020
Mason	002654.SZ	Small-batch production of Mini LED	Dec, 2019
Coreach	002983.SZ	Mini LED display technology was selected as a major scientific and technological project in Anhui Province, and some technologies have obtained patents and entered into the customer sample stage	May, 2020
Unilumin	300232.SZ	Launched Zhou Ming UMini (Mini LED) in 2020, which adopted full-flip LED chips, mass transfer and integrated packaging technology to achieve high-density and reliable LED display	May, 2020

Source: Company data

PVD: An area with high tech barriers; NAURA with initial breakthroughs

Physical Vapor Deposition (PVD) is a common technique (like CVD) used to deposit thin films during the wafer fabrication process. Compared with CVD, PVD makes thin films through physical process rather than chemical reactions like CVD does. Currently most of PVD uses sputtering process to expose a target material to a plasma (typically Ar) of ions and ions (Ar) to bombard the target material and knock off atoms from the target materials. The atoms then fall onto the wafer, forming a thin film (as below exhibit shows).

Exhibit 216: Illustration of PVD process

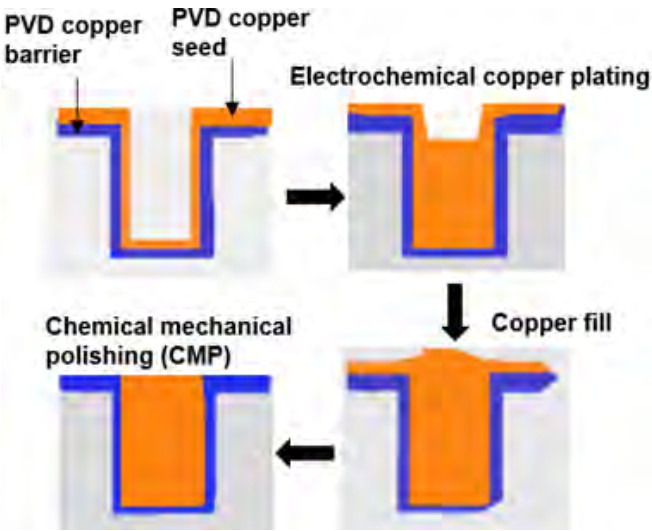


Source: Goldman Sachs Global Investment Research

Sputtering PVD is a US\$2-3bn market: Our industry checks suggest most of PVD tools are sputtering/plasma based, which is a US\$2-3bn market globally per Gartner. The PVD/sputtering segment is primarily dominated by Applied Materials globally, which has a wide product offering across various materials deposition and end-applications. In China's local market, NAURA has emerged as the leading local supplier of PVD tools (AMAT still dominates the PVD segment in the China market).

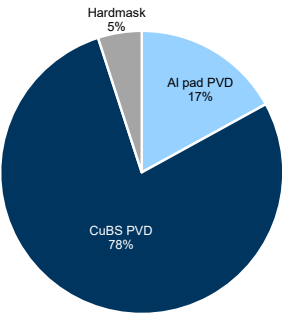
Local player NAURA achieving initial breakthroughs in CuBS PVD: NAURA's products mainly cover Aluminum-pad deposition (which is typically the top-most layer in chip structure) and hardmask layer (titanium nitride). More recently, NAURA's PVD equipment for copper barrier and seed layer (CuBS) deposition have passed qualification at YMTC and received initial orders of 3 sets of equipment. CuBS PVD represents another segment in which a local supplier achieved breakthrough and started initial localization. However, as chip size continues to shrink, new type of materials such as cobalt and ruthenium have been identified to replace or partially replace copper in metal interconnect as cobalt and particularly ruthenium show greatly improved electromigration resistance compared to copper in chip scaling beyond 10nm (*Note: Electromigration is the transport of material caused by the gradual movement of the ions in a conductor due to the momentum transfer between conducting electrons and diffusing metal atoms; This is a serious issue in high performance IC manufacturing*). NAURA currently does not have PVD product for cobalt and ruthenium deposition, which is a new area in which local suppliers would need to catch up with global leaders.

Exhibit 217: Illustration of CuBS and copper plating process



Source: Data compiled by Goldman Sachs Global Investment Research

Exhibit 218: In YMTC’s PVD equipment purchase tender, CuBS PVD made up 78% of the total by volume



Source: Company data

Exhibit 219: PVD: AMAT dominates; NAURA had initial breakthroughs locally

AMAT			NAURA		
Products	Technology	Applications	Products	Technology	Applications
ENDURA IMPULSE	Pulsed	PCRAM, ReRAM	eVictor AX30 Al pad	Plasma/Sputter	Aluminum pad interconnect
ENDURA CLOVER	Plasma/Sputter	MRAM	exiTin H630 TiN Metal HardMask	Plasma/Sputter	Ti/TiN hardmask for 55-28nm
ENDURA CIRRUS HT CO	RF-based Plasma	DRAM; TiN	eVictor GX20	Plasma/Sputter	Liner Barrier, Aluminum interconnect; Power Device, MEMS
ENDURA CIRRUS HTX	RF-based Plasma	TiN hardmask beyond 10nm node	Polaris G620	Plasma/Sputter	8" wafer; Packaging; Fan-out, Ti/Cu-copper pillar
Charger UBM	Plasma/Sputter	Underbump metallization; Flip-Chip package	Polaris T	Plasma/Sputter	3D WLP; TSV barrier; Copper, Titanium, Tantalum, Aluminum
COBALT SUITES	PVD/CVD/Anneal	Total solution for cobalt	Polaris B	Plasma/Sputter	Advanced WLP underbump metallization
ENDURA ALPS	Plasma/Sputter	Silicidation for Gate and Contact			
ENDURA AL	Plasma/Sputter	Aluminum interconnect for logic and DRAM			
ENDURA AMBER	Plasma/Sputter	Copper interconnect			
ENDURA AVENIR	RF-based Plasma	High-k metal gate/logic contact silicidation (22nm and beyond)			
ENDURA CUBS RFX	Plasma/Sputter	Copper seed and barriers; 3x/2x node			
ENDURA EXTENSA	Plasma/Sputter	Barrier deposition for Flash/DRAM (5xnm/below)			
ENDURA HAR COBALT	Plasma/Sputter	Cobalt and TiN cap deposition; DRAM periphery			
ENDURA VENTURA	Plasma/Sputter	TSV; Tantalum, Titanium barriers, copper seed deposition			
ENDURA VERSA	Plasma/Sputter	Tungsten deposition; DRAM 1xnm node			
ENDURA ILB PVD/ALD	Plasma/Sputter	TiN films; <32nm logic; 4xnm node DRAM			

Source: Company data

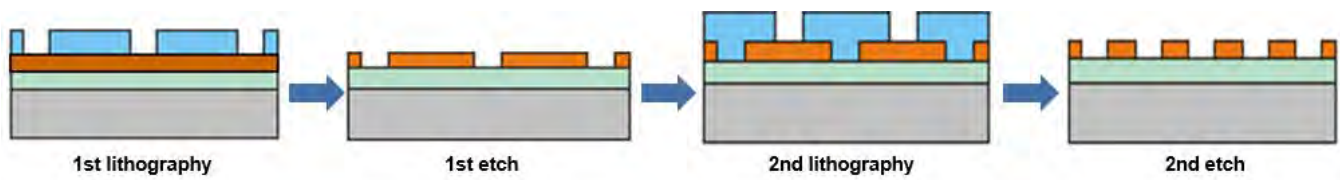
Etch systems: Local supplier AMEC showing significant progress in dielectric etch; NAURA focuses on silicon etch

Etching equipment (or etcher) has high technology barriers due to the complexity and strict requirement of uniformity in the etching process, and etch is a key process in making critical dimensions within a chip. This area is primarily dominated by LAM Research, Tokyo Electron, and Applied Materials. In recent years, local suppliers AMEC and NAURA have made meaningful progress in their technologies and product commercialization. AMEC’s dielectric etchers have penetrated into world leading wafer fabs such as TSMC’s 5nm production line. NAURA’s silicon etchers have also been accepted by local customers such as YMTC, Hua Hong, and Huali, etc. Given AMEC and NAURA’s progress in etching, we expect dielectric etcher segment to see fast localization going forward while silicon etcher will be relatively slower.

Etching process shape thin films into certain patterns desired by wafer fabs by using chemicals, reaction gases or ion chemical reaction. There are two types of etching, wet etching and dry etching. Wet etching typically involves chemical reaction in an acid or alkaline solution to produce corrosion and dissolution of the film. Dry etching cuts the film using mechanical and chemical reaction, introducing etching gas (chemical gas) into the plasma and etches the wafer surface by hitting it with the accelerated ions in the plasma. Currently most of the processes are dry etching. Wet etching is generally isotropic, which results in the etchant chemicals removing substrate material under the photoresist material. Wet etching also in general consumes more chemicals than dry etching does.

Exhibit 220: Double patterning in 14nm fabrication

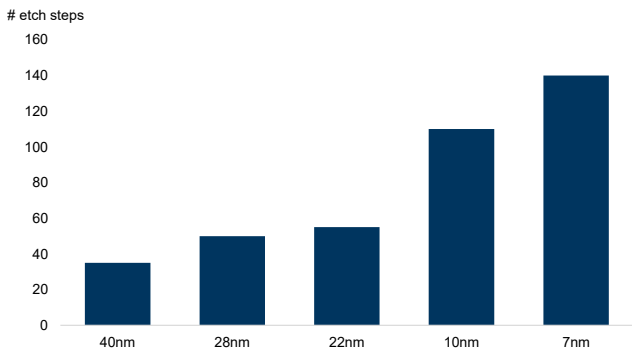
Illustration of etching process in wafer fabrication



Source: Company data, Data compiled by Goldman Sachs Global Investment Research

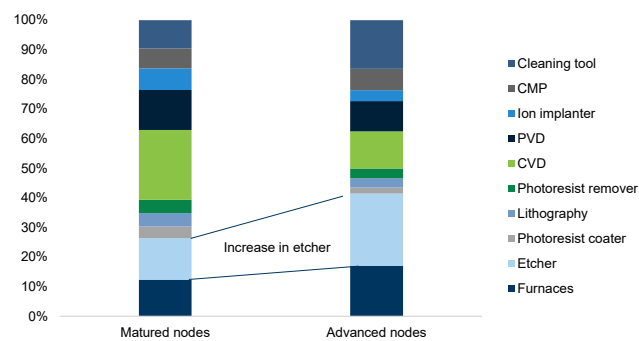
In non-EUV, multi-patterning increases lithography and etch/cleaning steps. 14nm requires double-patterning, with KrF 193nm immersion DUV lithography tool, and 7nm requires quadruple-patterning. We see a rising number of etch steps as the process node moves to more advanced nodes, which could drive up etch demand. However, the use of EUV lithography tool in 7nm+ and 5nm could reduce the need for multi-patterning and thus reduce etching steps.

Exhibit 221: # of etch steps in leading edge nodes increases significantly



Source: Company data

Exhibit 222: Etcher makes up a larger portion in advanced nodes equipment



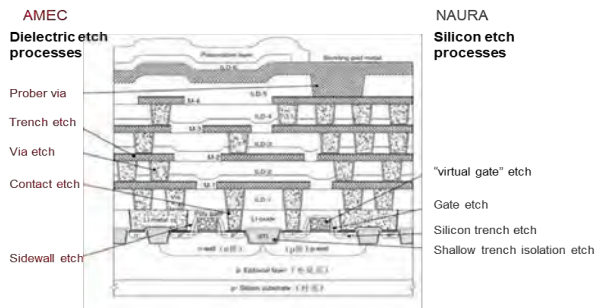
Source: Company data

The global leaders in etch equipment are LAM Research, Tokyo Electron and AMAT. These global leaders offer full etch equipment portfolio ranging from silicon etch (trench, gate, TSV), dielectric etch (Via, Contact, Side wall) and metal etch. NAURA and AMEC are local leaders in etcher segment. NAURA mainly focuses on silicon etch and AMEC mainly on dielectric etch.

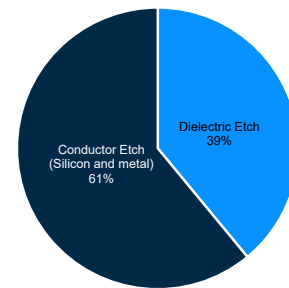
Exhibit 223: Product portfolio of global suppliers vs. Chinese

Etch by materials	Category	Sub-category	Application	LAM	TEL	AMAT	NAURA	AMEC
Silicon Etch	Trench	Shallow etch	Shallow Trench Isolation	✓	✓	✓	✓	
		Deep etch	Deep trench capacitor	✓	✓	✓	✓	
	Gate	Polysilicon etch	Form gate	✓	✓	✓	✓	
	TSV	TSV	TSV packaging	✓	✓	✓	✓	✓
Dielectric Etch	Via	-	Metal layer interconnection	✓	✓	✓		✓
	Contact	-	Metal layer and transistor connection	✓	✓	✓		✓
	Side wall	-	Multi-patterning	✓	✓	✓		✓
Metal Etch	Planar		Metal interconnect	✓	✓	✓	✓	

Source: Company data

Exhibit 224: Typical process in dielectric and silicon etch**Exhibit 225: Silicon and dielectric etch make up the majority of the market**

Conductor etch consists of predominately silicon etch with metal etch making up a small portion



Source: Data compiled by Goldman Sachs Global Investment Research

Source: Gartner

As global foundry leaders move to the 5nm node, etch systems are also following the technology migration. AMEC has received qualification from TSMC for 5nm etch, NAURA has qualified for SMIC and Huali has qualified for 14nm.

Exhibit 226: Global majors are at the 5nm node; AMEC qualified by TSMC for 5nm; NAURA at 14nm with SMIC/Huali

	1995	1998	1999	2000	2002	2005	2006	2007	2008	2009	2010	2011	2012	2014	2015	2017	2018	2019	2020
Global	0.35um	0.25um	0.18um	0.13um	90nm		65nm		45nm		32nm	28nm	22nm	16/14nm		10nm	7nm		5nm
SMIC								90nm		65nm		55nm	40nm			28nm		14nm	
NAURA equipment						100nm		90nm				65nm-40nm			28nm		14nm		
AMEC equipment								65-16nm					45-7nm				7-5nm		

Source: Company data

Global leaders have product series suitable for silicon, dielectric and metal etch. NAURA and AMEC have products specific to either silicon, dielectric or metal etching.

Exhibit 227: Etch systems: Product families of global leaders

LAM			TEL			AMAT		
Product series	Materials	End applications	Product	Materials	End applications	Product	Materials	End applications
DSIE	Silicon	MEMS, power device, TSV packaging	Tactras Vigus	Silicon/Dielectric	Advanced nodes	CENTRIS SYM3	Silicon	1x /10nm/below
FLEX	Dielectric	Advanced memory, Power devices	Tactras Vesta	Silicon/Dielectric	Advanced memory	CENTRIS AdvantEdge	Silicon	22nm/below
KIYO	Silicon/Dielectric/Metal	Advanced nodes/memory	Tractras RL5A	Silicon/Dielectric	Leading edge logic	CENTURA Avatar	Dielectric	3D NAND
RELIANT	Silicon/Dielectric/Metal	GaN, SiC, AlGaN	Certas LEAGA	Dielectric	Surface etch/cleaning	CENTURA Silvia	Silicon	TSV packaging
SENSE.I	Silicon/Dielectric	Leading edge logic/memory	UNITY ME Ox	Dielectric	4-8" devices	CENTURA TETRA EUV	Photomask	EUV process
SYNDION	Deep silicon	TSV for CIS; HAR for CIS, power/MEMS	UNITY ME Si/SiC	Silicon	4-8", SiC, TSV	CENTURA TETRA Z	Photomask	10nm/below (non-EUV)
VERSYS	Metal	TiN hardmask, Al pad				CENTURA ETCH 200mm	Al metal	Metal interconnect
						PRODUCER ETCH	Dielectric	90nm/below
						PRODUCER SELECTRA	Dielectric	FinFET/NAND/DRAM

Source: Company data

Exhibit 228: Etch systems: Product families of Chinese suppliers

NAURA			AMEC		
Product	Materials	End applications	Product	Materials	End applications
NMC508M	Al metal	8", 0.35-0.11um	Primo D-RIE	Dielectric	12", 65-16nm
NMC508C	Silicon	8", 0.35-0.11um	Primo AD-RIE	Dielectric	12", 40-7nm
NMC612C	Silicon	12", 90-40nm	Primo SSC AD-RIE	Dielectric	12", 16nm
NMC612D	Silicon	12", 28-14nm	Primo HD-RIE	Dielectric	12", 3D NAND, DRAM
NMC612M	TiN Metal	12", 40-14nm	Primo iDEA	Dielectric	12", etch/photoresist
NMC612G	Al metal	12" Al etch, Micro OLED	Primo nanova	Dielectric	12", 1x nm memory
HSE200/230	Silicon	MEMS, TSV packaging	Primo TSV	Silicon	Advanced packaging
Currently developing silicon etcher, PVD, ALD for 7nm/5nm			Advanced logic (7nm and below) Damascene etch		
			Advanced MEMS etcher; and Ether for 128L NAND (high aspect ratio)		

Source: Company data

Wafer cleaning tools: ACMR the leading local vendor with its proprietary megasonic technology

Wafer cleaning tools remove the random particles at microscopic level on silicon wafer after certain processes such as lithography, etching, deposition and CMP. Cleaning is the one of the most repeated steps in wafer fabrication process and typically make up 5-7% of the total SPE spending in a production line, per our supply chain check. There are several types of wafer cleaning technology including soaking/dissolving, scrubbing, ultrasonic, megasonic, and spin/jet spray. In the global wafer cleaning market, SCREEN, Tokyo Electron and LAM Research have leading positions. ACM Research, NAURA and PNC are the local suppliers. In YMTC's cleaning tools purchases as of end-2019, ACMR secured a c.20% share allocation, per our industry checks.

One of the key competitive advantage of ACMR is its proprietary megasonic technology. The use of megasonic technology is not a new development in cleaning tools and major cleaning tool suppliers had tried megasonic cleaning technique in 2000s but ended up largely abandoning this technology in 2008-10 due to megasonic's disadvantage (damage to critical structure of the chip). Megasonic creates cavitations (or bubbles) on the surface of the wafer, which is typically immersed in chemical liquids, and these bubbles push particles (residue to be removed) away from the wafer surface. The key disadvantage of this process is that when the bubble bursts, it can release energy that could damage the structure on the wafer surface. ACMR's proprietary megasonic technology controls the bubble and make it oscillate rather than burst, which avoids damaging the critical structure on the wafer surface.

ACMR's cleaning tools have been accepted by SK Hynix (covered by Giuni Lee), YMTC, and Hua Hong/Huali, etc. Per the company management, ACMR's cleaning tools (single-wafer cleaning and semi-critical cleaning) have a serviceable available market of US\$2.3bn (out of US\$3bn total addressable market in cleaning tools globally).

Exhibit 229: Product offering by vendors; ACMR emerging as the local leader in cleaning equipment

Cleaning technology	SCREEN	TEL	LAM	ACM Research	NAURA	PNC
Country of origin	Japan	Japan	US	China	China	China
Soaking/dissolving	√	√	√			
Scrubbing	√	√	√	√		
Ultrasonic						
Megasonic				√		
Spin/ Jet spray	√	√	√		√	√

Source: Company data

Wafer cleaning is required in several steps of wafer fabrication after etching, deposition, ion implant, CMP and photoresist as shown in the exhibit below. ACMR's products can be used in all of these processes. By technology nodes, ACMR's products can be used in 50 cleaning steps in DRAM manufacturing and c.15 steps in advanced logic manufacturing. On June 27, ACMR launched a cleaning tool that could address high-aspect ratio cleaning for 128-layer 3D NAND. The company targets to cover 90%+ of the cleaning process in the future.

Exhibit 230: Cleaning is the most repeated step in wafer fabrication; cleaning equipment makes up c.5% of WFE

Source: Company data

Exhibit 231: Global majors have more comprehensive product offerings; ACM Research can cover 50% of the cleaning processes

SCREEN				TEL				LAM			
Product	Technology	#Chambers	Throughput	Product	Technology	#Chambers	Throughput	Product	Technology	#Chambers	Throughput
FC-3100	Wet station	-	650	CELLESTA	Single wafer	-	1,000	CORONUS	Plasma cleaning	-	-
WS-620C/820L	Wet station	-	-	EXPEDIUS - i	Batch wet station	-	1,000	DV Prime	Spin/Jet spray	-	-
FC-821L	Wet station	-	-	EXPEDIUS +	Batch wet station	-	600	Da Vinci	Spin/Jet spray	-	-
CW-1500/2000	Wet station	-	150	NS 300Z	Scrubber	-	1,000	EOS	Spin/Jet spray	-	-
SU-3300/3200/3100	Spin/Jet spray	24/12/8	1600/800/300	ANTARES	Dry cleaning	-	-				
SU-2000	Spin/Jet spray (8")	4	-	ZETA 200/300	Batch spray	-	450				
SS-3200/3100/80EX	Spin scrubber	8	800	ZETA Semi-auto	Batch spray	-	450				
ACM Research				NAURA				PNC			
Product	Technology	#Chambers	Throughput	Product	Technology	#Chambers	Throughput	Product	Technology	#Chambers	Throughput
SAPS	Megasonic	8	225	Saqua	Spin/Megasonic	-	-	ULTRON S2xx/3xx	Spin/Jet spray	8-12	295-590
TEBO	Megasonic	12	330	Saqua Stacked	Spin/Megasonic	-	-	ULTRON B2xx/3xx	Batch cleaning	-	-
Tahoe	SPM/megasonic	8-12	-	Bpure	Batch cleaning	-	-				

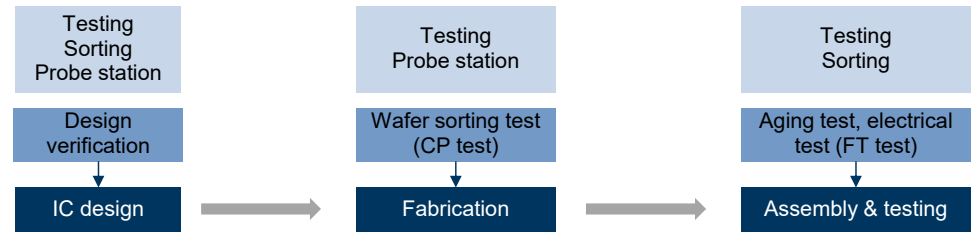
Source: Company data

ATE (automated testing equipment): AccoTest the local leader

Semiconductor automated testing equipment includes a range of testing equipment for IC and components, such as analog IC, memory, RF IC, power discrete, SOC, resistors, capacitors, inductors, etc. ATE systems are designed with probe cards and automatic

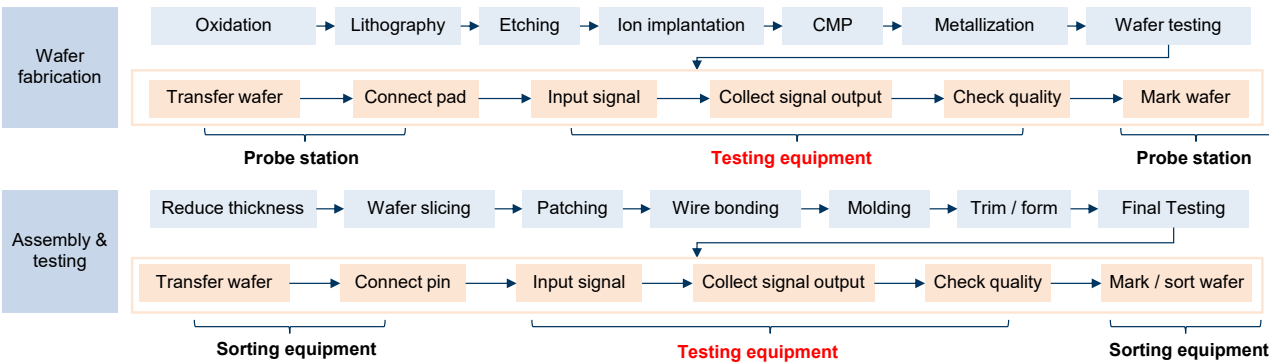
defect detection systems to reduce the labor costs in semiconductor testing. Testing equipment is used in various steps of wafer fabrication, including IC design, IC manufacturing and assembly/testing.

Exhibit 232: ATE is used in IC design, wafer fabrication, and assembly, with assembly contributing the majority of the revenues



Source: Company data

Exhibit 233: Illustration of the testing process



Source: Data compiled by Goldman Sachs Global Investment Research

Teradyne, Advantest, and Cohu are the leaders in the global ATE market. Their products cover SOC test, memory IC test, RF IC test and analog IC test. In China, local suppliers of ATE are still in the early stage of development. AccoTest and Changchuan offer analog IC test equipment only; AccoTest is developing SOC and power IC testing technology.

Exhibit 234: AccoTest is the leading local ATE supplier, focusing on analog IC test

Analog IC Test	Teradyne	Advantest	Cohu	AccoTest	Changchuan
SoC Test	√	√	√	R&D	
Memory IC Test	√	√			
RF Test	√	√	√		
Analog IC Test			√	√	√

Source: Company data

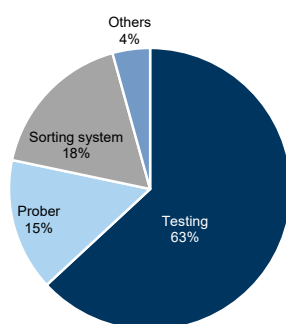
China’s ATE supply chain started in the 1990s while global peers were established as early as the 1940s. AccoTest and Changchuan are small in scale compared to global leaders.

Exhibit 235: Comparison of major ATE peers

Companies	2019 rev (US\$mn)	net profit (US\$mn)	Established	#Employee	R&D as % of Revenue
Advantest	2,542	486	1946	4,936	15%
Teradyne	2,295	467	1960	5,400	14%
Cohu	583	-70	1947	3,500	15%
AccoTest	36	15	1993	236	13%
Changchuan	14	2	2008	772	27%

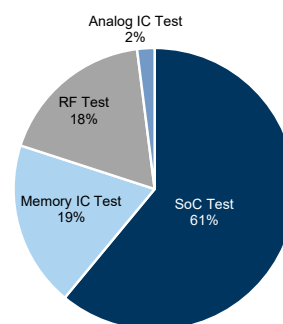
Source: Company data

Among the various types of ATE systems, testing equipment is the largest segment with 63% share, the rest are probers or sorting systems. Within testing equipment, SOC tests take up 61%, followed by memory IC tests at 19% and RF IC tests at 18%.

Exhibit 236: Testing equipment makes up 63% of ATE systems market

Data as of 2019

Source: Company data

Exhibit 237: Within testing, SoC makes up 64% while Analog IC 2%
AccoTest currently focuses on Analog IC test and is developing SoC test equipment

Data as of 2019

Source: Company data

China SPE spending: US\$160bn of capex over 5-7 years; SPE demand to grow by 31% CAGR in 2020-25E to US\$38bn

China's semiconductor industry has c.US\$160bn of investments planned over the next 5-7 years to build new 12" and 8" wafer fabs by Chinese foundries and IDMs (including memory), based on the key projects we currently track. Key drivers of the spending are foundry technology migration (e.g., SMIC) and the ramp-up of China's memory capacity (e.g., at YMTC, CXMT, and Unigroup). We expect these projects to create SPE demand of c.US\$10bn/US\$38bn in 2020/25E.

Exhibit 238: We expect China's SPE spending to reach US\$9.9bn in 2020 and then grow by a 31% CAGR to c.US\$38bn in 2025E

China WFE capex	2018	2019	2020E	2021E	2022E	2023E	2024E	2025E	2026E
Foundries		3,063	5,578	6,851	7,445	7,634	8,243	8,592	9,110
SMIC (overall)		1,363	3,428	3,841	4,355	4,332	4,786	4,780	5,142
Hua Hong		700	760	710	730	802	807	812	818
Other Chinese foundries		1,000	1,390	2,300	2,360	2,500	2,650	3,000	3,150
Memory		2,625	3,750	5,250	7,875	11,625	17,250	27,750	22,750
NAND		1,125	2,250	3,750	4,875	7,125	11,250	18,000	15,250
DRAM		1,500	1,500	1,500	3,000	4,500	6,000	9,750	7,500
Other smaller 12" IDM projects		300	400	500	800	800	1,000	1,000	1,000
8" projects		100	199	364	400	400	400	400	400
China SPE capex (US\$ mn)	4,500	6,088	9,927	12,965	16,520	20,459	26,893	37,742	33,260
YoY			63%	31%	27%	24%	31%	40%	-12%

Source: Company data, Goldman Sachs Global Investment Research

We note our SPE demand forecasts in China and revenue/earnings estimates for local SPE companies represent the mid-line trend rather than simulations of the actual spending cycles into the future. SPE spending is cyclical in nature and can fluctuate significantly from year to year. Our forecasts are based on the aggregation of all the semiconductor construction/capacity expansion projects we track in China. With China's rising investment in the space to catch up in semiconductor technology and firm up the local supply chain, we believe the investment will remain on an uptrend in the coming 5 years. However, due to the cyclical nature of the industry, the SPE spending within our forecast period could experience a decline in one or more years depending on each project's investment plans, and the decline could impact SPE companies' revenue and earnings growth. However, a decline is usually followed by a rebound, and we believe our forecasts of a solid uptrend will remain intact in 2020-25E.

Drawing reference from previous cycles globally, the cycles are usually driven by the memory customers. Leading foundries and IDMs such as Intel and TSMC are certainly big enough to move the needle, but the rate of change tends to be more modest in logic/foundry vs memory. In memory, it is supply/demand imbalances and ultimately ASP fluctuations that lead to changes in customer spending decisions. We note in our SPE spending forecast in China, memory (NAND and DRAM) makes up c.60-70% of total spending in 2023-25E, mainly contributed by projects such as YMTC, CXMT, and Unigroup (Nanjing, Chengdu, and Chongqing). These projects could also potentially cause volatilities in China's SPE spending.

Local memory IDMs and advanced nodes foundry/logic are key drivers of SPE spending. We note there are 15 projects (12") under construction or in capacity expansion across foundry, memory and power IDMs. Memory investments make up c.70% of the total capex in 12" projects and are mainly driven by new fab constructions and capacity expansions from YMTC, CXMT (also known as Hefei Innoson), and Unigroup's Nanjing, Chengdu, and Chongqing projects (see exhibit below). In the foundry/logic space, a key driver of the spending are capacity expansions associated with technology migrations to more advanced nodes, namely, SMIC and Huali's migration to 14nm, Hua Hong's new fab in 12", and Wuhan Hongxin Semiconductor Manufacturing Corp's new fab in advanced nodes (14-7nm).

Exhibit 239: China's new 12" fabs: Capex exceeding US\$156bn

Company / project name	Ticker	Type	Capex (USD)	Products	Construction start	Equipment move in
SMIC	981.HK	Foundry	10.5bn	14nm and above advanced nodes	-	Aug-2019
Hua Hong (Wuxi)	1347.HK	Foundry	10bn (Phase 1: 2.5bn)	90nm, 65/55nm	Mar-2018	May-2019
Huali (Fab 6)	Private	Foundry	5.5bn	28nm/14nm	Dec-2016	May-2018
GTA Semiconductors	Private	Foundry	4bn (Phase 2)	Power discretes, PMIC, CIS	Aug-2018	-
Wuhan HSMC*	Private	Foundry	20bn	14nm/7nm logic	Mar-2019	Nov-2019
Hefei Nexchip	Private	Foundry	1.8bn	Touch/Display driver IC	Oct-2015	Apr-2017
Silan Microelectronics (Xiamen)	600460.SS	IDM	2.3bn (Phase 1: 1bn)	MEMS, power discretes	Oct-2018	2Q20
Jiangsu AMS	Private	IDM	1.8bn	EEPROM	Aug-2017	Mar-2018
CR Microelectronics	688396.SS	IDM	1.4bn	Power discretes, PMIC	2019	2021
Cansemi	Private	IDM	1bn	MCU, PMIC, analog, power discretes	Mar-2018	Mar-2019
Yangtze Memory (YMTC)	Private	Memory	24bn	3D NAND Flash	Dec-2016	Apr-2018
Changxin Memory (CXMT)	Private	Memory	22bn	DRAM	Jul-2017	1Q18
Unigroup (Nanjing)	Private	Memory	30bn (Phase 1: 10bn)	3D NAND Flash/DRAM	Sep-2018	-
Unigroup (Chengdu)	Private	Memory	24bn (Phase 1: 10bn)	3D NAND Flash	Aug-2018	1Q21
Unigroup (Chongqing)	Private	Memory	10bn	DRAM	4Q19	2021

Total: US\$156bn+

HSMC*: Wuhan Hongxin Semiconductor Manufacturing Corp.

Source: Company data, Goldman Sachs Global Investment Research

In 3D NAND, YMTC has upgraded its 3D NAND products from 32-layer in 2018 to 64-layer in 2019 and 128-layer in 2020. The company announced in April ([report link](#)) that it has successfully developed a QLC-based 128-layer 3D NAND flash (X2-6070) and passed sample verification on SSD platform at multiple controller partners. The mass production of 128-L production will likely start in 4Q20 or early 1Q21, this narrows the 128-L technology gap vs. global major memory makers to a year vs. 2 years in 64-L products. YMTC has maintained its capacity plan as previously highlighted in our report ([link](#)). The company had 20k wpm of capacity at end-2019 and plans to expand by 30k wpm in 2020, reaching 100k wpm of total capacity by 2021 and 300k wpm in 2023. Currently, production is mainly focused on 64-layer 3D NAND flash products, which entered into mass production in September 2019.

Based on our checks with local SPE makers, etcher and CVD equipment made up the largest portion of YMTC's equipment purchase so far and most of the 64-L 3D NAND production equipment can be used for 128-L production except those associated with the high aspect ratio fabrication processes.

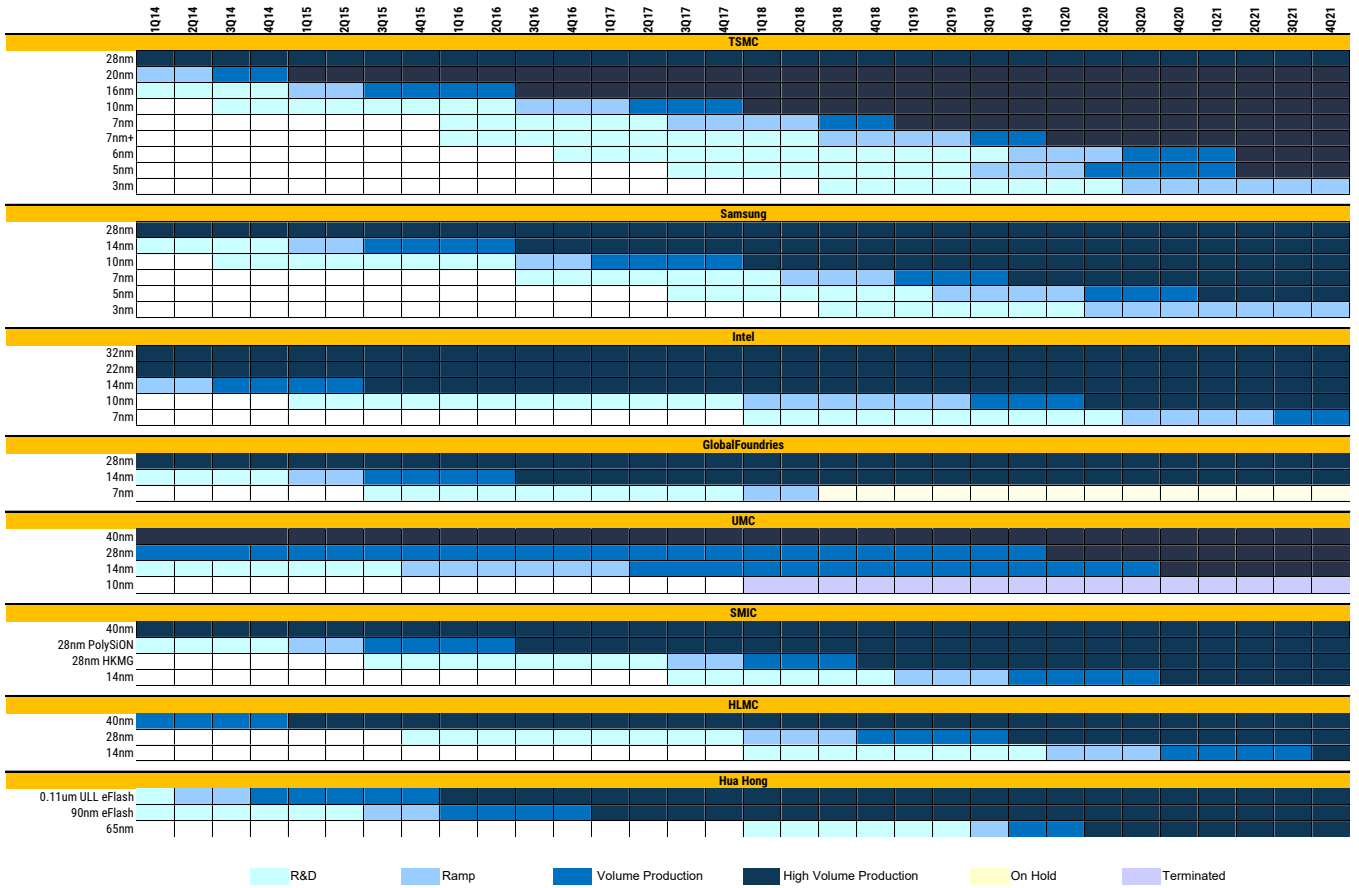
In DRAM, CXMT's 19nm DRAM has entered into mass production in 2019 and the company plans to add 20k wpm of new capacity in 2020E. CXMT targets total capacity of 120k wpm for Phase-1 and aims to reach 360k wpm eventually. Our checks with local SPE makers suggest CXMT has yet started purchasing local equipment in large volume and has instead mostly purchased foreign equipment to achieve a robust yield rate. But as CXMT's production improves, more equipment allocation could be made to local SPE makers, which is also in line with the industry practice.

Exhibit 240: Chinese memory YMTC narrowing the gap
YMTC's 64L lags behind by 2 years; currently migrating to 128L, lagging behind by 1 year

Companies	2017	2018	2019	2020	2021	2022
Samsung	48L	64L	92L	128L	1xxL	2xxL
SK Hynix	48L	72L	96L	128L	192L	
Micron	32L	64L	96L	128L	1xxL	
Intel	32L	64L	96L	144L	1xxL or 2xxL	
YMTC		32L	64L	128L	1xxL or 2xxL	

Source: Company data, Goldman Sachs Global Investment Research

Exhibit 241: Foundries' technology roadmap: SMIC migrating to 14nm and Hua Hong migrating from 8" fab to 12" 65nm nodes



Source: Company data, Goldman Sachs Global Investment Research

8" projects are also on the rise and are mainly focused on the production of power semiconductors, MCU, and analog ICs. Unlike 12" fabs, 8" fabs typically buy a large portion of equipment from the preowned market and focus on legacy technologies, which in nature have much lower capex intensity. As we highlighted in our [SiEn visit report](#), SiEn has an in-house engineering team that refurbishes equipment purchased from preowned market. Thus 8" projects' spending on new SPE are significantly less.

Exhibit 242: New 8" fab capex totaling US\$6bn+

Company / project name	Ticker	Type	Capex (USD)	Products	Construction start	Equipment move in
GTA Semiconductors	Private	Foundry	1bn (Phase 1)	Power IC, power discretes, TSV	Aug-2018	4Q19
SMEC (Shaoxing)*	Private	Foundry	820mn	MEMS, IGBT, MOSFE, RF	May-2018	Aug-2019
SMIC (Tianjin) T2	981.HK	Foundry	1.5bn	Finger-print IC, power IC, CIS	Oct-2016	Jul-2018
NSIC** N2	Private	Foundry	570mn	BCD, RF	Nov-2018	2020
SiEn (Qingdao)	Private	IDM	1.1bn+	MCU, analog IC, power discretes	May-2018	4Q19-1H20
CR Microelectronics	Private	IDM	330mn	BCD, MEMS	1Q19	3Q19
Yandong Microelectronics	Private	IDM	685mn	Power discretes, driver IC	Sep-2017	Jun-2019

Total: US\$6bn+

SMEC (Shaoxing): Semiconductor Manufacturing Electronics (Shaoxing) Corporation, 23.5% owned by SMIC

NSIC: Ningbo Semiconductor International Corporation, 38.6% owned by SMIC

Source: Company data, Data compiled by Goldman Sachs Global Investment Research

Based on public tenders and the disclosure made by semiconductor firms, we summarize the number of equipment needed for production lines by different technology nodes (shown in below exhibit). We use this as the basis to calculating the equipment needed per unit capacity (i.e. 10k wafers per month).

Exhibit 243: Chinese semiconductor manufacturers' equipment purchases for their production lines, by equipment type

	SMIC Tianjin T2 8" Fab	GTA Semiconductors (6"/8" fab)	SMIC Tianjin T3 12" Fab (mature nodes)	TSMC (Nanjing) 12" Fab (16nm)
Monthly Capacity (k wpm)	90	n.a	10	20
Furnace	113	40	22	83
Etcher	92	17	25	119
Photoresist coater	39	5	7	10
Lithography	39	3	8	15
Photoresist remover	32	4	8	16
CVD	89	14	42	61
PVD	43	6	24	50
Ion implanter	31	8	13	18
CMP	33	12	12	35
Cleaning tool	41	25	17	80

Source: Company data

We forecast equipment demand by calculating the average equipment per 10k wpm capacity, then we apply the number to future capacity plans.

Exhibit 244: Equipment needed per 10k wpm of new capacity, by equipment type and technology nodes

SPE equipment demand estimates

	8"	12"	12"	12"	12"	12"	12"
	Matured nodes	Matured nodes	Advanced nodes (16/14nm)	Advanced nodes (7nm)	Advanced nodes (5nm)	Advanced nodes (3nm)	3D NAND
Furnaces	13	22	42	48	62	68	40
Etcher	10	25	60	71	100	115	70
Photoresist coater	4	7	5	6	7	8	8
Lithography	4	8	8	9	11	12	8
Photoresist remover	4	8	8	9	12	13	8
CVD	10	42	31	35	46	50	110
PVD	5	24	25	29	37	41	10
Ion implanter	3	13	9	10	13	15	10
CMP	4	12	18	20	26	29	18
Cleaning tool	5	17	40	46	60	66	40

Source: Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 245: Chinese semiconductor manufacturers' capacity expansion plans and our forecasts on equipment demand for their production lines, by equipment type

12" matured nodes	2019	2020	2021	2022	2023	2024	2025	2026
Capacity addition (k wpm)								
SMIC	7	15	39	33	42	40	49	51
Hua Hong (Wuxi)	10	10	10	11	12	14	4	10
Silan	-	5	10	10	10	10	10	10
GTA Semiconductors	-	3	-	-	10	10	15	15
CR Microelectronics	-	-	5	5	10	10	10	10
Cansemi	5	10	10	15	10	5	5	5
Nexchip	10	20	10	10	20	-	-	-
Total	32	63	84	84	114	89	93	101
Equipment demand (# units)								
Furnaces	71	139	185	185	252	197	205	222
Etcher	80	158	210	210	286	224	233	252
Photoresist coater	23	45	59	59	80	63	66	71
Lithography	26	51	68	68	92	72	75	81
Photoresist remover	26	51	68	68	92	72	75	81
CVD	135	265	353	353	480	376	391	423
PVD	77	152	202	202	274	215	224	242
Ion implanter	42	82	110	110	149	117	121	131
CMP	39	76	101	101	137	108	112	121
Cleaning tool	55	108	143	143	195	152	159	171

Source: Company data, Goldman Sachs Global Investment Research

The exhibit below shows the SPE required for a 12" by types of etcher, CVD and PVD.

Exhibit 246: SPE equipment demand from 12" fab matured nodes (SMIC's Tianjin T3 fab)

Demand breakdown of etcher, CVD, PVD

Matured nodes etchers units by etch process (per 10k wpm of capacity)		Matured nodes CVD units by layers (per 10k wpm of capacity)		Matured nodes PVD units by layers (per 10k wpm of capacity)	
Protection layer etch	2	TiN	2	Al-pad PVD	1
Dielectric etch	7	Nitride	4	Nickel	1
Contact	1	Nitrogen oxides	1	Titanium/TiN PVD	1
Aluminum	2	Oxides	13	Barrier/seed layer PVD	3
STI	2	Oxyfluoride	6	Copper	18
Gate etch	3	Carbon oxide	3		
Hardmask etch	3	STI oxides	1		
Nitride etch	1	Carbide	1		
Silicon etch	4	Tungsten	1		
		SiGe	5		
		Gate oxides	2		
		Others	3		

Source: Company data

In the foundry and logic space, key local players include SMIC, Hua Hong, Huali Micro, and Wuhan Hongxin (HSMC), etc. SMIC remains as the largest spender among foundry peers given its migration to more advanced nodes (migrating to 14nm currently, to 8nm and 5nm in the future)

Exhibit 247: SMIC, Huali, Wuhan Hongxin Semiconductor Manufacturing Corp. (HSMC) are key drivers of advanced nodes expansion

Capacity expansion plans in advanced nodes by local foundries

12" Advanced nodes	2019	2020	2021	2022	2023	2024	2025	2026
Capacity addition (k wpm)								
SMIC	3	9	18	9	9	21	12	8
14/12nm	3	9	18	6	-	-	-	-
7/8nm	-	-	-	3	9	18	-	-
5nm	-	-	-	-	-	3	12	5
3nm	-	-	-	-	-	-	-	3
2nm	-	-	-	-	-	-	-	-
Huali	-	10	10	10	-	-	-	-
14/12nm	-	10	10	10	-	-	-	-
Other advanced foundries	-	3	10	10	10	10	10	10
14/12nm	-	3	10	7	-	-	-	-
7/8nm	-	-	-	3	10	7	-	-
5nm	-	-	-	-	-	3	10	7
3nm	-	-	-	-	-	-	-	3
2nm	-	-	-	-	-	-	-	-
Total	3	22	38	29	19	31	22	18
14/12nm	3	22	38	23	-	-	-	-
7/8nm	-	-	-	6	19	25	-	-
5nm	-	-	-	-	-	6	22	12
3nm	-	-	-	-	-	-	-	6

Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 248: Our forecasts on SPE equipment demand from advanced nodes foundries (14nm, 7nm, 5nm, 3nm)

12" Advanced nodes	2019	2020	2021	2022	2023	2024	2025	2026
14nm Equipment demand (# units)								
Furnaces	13	92	158	96	-	-	-	-
Etcher	18	131	227	137	-	-	-	-
Photoresist coater	2	11	19	12	-	-	-	-
Lithography	3	17	29	18	-	-	-	-
Photoresist remover	3	18	31	19	-	-	-	-
CVD	10	68	116	71	-	-	-	-
PVD	8	55	95	58	-	-	-	-
Ion implanter	3	20	35	21	-	-	-	-
CMP	6	39	67	41	-	-	-	-
Cleaning tool	12	88	152	92	-	-	-	-
7nm Equipment demand (# units)								
Furnaces	-	-	-	29	91	120	-	-
Etcher	-	-	-	43	136	179	-	-
Photoresist coater	-	-	-	4	11	15	-	-
Lithography	-	-	-	6	17	22	-	-
Photoresist remover	-	-	-	6	18	23	-	-
CVD	-	-	-	22	67	88	-	-
PVD	-	-	-	18	55	72	-	-
Ion implanter	-	-	-	7	20	26	-	-
CMP	-	-	-	13	39	51	-	-
Cleaning tool	-	-	-	28	88	115	-	-
5nm Equipment demand (# units)								
Furnaces	-	-	-	-	-	38	137	75
Etcher	-	-	-	-	-	60	220	120
Photoresist coater	-	-	-	-	-	5	17	9
Lithography	-	-	-	-	-	7	25	14
Photoresist remover	-	-	-	-	-	8	27	15
CVD	-	-	-	-	-	28	101	55
PVD	-	-	-	-	-	23	83	45
Ion implanter	-	-	-	-	-	9	30	17
CMP	-	-	-	-	-	16	58	32
Cleaning tool	-	-	-	-	-	36	132	72
3nm Equipment demand (# units)								
Furnaces	-	-	-	-	-	-	-	41
Etcher	-	-	-	-	-	-	-	69
Photoresist coater	-	-	-	-	-	-	-	5
Lithography	-	-	-	-	-	-	-	8
Photoresist remover	-	-	-	-	-	-	-	8
CVD	-	-	-	-	-	-	-	31
PVD	-	-	-	-	-	-	-	25
Ion implanter	-	-	-	-	-	-	-	9
CMP	-	-	-	-	-	-	-	18
Cleaning tool	-	-	-	-	-	-	-	40
Total 12" advanced nodes								
Furnaces	13	92	158	125	91	158	137	116
Etcher	18	131	227	180	136	239	220	189
Photoresist coater	2	11	19	16	11	20	17	14
Lithography	3	17	29	24	17	29	25	22
Photoresist remover	3	18	31	25	18	31	27	23
CVD	10	68	116	93	67	116	101	86
PVD	8	55	95	76	55	95	83	70
Ion implanter	3	20	35	28	20	35	30	26
CMP	6	39	67	54	39	67	58	50
Cleaning tool	12	88	152	120	88	151	132	112

Source: Goldman Sachs Global Investment Research, Gao Hua Securities Research

The exhibit below shows our forecasts for China memory SPE equipment demand by fab.

Exhibit 249: China memory SPE equipment demand

3D NAND	2019	2020	2021	2022	2023	2024	2025	2026
Capacity addition (k wpm)								
YMTC	15	30	50	50	50	50	50	-
Unigroup (Nanjing)	-	-	-	5	15	40	90	90
Unigroup (Chengdu)	-	-	-	10	30	60	100	100
Total:	15	30	50	65	95	150	240	190
Equipment demand (# units)								
Furnaces	60	120	200	260	380	600	960	760
Etcher	105	210	350	455	665	1,050	1,680	1,330
Photoresist coater	12	24	40	52	76	120	192	152
Lithography	12	24	40	52	76	120	192	152
Photoresist remover	12	24	40	52	76	120	192	152
CVD	165	330	550	715	1,045	1,650	2,640	2,090
PVD	15	30	50	65	95	150	240	190
Ion implanter	15	30	50	65	95	150	240	190
CMP	27	53	88	114	167	263	420	333
Cleaning tool	60	120	200	260	380	600	960	760

DRAM	2019	2020	2021	2022	2023	2024	2025	2026
Capacity addition (k wpm)								
CXMT	20	20	20	30	40	60	80	90
Unigroup (Chongqing)	-	-	-	10	20	20	50	-
Total	20	20	20	40	60	80	130	90
Equipment demand (# units)								
Furnaces	80	80	80	160	240	320	520	360
Etcher	140	140	140	280	420	560	910	630
Photoresist coater	16	16	16	32	48	64	104	72
Lithography	16	16	16	32	48	64	104	72
Photoresist remover	16	16	16	32	48	64	104	72
CVD	220	220	220	440	660	880	1,430	990
PVD	20	20	20	40	60	80	130	90
Ion implanter	20	20	20	40	60	80	130	90
CMP	35	35	35	70	105	140	228	158
Cleaning tool	80	80	80	160	240	320	520	360

Total memory equipment (#units)								
Furnaces	140	200	280	420	620	920	1,480	1,120
Etcher	245	350	490	735	1,085	1,610	2,590	1,960
Photoresist coater	28	40	56	84	124	184	296	224
Lithography	28	40	56	84	124	184	296	224
Photoresist remover	28	40	56	84	124	184	296	224
CVD	385	550	770	1,155	1,705	2,530	4,070	3,080
PVD	35	50	70	105	155	230	370	280
Ion implanter	35	50	70	105	155	230	370	280
CMP	62	88	123	184	272	403	648	491
Cleaning tool	140	200	280	420	620	920	1,480	1,120
Total	1,126	1,608	2,251	3,376	4,984	7,395	11,896	9,003

Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Valuation: China SPE peers have higher valuations and higher growth than global peers

The average 2022E P/E of China SPE names is 39x, above the global peer average of 32x. We believe this higher valuation is supported by a higher growth outlook for China SPE names (44% 2022E EPS YoY on average vs 38% of global peers).

Exhibit 250: SPE comp table

SPE	Local	Ticker	Rating	Analyst	Pricing currency	PX (LCY)	TP (LCY)	Upside (%)	Market cap (US\$m)	EV (US\$m)	LTM PX move (%)	LTM ADTV (USDmn)	EPS growth			Trading P/E			Trading P/B			ROE			Div Yield		
													2020E	2021E	2022E	2020E	2021E	2022E	2020E	2021E	2022E	2020E	2021E	2022E	2020E	2021E	2022E
													Local														
AMEC	688012.SS	Buy	Allen Chang, Jin Guo	CNY	269.2	382	42%	20,570	20,241	828	99	59%	97%	78%	458.8	233.1	130.9	35.4	30.7	24.9	8%	14%	21%	0.0%	0.0%	0.0%	
AccuTest	688200.SS	Buy	Jin Guo	CNY	317.1	486	48%	2,772	2,740	196	52	27%	52%	79%	109.7	72.3	40.3	9.5	8.8	7.7	13%	13%	20%	0.3%	0.5%	0.9%	
ACM Research	ACMR	Buy*	Jin Guo	USD	41.6	150	84%	1,465	1,446	365	15	8%	117%	57%	66.5	30.6	19.5	12.3	8.8	6.1	21%	33%	37%	0.0%	0.0%	0.0%	
Naura	002371.SZ	Buy	Jin Guo	CNY	221.3	307	39%	15,654	15,567	223	179	52%	108%	96%	216.5	104.2	53.1	17.4	15.1	12.0	8%	16%	25%	0.0%	0.1%	0.2%	
Kingsemi	688037.SS	NC	NA	CNY	144.2	NA	NA	1,731	1,652	435	69	25%	69%	53%	250.8	148.7	97.5	15.3	14.3	13.0	6%	10%	13%	NA	NA	NA	
Changchuan	300604.SZ	NC	NA	CNY	34.8	NA	NA	1,564	1,559	76	33	775%	16%	33%	99.5	86.0	64.5	10.2	9.2	8.2	7%	11%	13%	NA	NA	NA	
PNC	603690.SS	NC	NA	CNY	60.5	NA	NA	2,230	2,351	193	38	62%	45%	23%	82.2	56.5	46.0	10.5	9.1	6.6	15%	18%	15%	0.1%	0.1%	0.1%	
Jingcheng	300316.SZ	NC	NA	CNY	28.3	NA	NA	5,193	5,256	143	73	46%	25%	21%	38.7	31.0	25.5	6.8	5.8	4.9	17%	18%	18%	0.4%	0.7%	0.4%	
Wanye	600641.SS	NC	NA	CNY	25.6	NA	NA	2,946	2,350	134	43	5%	-8%	-26%	32.5	35.3	47.4	2.9	2.8	2.7	9%	8%	6%	1.0%	1.0%	NA	
Mattson	Private	NC	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
Hwatsing	Private	NC	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
Piotech	Private	NC	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
Raintree	Private	NC	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
Global																											
Applied Material	AMAT	Buy	Toshiya Hari	USD	62.6	69	10%	57,362	58,717	42	453	25%	-9%	46%	16.4	18.1	12.4	5.7	5.4	4.7	37%	31%	40%	1.4%	1.5%	1.6%	
ASML	ASML.AS	Buy	Alexander Duval	EUR	346.7	366	5%	167,723	167,448	91	328	10%	55%	20%	51.9	33.4	27.8	11.2	10.1	8.8	22%	32%	34%	0.7%	0.7%	0.9%	
Entegris	ENTG	Buy	Toshiya Hari	USD	59.1	65	10%	7,949	8,746	65	47	4%	2%	45%	29.4	28.9	20.0	6.2	6.2	5.9	17%	16%	25%	0.5%	0.6%	0.7%	
Lam Research	LRCX	Buy	Toshiya Hari	USD	340.0	330	-3%	49,352	49,220	88	506	3%	-6%	49%	22.6	24.1	16.2	9.9	9.2	8.2	46%	41%	54%	1.4%	1.4%	1.5%	
Keyight	KEYS	Neutral	Toshiya Hari	USD	97.6	93	-5%	18,262	18,371	10	167	-16%	16%	23%	27.1	23.3	19.0	5.6	5.1	4.7	22%	23%	26%	0.0%	0.0%	0.0%	
KLAC	KLAC	Neutral	Toshiya Hari	USD	202.3	193	-5%	31,360	33,283	73	243	22%	-2%	9%	19.5	20.0	18.3	13.4	12.8	13.0	65%	65%	69%	1.8%	2.0%	2.2%	
Teradyne	TER	Neutral	Toshiya Hari	USD	87.4	84	-4%	14,485	14,044	91	147	31%	0%	13%	23.6	23.6	21.0	7.4	6.7	6.4	37%	31%	32%	0.4%	0.5%	0.6%	
Tokyo Electron	8035.T	CS	NA	JPY	29,610.0	NA	NA	43,541	40,408	86	292	20%	19%	NA	22.5	18.9	NA	5.0	4.5	NA	23%	25%	NA	2.2%	2.6%	4.0%	
Advantest	6857.T	CS	NA	JPY	6,960.0	NA	NA	12,992	11,903	133	157	4%	26%	NA	27.3	21.6	NA	5.3	4.6	NA	20%	23%	NA	1.1%	1.4%	3.0%	
Screen Holdings	7735.T	CS	NA	JPY	5,270.0	NA	NA	2,504	2,762	9	53	103%	37%	NA	16.2	11.9	NA	1.3	1.2	NA	8%	10%	NA	1.5%	2.0%	3.0%	
Ulvac	6728.T	CS	NA	JPY	3,245.0	NA	NA	1,498	1,362	(7)	17	1%	38%	NA	16.4	11.8	NA	1.0	0.9	NA	6%	8%	NA	2.7%	3.1%	2.0%	
Nanometrics	ONTO	NC	NA	USD	35.4	NA	NA	1,720	1,452	6	10	NM	45%	33%	22.9	15.8	11.9	2.9	NA	NA	7%	10%	NA	NA	NA	NA	
Cohu	COHU	NC	NA	USD	16.8	NA	NA	702	920	20	5	NM	625%	49%	105.2	14.5	9.8	1.5	1.5	1.4	2%	12%	17%	0.4%	NA	NA	
Average											151	63%	62%	30%	70.8	48.3	37.8	8.9	8.2	6.2	19%	21%	27%	0.6%	1.0%	1.2%	
Median											71	24%	32%	39%	30.9	20.5	23.2	7.1	6.7	6.6	16%	17%	25%	0.5%	0.7%	0.9%	

(Prices as of Jul 10, 2020. NC = Not Covered, CS=Coverage suspended). * denotes on Conviction List

Source: Bloomberg, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Silicon Wafers: Breakthroughs in local 12" wafer; tapping a market set to grow by 9x



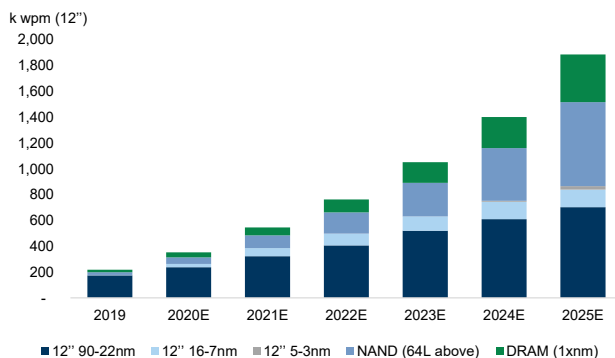
Silicon wafer is a fundamental raw material in semiconductor manufacturing, yet it is also one of the areas in China's semiconductor supply chain that has the lowest level of local production, especially in 12" silicon wafers which still largely rely on imports. However, breakthroughs have been made by local producers such as NSIG, the first wafer supplier in China achieved mass production of 12" wafers (in 2018).

China 12" wafer demand to reach 1.9mn wpm by 2025E, c.9x vs 2020E

The bottom line: We expect China's 12" wafer demand to grow by c.9x during 2020-25E, primarily driven by China's investments in building new fabs and expanding capacity across foundry, memory and IDMs. With these new projects, China's 12" wafer fab capacity could reach 1.9mn wpm by 2025E, or 8.7x that in 2019. The strong demand growth, coupled with the trend to localize wafer production, brings significant growth opportunities for local suppliers. **NSIG, as the leading local mass producer of 12" wafers, is well positioned to tap into the structural uptrend; we initiate on the company with a Buy rating and a 12-month TP of Rmb60.**

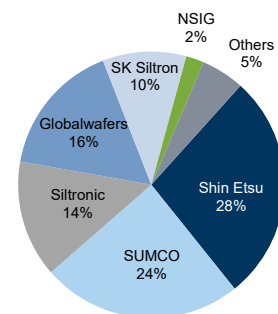
Exhibit 251: China's 12" wafer fab capacity to grow by c.9x during 2020-25E to 1.9mn wpm in 2025E

China's local 12" fab capacity by technologies



Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 252: Silicon wafer market is dominated by global majors



Data as of 2019

Source: Company data

What is silicon wafer? The basics.

Silicon wafers are substrates for semiconductor devices, each semiconductor process technology uses different wafers with unique characteristics. A wafer manufacturer with

a broad customer base may produce up to several hundred different types of wafers. The production process of a semiconductor silicon wafer is illustrated in the below exhibit. Companies generally use in-house monocrystalline pulling equipment in the ingot manufacturing process. The average production lead time is 2 months. Purchasing contracts are usually 3-6 months, but could be extended to 12 months or longer, depending on the supply-demand situation and the customers involved.

Exhibit 253: Wafer sizes and their end applications

Wafer size	Process node	Application
12"	7-10nm	High-end smartphone AP, CPU for PC / servers, GPU
	14 / 16nm	Smartphone AP, CPU, GPU
	20-22nm	DRAM, NAND, low-end smartphone AP, TV / set-top-box IC
	28-32nm	Wi-Fi Bluetooth IC, audio processing IC, TV / set-top-box IC
8"	45-65nm	CIS, RF IC, GPS / NFC IC, NOR flash
	90nm-0.13um	IoT IC, automobile MCU, RF IC, base station DSP
	0.13-0.15um	Fingerprint IC, PMIC, LED driver IC, sensors
2"-6"	0.18-0.25um	CIS, eNVM
	0.35-0.5um	MOSFET, IGBT
	0.5-1.2um	MOSFET, IGBT, MEMS, diode, triode

Source: Data compiled by Goldman Sachs Global Investment Research

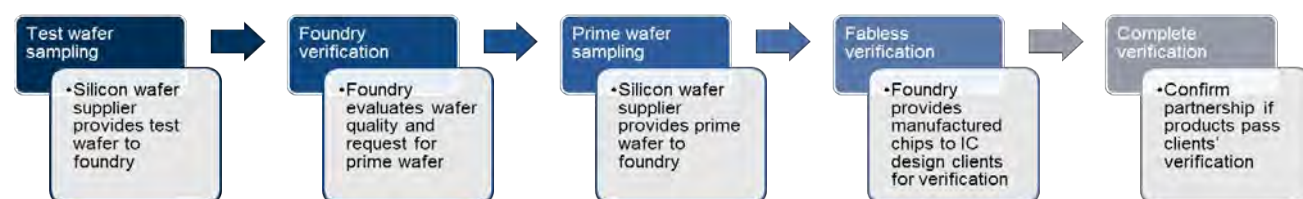
The key barriers in silicon wafer production

The quality of silicon wafers can directly impact the yield rate of chip manufacturing. Key challenges in silicon wafer production are purity (requires 99.999999999% at least), crystalline defects and electronic properties. The goal is to produce a high purity wafer with strictly controlled crystalline defect density and desired electronic properties. The calibration of the equipment, temperature, ingot pulling speed, and seed spin velocity could all affect the wafer quality and yield rate.

Secondly, the customers' qualification process and customer stickiness are additional entry barriers. New suppliers and new products will need to obtain customers' qualification before shipments can begin. The process can take 12-18 months, and for some critical applications such as medical and automotive, the qualification process can take as long as 5 years. Because of the lengthy process, customers typically do not switch suppliers frequently.

Exhibit 254: Silicon wafer verification can take 12-18 months

Customer verification steps



Source: NSIG

Exhibit 255: NSIG's 12" product are in the customer qualification process, which can take 1-5 years depending on the end application

End application	Typical qualification period
Typical applications (polished wafer and epitaxial wafer)	9-18 months
SOI wafers	1-2 years
Automobile electronics; Healthcare/medical; Aerospace/Aviation	3-5 years

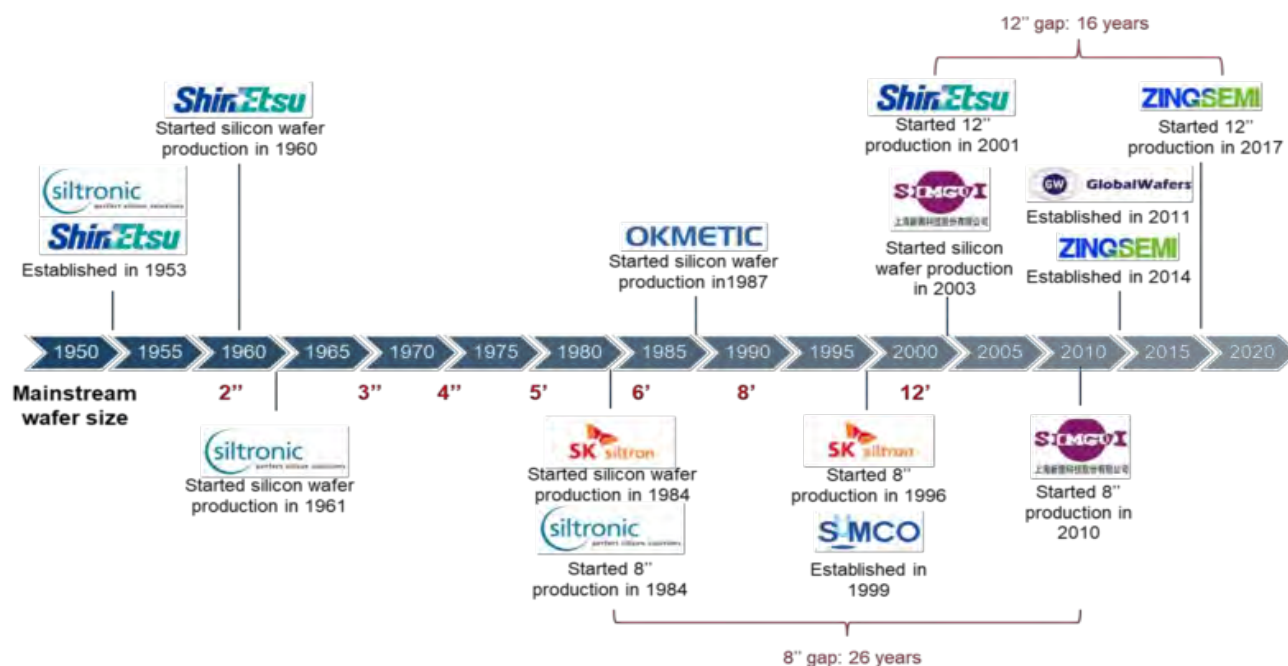
Source: Company data

Exhibit 256: Secured 64 customers for 12" wafers

Customer type	Wafer size	2016	2017	2018	2019
Verification completed	8"	320	364	403	551
	12"	-	20	36	49
Existing customers, new products	8"	60	77	74	92
	12"	-	5	10	11
New customers	8"	13	15	14	12
	12"	-	1	4	4
Total	8"	393	456	491	655
	12"	-	26	50	64

Source: NSIG

China's wafer producers started late vs. global majors in wafer production. China's local 8" wafer production started 26 years later than global leader and 16 years later in 12" wafer. However, breakthroughs have been made over the past few years and a number of local wafer producers have emerged with NSIG leading the pack (Zing semi in below exhibit is a subsidiary of NSIG).

Exhibit 257: Silicon wafer leaders entered the market in the 1950s, Chinese suppliers entered in the 2000s; Large gap but catching up


Source: Company data, Compiled by Goldman Sachs Global Investment Research

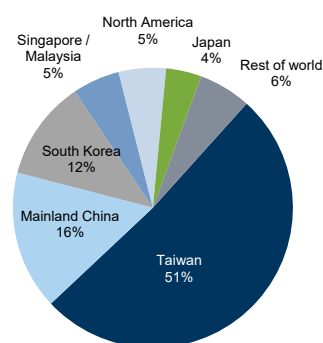
Current standing of China's silicon wafer space: Rising demand from local fab expansion; local supply capability catching up
12" wafer fab capacity poised to grow by c.9x by 2025E

China's wafer fab capacity makes up c.16% of the global total, or c.12mn out of 78mn wafers per year (per Gartner). As China continues to invest in new fabs (both 8" and 12"), we expect China's wafer fab capacity to quintuple by 2025E (5.4mn wpm, 8" equivalent) vs. 2019 (1mn wpm, 8" equivalent). The strong growth will mainly be driven by 12" capacity expansion in particular. 15 projects in 12" fab construction or capacity expansion are planned for the next 5-7 years, with a total investment of US\$156bn.

These projects could add new capacity to 1.9mn wpm (12") by 2025E vs. 218k wpm in 2019, representing a growth of 8.7x from 2019 to 2025E. The new capacity additions will mainly come from memory and advanced nodes foundry/logic, and as a result of strong expansion in 12", we expect 12" wafer capacity will make up c.70% of all sizes by 2025E.

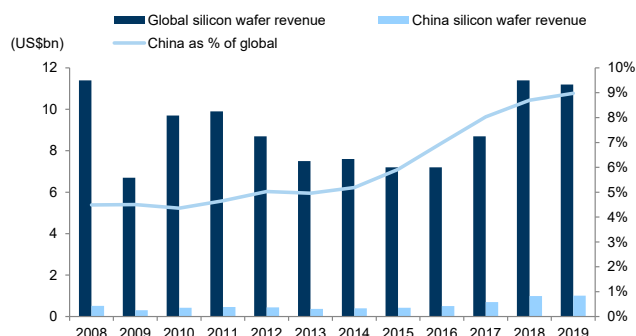
Exhibit 258: China (mainland) contributes 16% of global foundry capacity

Global foundry capacity by region (2019)



Source: Gartner

Exhibit 259: But silicon wafer revenue in China made up c.9% of global total in 2019 (vs. c.4% a decade ago)



Source: SEMI, company data, Data compiled by Goldman Sachs Global Investment Research

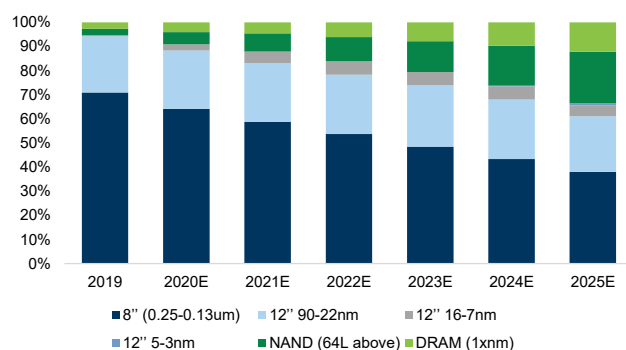
Exhibit 260: 15 projects on 12" fab have been planned, driving 12" wafer fab capacity to grow by almost 8x from 2019-2025E

Company / project name	Ticker	Type	Capex (USD)	Products	Construction start	Equipment move in
SMIC	981.HK	Foundry	10.5bn	14nm and above advanced nodes	-	Aug-2019
Hua Hong (Wuxi)	1347.HK	Foundry	10bn (Phase 1: 2.5bn)	90nm, 65/55nm	Mar-2018	May-2019
Huali (Fab 6)	Private	Foundry	5.5bn	28nm/14nm	Dec-2016	May-2018
GTA Semiconductors	Private	Foundry	4bn (Phase 2)	Power discretes, PMIC, CIS	Aug-2018	-
Wuhan HSMC*	Private	Foundry	20bn	14nm/7nm logic	Mar-2019	Nov-2019
Hefei Nexchip	Private	Foundry	1.8bn	Touch/Display driver IC	Oct-2015	Apr-2017
Silan Microelectronics (Xiamen)	600460.SS	IDM	2.3bn (Phase 1: 1bn)	MEMS, power discretes	Oct-2018	2Q20
Jiangsu AMS	Private	IDM	1.8bn	EEPROM	Aug-2017	Mar-2018
CR Microelectronics	688396.SS	IDM	1.4bn	Power discretes, PMIC	2019	2021
Cansemi	Private	IDM	1bn	MCU, PMIC, analog, power discretes	Mar-2018	Mar-2019
Yangtze Memory (YMTC)	Private	Memory	24bn	3D NAND Flash	Dec-2016	Apr-2018
Changxin Memory (CXMT)	Private	Memory	22bn	DRAM	Jul-2017	1Q18
Unigroup (Nanjing)	Private	Memory	30bn (Phase 1: 10bn)	3D NAND Flash/DRAM	Sep-2018	-
Unigroup (Chengdu)	Private	Memory	24bn (Phase 1: 10bn)	3D NAND Flash	Aug-2018	1Q21
Unigroup (Chongqing)	Private	Memory	10bn	DRAM	4Q19	2021

Total: US\$156bn+

HSMC*: Wuhan Hongxin Semiconductor Manufacturing Corp.

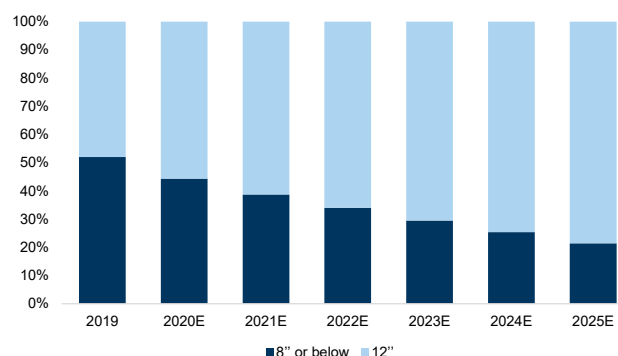
Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 261: China's wafer fab capacity mix by technology, increasing share from memory

Source: Company data, Goldman Sachs Global Investment Research

Exhibit 262: We expect 12" wafer fab capacity to make up c.80% of total output in 2025E in China

China's wafer fab capacity by wafer size



Source: Goldman Sachs Global Investment Research

Local wafer production catching up

Most of the local wafer producers have achieved the ability to mass produce 8" wafers (or smaller sizes). Efforts have also been made to expand production into 12" wafers. Given 12" production is much more challenging than the smaller size, only 4 key players are trying to produce 12" wafers, with NSIG (or Zing Semi) leading the progress so far. NSIG entered mass production of 12" wafers in 2018, and had obtained 64 customer qualifications as of end-2019, including SMIC, Global Foundries, YMTC, CR Micro, etc.

Exhibit 263: Local wafer production: progress has been made toward 12"; most producers can make 8" (or below)

Company name	Ticker	Year established	Wafer size	Main products	Applications
Anhui Yixin	Private	2016	12"	Polished wafers, annealed wafers, epitaxial wafers, test wafers, silicon ingot	Integrated circuits
Zing Semi*	Private	2014	12"	Polished wafers, epitaxial wafers, test wafers	Power IC (diodes, IGBT), digital IC, analog IC
Nanjing Guosheng	Private	2003	4", 5", 6", 8"	Epitaxial wafers	Power IC (MOSFET, Schottky diode, IGBT, FRD)
Li-On Micro	Private	2002	6", 8", 12"	Polished wafers, epitaxial wafers	Power IC (mainly Schottky diode)
Shanghai Simgui Tech*	Private	2001	4", 5", 6", 8"	SOI wafers, SOI epitaxial wafers, SIMOX wafers, bonding wafers	CMOS, analog IC, MCU, RF IC, MEMS etc.
GRINM Semi Materials	Private	2001	4", 5", 6", 8", 12"	Polished wafers, etching wafers, lapped wafers	IC, energy-saving lamps
Poshing	Private	2000	4", 5", 6", 8"	Epitaxial wafers, SiC epitaxial wafers	CMOS, power IC, discrete components
Zhonghuan Semi	002129.SZ	1989	8"	Polished wafers, etching wafers, silicon ingot	Power IC, solar cells, solar modules
Advanced Silicon Tech	Private	2008	8", 12"	Polished wafers, annealed wafers, epitaxial wafers, test wafers	Integrated circuits

*Zing Semi and Simgui Tech are subsidiaries of National Silicon Industry Group

Source: Company data, compiled by Goldman Sachs Global Investment Research

NSIG's 12" research and development is also supported by the China government's VLSI (Very Large Scale Integrated Circuits) research program (also known as "02 Project"). The company's 12" product can cover up to 28nm process node and is developing products for 20-14nm as part of the "02 Projects". Compared with global majors, local suppliers' product offerings are behind in terms of comprehensiveness and technology depth. However, most of China's foundry capacity is on matured nodes (90-28nm), and advanced nodes (14nm) have only started to ramp up. Matured nodes (8" and 12") and 3D NAND memory make up 95%/90% of China's total wafer fab capacity in 2019/20E, which means NSIG's products can already cover 90%+ of the local demand. NSIG, as a newcomer in the wafer production space, only makes up a small fraction of China's demand currently. With its product expansion and China local fabs' intention to allocate more purchase orders to local suppliers to mitigate supply risks amid trade tensions, NSIG stands to be a key beneficiary and is well positioned to win market share from local customers.

Exhibit 264: NSIG silicon wafer products vs peers: major gap in anneal wafer and SOI 12” wafer

NSIG’s 12” wafer can be used up to 28nm; 20-14nm wafers are in the development phase; global majors are at 5nm

	Polished Wafer					Epitaxy Wafer					Annealed Wafer			SOI wafer				
	4"	5"	6"	8"	12"	4"	5"	6"	8"	12"	6"	8"	12"	4"	5"	6"	8"	12"
Shin Etsu	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			✓	✓	✓
SUMCO	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			✓	✓	
Siltronic				✓	✓		✓	✓	✓	✓			✓					
Globalwafers	✓	✓	✓	✓	✓		✓	✓	✓	✓		✓	✓	✓	✓	✓		
SK Siltron		✓	✓	✓	✓		✓	✓	✓	✓			✓					
NSIG			✓	✓	✓				✓	✓				✓	✓	✓	✓	
Li-On Micro	✓	✓	✓	✓	✓	✓	✓	✓	✓									
GRINM Semi		✓	✓	✓	✓													
AST			✓	✓	✓			✓	✓	✓	✓	✓	✓					

Source: Company data

Exhibit 265: NSIG vs. peers: higher revenue growth, lower margins as 12" production still in ramp-up

2020E	NSIG	Zhonghuan Semi	China avg	Global Wafers	Soitec	Siltronic	Shin Estu	SUMCO	Peers avg	China vs global
1) Scale										
Revenue (US\$m)	243	3,328 (semi rev: 161)	202	1,913	671	1,322	14,032 (silicon wafer rev: 2,105)	2,748	1,756	-88%
Net income (US\$m)	(5)	220	107	429	117	160	2,914	267	602	-82%
Global market share	2%	<1%		16%	6%	14%	28%	24%		
2) Growth (2020-22E CAGR)										
Revenue	41%	21%	31%	10%	17%	7%	3%	6%	13%	14 ppt
OP income	-2%	30%	30%	13%	22%	16%	4%	20%	19%	10 ppt
Net income	-2%	26%	26%	14%	24%	24%	6%	20%	20%	6 ppt
3) Profitability										
GM	17%	19%	18%	37%	33%	36%	36%	26%	35%	-16 ppt
OPM	-2%	12%	5%	29%	20%	26%	26%	17%	24%	-19 ppt
NM	-2%	5%	2%	22%	18%	18%	20%	11%	19%	-17 ppt
4) R&D										
R&D to revenue	6%	5%	6%	3%	5%	6%	-	2%	6%	0 ppt
5) Return										
ROE	-1%	7%	3%	28%	23%	20%	12%	10%	18%	-15 ppt
CROCI	9%	30%	19%	17%	25%	3%	12%	7%	13%	6 ppt

Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

China wafer producers

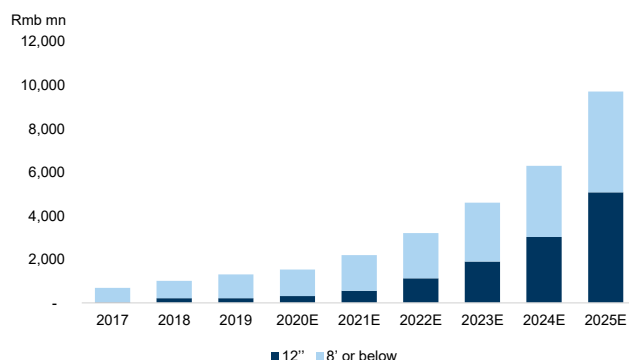
NSIG stands to be a key beneficiary of rising local demand and supply chain localization; Initiate at Buy

Our constructive view on NSIG is based on 1) strong wafer fab capacity expansion, driving up demand from local customers; and 2) increasing order allocation from local customers to mitigate their supply chain risks amid trade tensions. We expect China's local wafer fab capacity to grow by c.8x during 2020-25E to 1.9mn wpm by 2025E driven by new memory and foundry projects and existing fabs' capacity expansion (e.g., SMIC, Hua Hong, etc.). NSIG's 12" wafer has received qualifications from 64 customers including YMTC, SMIC, Hua Hong, Huali, and Global Foundries, etc. With a strong demand growth locally and expanding customer base, we expect NSIG's wafer revenues to quintuple over 2020-25E.

From a market share perspective, NSIG's 12" wafer shipment is only a fraction of China local fabs' demand. For instance, SMIC's annual wafer purchase topped Rmb2bn in 2019 and NSIG's 12" wafer sales were Rmb215mn (for context, c.11% of SMIC's purchases). NSIG's sales to China customers (including all wafer sizes) was Rmb439mn in 2019, or 22% of SMIC's wafer demand. SMIC is only one of several local customers, and NSIG's shipments represent an even lower portion when compared to the total wafer demand from all local customers. This suggests NSIG, as the leading local wafer producer, has significant potential to win order allocations from local customers as they seek local back-ups to reduce risks of losing critical raw materials.

We expect NSIG's revenue to grow 15%/38%/43% yoy in 2020/21/22E and at a 42% CAGR in 2020-25E driven by growth in 12" wafer shipments. 12" wafer revenue made up c.21%/14% of total sales in 2018/19, and we expect it to contribute 19%/51% in 2020/25E supported by an increase in China local fabs' 12" wafer demand and NSIG's customer expansion locally. We expect 8" (or below) wafer revenue to grow at a 30% CAGR during 2020-25E driven by SOI sales in RF applications and expansion in local 8" customers. However, we expect NSIG to remain in net loss (Rmb36mn) for 2020E (vs. loss of Rmb90mn in 2019) and turn profitable in 2021E. **We expect net profit to grow by 319%/88% yoy in 2022/23E and at a 138% CAGR in 2021-25E, from a low base.** The earnings growth estimates are mainly driven by 12" wafer revenue expansion and margin improvements.

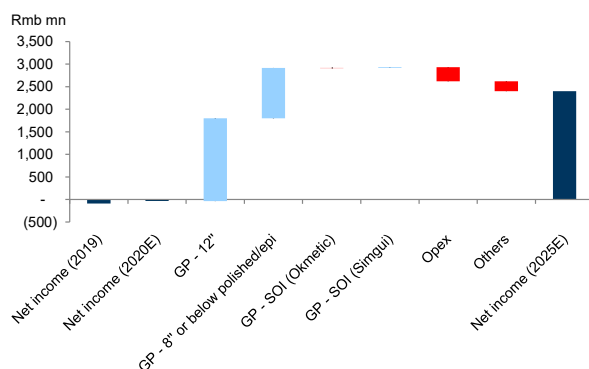
Exhibit 266: NSIG: We expect revenue to grow by 42% CAGR during 2020-25E driven by 12" wafer ramp-up and robust growth in 8" products



Source: Company data, Goldman Sachs Global Investment Research

Exhibit 267: NSIG: 12" to be the main contributor to profit during 2020-25E

Net profit waterfall chart 2020-25E



Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Other key wafer producers include:

Li-On Electronics (Private, Not Covered)

Li-On Electronics develops and manufactures 6"/8" silicon wafers, Schottky diodes and MOSFET. Its silicon wafers are produced by subsidiary JRH QL Electronics. Silicon wafers revenue accounted for 66% of total revenue as of 2018. Li-On Electronics' major silicon wafer customers in 2018 include CR Microelectronics (20%), GTA Semiconductors (7%), Silan (4%), Episil (3%) and Shenzhen SI Semi (3%).

Capacity plan: According to Li-On, it plans to build a new 8" fab to expand 8" silicon wafer capacity to 100k wpm, with a total investment of Rmb704mn over two years. Its subsidiary Zhejiang JRH QL Electronics is constructing 12" wafer production lines with total planned capacity of 150k wpm and a total investment of Rmb3.5bn. Phase-1 of the 12" project targets to achieve capacity of 50k wpm, and phase-2 will expand by another 100k wpm. Construction of 12" production lines has started, with equipment purchase started in 1H19.

GRINM Semiconductor Materials (Private, Not Covered)

GRINM Semiconductor Materials is a subsidiary of Beijing General Research Institute of Nonferrous Metals (GRINM) that supplies silicon wafers and silicon materials. The main products of GRINM Semi include 5"-12" polished wafers for IC.

Current capacity: GRINM Semi has production lines ranging from 4" to 12". By product line, 4"/5" capacity is at 200k wpm; 6"/8" is at 100k wpm; and 12" polished wafer is at 10k wpm and 12" epitaxial wafer is at 5k wpm, according to the company.

12" capacity expansion: GRINM announced in Dec 2019 ([link](#)) that it plans to build a new facility to focus on 12" silicon wafers, with planned capacity of 300k wpm and an investment budget of Rmb6.2bn (US\$900mn).

Advanced Silicon Technology (Private, Not Covered)

Advanced Silicon Technology (AST) manufactures 8" and 12" silicon wafers, with production sites in Chongqing, Chengdu and Shanghai (under construction).

Capacity plan: The company's main products include 8"/12" polished wafers, epitaxial wafers, annealed wafers, test wafers and 4-12" silicon ingot. The Chongqing production site had capacity of 150k 8" silicon wpm as of September 2019. The Shanghai production facility will focus on 12" wafers, with a designed capacity of 300k wpm 12" polished wafers/ epitaxial wafers and 10k wpm for 18" polished wafers ([link](#)).

Exhibit 268: Silicon wafer peers comp table

Ticker	Rating	Analyst	Pricing currency	PX (LCY)	TP (LCY)	Upside (%)	Market cap (US\$m)	EV (US\$m)	LTM PX move (%)	LTM ADTV (US\$mn)	EPS growth			Trading P/E			Trading P/B			ROE			Div Yield				
											2020E	2021E	2022E	2020E	2021E	2022E	2020E	2021E	2022E	2020E	2021E	2022E	2020E	2021E	2022E		
Silicon wafer																											
Local																											
NSIG	688126.SS	Buy	Jin Guo	CNY	48.1	60	25%	17,059	17,237	1,138	431	NM	NM	319%	NM	NM	380.7	16.0	15.9	15.2	-1%	1%	4%	0.0%	0.0%	0.0%	
Zhonghuan Semi	002129.SZ	NC	NC	CNY	25.8	NA	NA	10,282	13,449	181	212	64%	33%	23%	48.5	36.4	29.6	4.5	4.0	3.6	9%	11%	12%	0.2%	0.2%	0.3%	
Yixin	Private	NC	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA		
Guosheng	Private	NC	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA		
Li-On Micro	Private	NC	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA		
Grimm	Private	NC	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA		
Poshing	Private	NC	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA		
Advanced Silicon Tech	Private	NC	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA		
Global																											
Global Wafer	6488.TWO	Buy	Thurston Lee	TWD	423.0	480	13%	6,259	5,588	36	66	-6%	16%	12%	14.3	12.3	11.1	3.9	3.6	3.3	28%	30%	31%	5.6%	6.4%	7.2%	
Shin Etsu	4063.T	Buy*	Shuhei Nakamura	JPY	12,410.0	14,000	13%	48,366	39,120	31	135	4%	12%	8%	16.3	14.6	13.5	1.9	1.8	1.6	12%	12%	12%	1.9%	2.0%	2.2%	
Wafer Works	6182.TWO	NC	NC	TWD	35.6	NA	NA	615	799	1	10	-31%	6%	NA	21.4	20.1	NA	2.1	2.0	NA	5%	7%	NA	3.7%	2.7%	NA	
Soltec	SCOT.PA	NC	NC	EUR	105.6	NA	NA	3,971	3,129	13	12	12%	-25%	63%	32.8	44.0	27.1	6.5	5.1	4.6	23%	16%	18%	0.0%	0.0%	0.0%	
Siltronic	WAFGn.DE	NC	NC	EUR	91.9	NA	NA	3,116	2,597	57	16	-36%	33%	20%	19.2	14.5	12.1	2.7	2.3	1.9	15%	18%	17%	2.1%	2.8%	3.2%	
SUMCO	3436.T	CS	NA	JPY	1,620.0	NA	NA	4,412	5,570	27	146	15%	26%	NA	13.8	10.9	NA	1.4	1.3	NA	10%	12%	NA	2.3%	2.8%	2.0%	
Average											185	128	3%	14%	74%	23.8	21.8	79.0	4.9	4.5	5.0	13%	13%	16%	2.0%	2.1%	2.1%
Median											33	100	4%	16%	21%	19.2	14.6	20.3	3.3	3.0	3.4	11%	12%	15%	1.1%	1.2%	1.2%

(Prices as of July 10, 2020. NC = Not Covered, CS=Coverage Suspended. NC estimates from Bloomberg consensus). *On Conviction List.

Source: Bloomberg, Goldman Sachs Global Investment Research, Gao Hua Securities Research

CMP Slurry: Intro, Competitive Landscape, TAM and Serviceable Available Market



We expect strong CMP slurry demand growth from new wafer fabs and capacity expansion in China; we expect China's 12" wafer fab capacity to grow c.8x to 1.9mn wafers per month (wpm) by 2025E, and 8" wafer fab capacity to double during the same period, based on the new projects we track. With the strong growth in wafer starts, we forecast CMP slurry demand to grow by c.7x by 2025E vs. 2019;

Bottom line: with the strong demand growth and a clear intention from local wafer fabs to find local substitutes for imports (key CMP slurry suppliers globally are from US and Japan), we believe local CMP slurry suppliers with strong technology and robust product quality are well positioned to capture the multi-year growth uptrend. There were 23mn liters of CMP used in 2019, and we expect this to grow to 234mn liters in 2026E; representing 39% 2019-26E CAGR. Anji, as the leading local suppliers with proven products with TSMC, SMIC, and YMTC, will be a primary beneficiary. We initiate on Anji with a Buy rating and a 12-month target price of Rmb647, suggesting 42% upside.

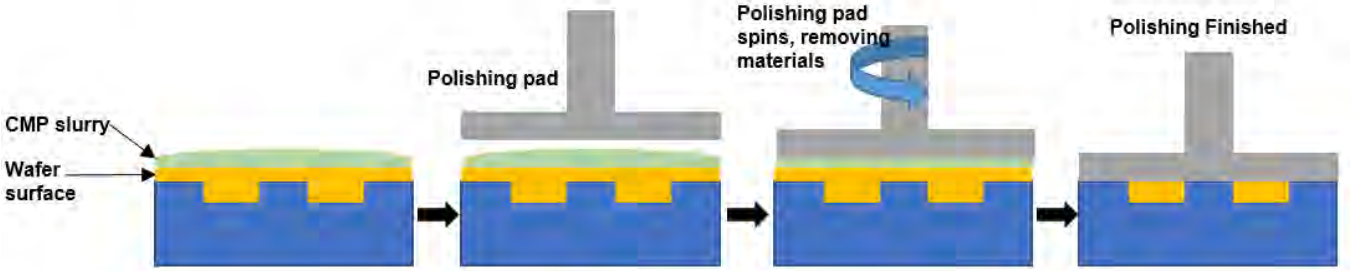
CMP slurry introduction: Helping to polish the surface of a wafer

What does it do? CMP slurries are water-based solution and a type of chemical consumable used in the wafer fabrication process (CMP process). The demand for CMP slurry is closely correlated with the number of CMP steps per wafer and the number of wafer starts fabricated. This is the key reason that CMP slurry demand does not fluctuate as much as the SPE sector, chiefly because it is costly for wafer fabs to change production dramatically given high fixed costs, whereas wafer fabs can quickly adjust their capex based on their business outlook.

CMP (chemical mechanical planarization) is a key process to achieve wafer surface planarization in the manufacturing process. Different from the old traditional pure mechanical or pure chemical polishing methods, CMP process is a combination of surface chemistry and mechanical grinding technology to achieve the removal of micro/nano-level materials on the wafer surface to reach the desired height of the wafer surface (nano level). This is to ensure a sound wafer surface uniformity, which is critical for improving wafer fabrication yield rate.

The main working principle of CMP is that under a certain pressure and in the presence of a polishing liquid (i.e. CMP Slurry), the polished wafer moves relative to the polishing pad (Shown in exhibit below). With the help of nano-mechanical grinding and the chemical reactions of various chemical reagents, the polished wafer surface meets the requirements of high planarization, low surface roughness and very few defects. Based on the requirements of different processes and technology nodes, each wafer will undergo several or even dozens of CMP polishing process steps in the production process.

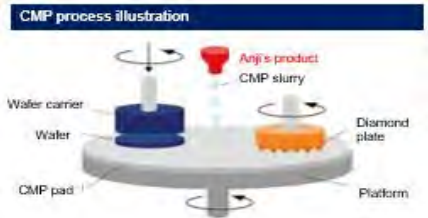
Exhibit 269: CMP process illustration



Source: Goldman Sachs Global Investment Research, Gao Hua Securities Research

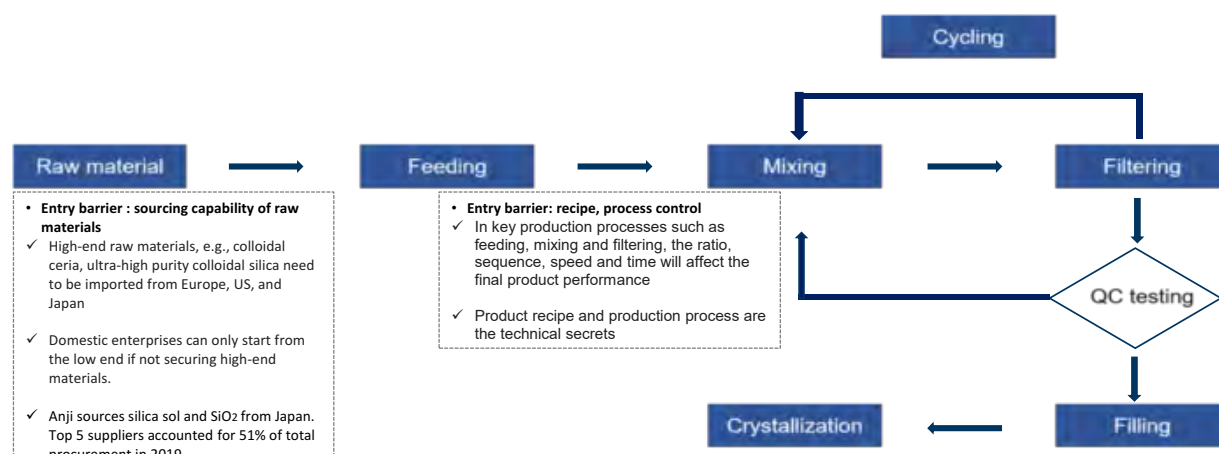
Exhibit 270: CMP process illustration, continued

CMP process goal	CMP process benefit
Overall planarization of the film plane	Compensate for the insufficient line focal depth in the large image field of the stepper in submicron lithography.
Metal step coverage and related reliability	Significantly improve wafer yield in chip testing.
Increase the number of layers for smaller chip sizes	Allow the formed device to have a higher aspect ratio.



Source: Anji, Goldman Sachs Global Investment Research, Gao Hua Securities Research

How CMP slurry is made: CMP slurry’s production process is a formula-type compounding process, which mainly consists of feeding, mixing and filtering at normal temperature and pressures. The process does not involve complicated and severe chemical reactions. Different types of CMP slurries have different formulas and raw materials, but the key processes of the production process are basically the same.

Exhibit 271: Illustration of CMP slurry's production process

Source: Anji, Goldman Sachs Global Investment Research, Gao Hua Securities Research

CMP slurry application by IC type

- **Cu CMP slurry:** For logic IC, copper replaced aluminum and tungsten as interconnected metal materials with better conductivity. Thus Cu CMP slurry is widely used in the manufacturing process of logic chips (130nm and below technology nodes). It has minor applications in memory chips too.
- **W CMP slurry:** W CMP slurry is largely used in a memory chip's manufacturing process, as wire connection of the storage unit is filled with tungsten. W CMP slurry has minor applications in logic chips.
- **Co CMP slurry:** in order to further improve the performance of the chip, for the node of 10nm and below, cobalt will partially replace copper as the wire, requiring Co CMP slurry to polish it.
- **Si CMP slurry:** Si CMP slurry is used in the preliminary processing of silicon wafer.

Exhibit 272: CMP slurry application by IC types

IC type	CMP slurry type	Reason
Logic 130nm and below	Cu CMP (main), W CMP (minor)	For logic IC, copper replaces aluminum and tungsten as interconnected metal materials with better conductivity
Logic 10nm and below	Co CMP	To further improve chip performance, for 10nm and below, cobalt will partially replace copper in wire
Memory	W CMP (main), Cu CMP (minor)	Wire connection of the storage unit is filled with tungsten
Silicon	Si CMP	Preliminary processing of silicon wafer

Source: Anji, Goldman Sachs Global Investment Research, Gao Hua Securities Research

CMP slurry competitive landscape

Anji's product comparison vs. global leaders: less comprehensive offerings but expanding

Anji's current products offerings include a series of CMP (Chemical Mechanical Polishing) slurry and photoresist removers, used in IC manufacturing and advanced packaging. CMP slurry products have achieved large-scale sales at 130-14nm technology node, which is mainly used for 8" and 12" wafers. CMP slurry products at 10-5nm technology node are under development. By materials types, Anji provides Copper slurry, Tungsten slurry, and Silicon/Oxide slurry, etc, with Co (Cobalt) slurry under development. Copper slurry (for logic IC) makes up 71% of its the total CMP slurry sales, while tungsten slurry (for memory) will be the key growth driver. For photoresist removers, CMP is used in semiconductor manufacturing, packaging and LCD/OLED.

Anji's larger global peers have more comprehensive CMP slurry product lineups that cover up to 5nm in logic IC and almost all types of materials ranging from tungsten, copper, cobalt, and other dielectric slurry. Key competitors include **Cabot** (tungsten, dielectrics, metal interconnect), **DuPont** (dielectrics, barrier metals, TSV [Through Silicon Via]), **Hitachi Chemical** (barrier metals, TSV), **Fujimi** (dielectrics, barrier metals), **Fuji Film** (copper, barrier metals), **Versum** (advanced oxide STI barrier, copper strengthening, and tungsten). See our US analyst Toshiya Hari's Cabot initiation ([link](#)).

Exhibit 273: Anji vs. peers: higher revenue growth, gross margin and returns, still at an early stage with smaller scale

2020E	Anji Micro	Sinyang	China avg	Cabot	Dow	JSR	Hitachi	Fujimi	Fujibo	KPX	Global avg	China vs global
1) Scale												
Revenue (US\$m)	65	108 (materials rev: 31)	65	1,060	36,077	4,425	81,471	351	361	573	17,760	-100%
Net income (US\$m)	14	11	13	169	764	230	849	37	27	29	301	-96%
Market cap (US\$m)	3,456	3,377	3,417	3,919	29,911	4,471	30,310	918	336	187	10,007	-66%
Global market share	2%	1%		36%	6%	na	15%	11%	na	na		
2) Growth (2020-22E CAGR)												
Revenue		61% 20%	41%	-1%	7%	-1%	1%	5%	1%	-1%	2%	39 ppt
OP income		113% 0%	113%	-9%	26%	2%	3%	14%	4%	-1%	6%	108 ppt
Net income		94% 34%	64%	-3%	47%	2%		14%	3%	1%	11%	53 ppt
3) Profitability												
GM		51% 32%	42%	43%	21%	30%	27%	44%	33%	13%	30%	12 ppt
OPM		19% -6%	6%	19%	7%	7%	2%	16%	11%	6%	10%	-3 ppt
NM		22% 33%	27%	18%	3%	5%	1%	11%	6%	5%	7%	20 ppt
4) R&D												
R&D to revenue	18%	7%	12%	5%	2%	5%	4%	10%	3%	1%	4%	8 ppt
5) Return												
ROE		11% 15%	13%	13%	7%	6%	3%	8%	7%	8%	7%	6 ppt
CROCI		10% 3%	7%	12%	6%	3%	7%	6%	4%	-12%	4%	3 ppt

Market cap as of July 10, 2020

Source: Company data, Goldman Sachs Global Investment Research, Bloomberg, Gao Hua Securities Research

Exhibit 274: Anji vs. global peers CMP slurry offerings by logic node and memory

Company	130nm	65nm	45nm	28nm	20nm	16/14 nm	10nm	7nm	5nm	3D NAND	3D DRAM
Anji	✓	✓	✓	✓	✓	✓	R&D	R&D	R&D	✓	✓
Cabot	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Hitachi	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Fujimi	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Source: Company data

We estimate China's CMP slurry consumption to grow by 39% CAGR from 23k tons in 2019 to 234k tons in 2026E, with a market size of US\$150mn in 2019 to US\$1.6bn in 2026E

Key assumptions and forecasts:

- 531k wpm 8" capacity in China for 2019; 1,232k wpm 8" capacity in 2026E; representing 13% 2019-26E CAGR
- 218k wpm 12" capacity in 2019; 2,285k wpm 12" capacity in 2026E; representing 40% 2019-26E CAGR
- 23k tons of CMP slurry consumption in 2019; 234k tons CMP slurry usage in 2026E; representing 39% 2019-26E CAGR

Exhibit 275: We expect China's 12" wafer fab capacity to grow from 218k wpm in 2019 to 2.3mn wpm in 2026, driven by memory projects (assuming all projects will progress as planned)

Our forecasts of China's wafer fab capacity by companies and projects

8" capacity (k wpm)	2019	2020E	2021E	2022E	2023E	2024E	2025E	2026E
SMIC	228	251	279	305	339	372	413	455
Hua Hong	178	181	184	189	198	208	219	230
GTA Semiconductors	-	10	40	60	60	60	60	60
SMEC (Shaoxing)*	-	10	22.5	32.5	42.5	42.5	42.5	42.5
NSIC	10	20	30	38	38	38	38	38
SiEn (Qingdao)	-	5	15	30	50	50	50	50
Silan	5	15	20	25	30	36	36	36
Sino Micro	-	10	20	20	20	20	20	20
CR Microelectronics	110	110	125	145	171	205	238	262
Yandong Microelectronics	-	20	40	40	40	40	40	40
Total	531	632	776	884	988	1,072	1,156	1,232

12" capacity (k wpm)	2019	2020E	2021E	2022E	2023E	2024E	2025E	2026E
SMIC (advanced nodes)	3	12	30	39	48	69	81	89
SMIC (matured nodes)	95	110	149	182	224	264	313	364
Hua Hong (Wuxi)	10	20	30	41	53	67	71	81
Huali (Fab 6)	45	55	65	75	75	75	75	75
GTA Semiconductors	-	3	3	3	13	23	38	53
Wuha HSMC*	-	3	13	23	33	43	53	63
Hefei Nexchip	20	40	50	60	80	80	80	80
Silan Microelectronics (Xiamen)	-	5	15	25	35	45	55	65
CR Microelectronics	-	-	5	10	20	30	40	50
Cansemi	5	15	25	40	50	55	60	65
Yangtze Memory (YMTC)	20	50	100	150	200	250	300	300
Changxin Memory (CXMT)	20	40	60	90	130	190	270	360
Unigroup (Nanjing)	-	-	-	5	20	60	150	240
Unigroup (Chengdu)	-	-	-	10	40	100	200	300
Unigroup (Chongqing)	-	-	-	10	30	50	100	100
Total (12")	218	353	545	763	1,051	1,401	1,886	2,285
Convert to 8" equivalent	491	794	1,226	1,717	2,365	3,153	4,245	5,141

CMP steps by tech								
8" (0.25-0.13um)	9	9	9	9	9	9	9	9
12" 90-22nm	14	14	14	14	14	14	14	14
12" 16-7nm	30	30	30	30	30	30	30	30
12" 5-3nm	35	35	35	35	35	35	35	35
NAND (64L above)	32	32	32	32	32	32	32	32
DRAM (1xnm)	17	17	17	17	17	17	17	17

Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 276: CMP slurry consumption in China: we expect it to grow from 23k tons in 2019 to 234k tons in 2026E as China's wafer fab capacity ramps up

Year	2019	2020E	2021E	2022E	2023E	2024E	2025E	2026E
Capacity by technology (k wpm)								
8" (0.25-0.13um)	531	632	776	884	988	1,072	1,156	1,232
12" 90-22nm	175	238	322	406	520	609	702	803
12" 16-7nm	3	25	63	92	111	136	136	136
12" 5-3nm	-	-	-	-	-	6	28	46
NAND (64L above)	20	50	100	165	260	410	650	840
DRAM (1xnm)	20	40	60	100	160	240	370	460
12" to 8" conversion factor	2.25	2.25	2.25	2.25	2.25	2.25	2.25	2.25
In 8" equivalent (k wpm)								
8" (0.25-0.13um)	531	632	776	884	988	1,072	1,156	1,232
12" 90-22nm	394	536	725	914	1,170	1,371	1,581	1,807
12" 16-7nm	7	56	142	207	250	306	306	306
12" 5-3nm	-	-	-	-	-	14	63	104
NAND (64L above)	45	113	225	371	585	923	1,463	1,890
DRAM (1xnm)	45	90	135	225	360	540	833	1,035
Total	1,022	1,426	2,002	2,601	3,353	4,225	5,401	6,374
Utilization	85%	85%	85%	85%	85%	85%	85%	85%
Production	868	1,212	1,701	2,211	2,850	3,591	4,591	5,418
CMP slurry usage per CMP step (8" equivalent)								
Consumption per CMP step	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18
CMP usage (k Liters, or tons)								
8" (0.25-0.13um)	8,774	10,443	12,814	14,607	16,326	17,710	19,104	20,365
12" 90-22nm	10,121	13,764	18,623	23,481	30,081	35,248	40,627	46,444
12" 16-7nm	372	3,098	7,808	11,402	13,756	16,854	16,854	16,854
12" 5-3nm	-	-	-	-	-	868	4,048	6,651
NAND (64L above)	2,644	6,610	13,219	21,812	34,370	54,199	85,925	111,041
DRAM (1xnm)	1,405	2,809	4,214	7,023	11,236	16,854	25,984	32,304
Total	23,315	36,725	56,677	78,324	105,770	141,734	192,544	233,659
By logic/foundry and memory (CMP slurry usage in k Liters, or tons)								
Logic/foundry	19,267	27,306	39,245	49,489	60,163	70,681	80,635	90,314
Memory	4,048	9,419	17,433	28,834	45,606	71,053	111,909	143,346
YoY		58%	54%	38%	35%	34%	36%	21%
Logic/foundry		42%	44%	26%	22%	17%	14%	12%
Memory		133%	85%	65%	58%	56%	58%	28%

Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 277: CMP slurry mix forecasts: rising Tungsten slurry consumption driven by memory ramp-up

Year	2019	2020E	2021E	2022E	2023E	2024E	2025E	2026E
CMP Slurry by materials mix								
Logic/Foundry	8"	12" matured	16-7nm	5-3nm				
Copper	80%	70%	40%	30%				
Tungsten	10%	10%	10%	5%				
Others	10%	20%	50%	65%				
8" (0.25-0.13um) (Tons)								
Copper	7,019	8,355	10,251	11,686	13,061	14,168	15,284	16,292
Tungsten	877	1,044	1,281	1,461	1,633	1,771	1,910	2,036
Others	877	1,044	1,281	1,461	1,633	1,771	1,910	2,036
12" 90-22nm								
Copper	7,085	9,635	13,036	16,436	21,057	24,674	28,439	32,510
Tungsten	1,012	1,376	1,862	2,348	3,008	3,525	4,063	4,644
Others	2,024	2,753	3,725	4,696	6,016	7,050	8,125	9,289
12" 16-7nm								
Copper	149	1,239	3,123	4,561	5,502	6,742	6,742	6,742
Tungsten	37	310	781	1,140	1,376	1,685	1,685	1,685
Others	186	1,549	3,904	5,701	6,878	8,427	8,427	8,427
12" 5-3nm								
Copper	-	-	-	-	-	260	1,215	1,995
Tungsten	-	-	-	-	-	43	202	333
Others	-	-	-	-	-	564	2,631	4,323
Logic/Foundry (tons)								
Copper slurry	14,253	19,229	26,410	32,683	39,620	45,844	51,679	57,539
Tungsten slurry	1,927	2,731	3,924	4,949	6,016	7,025	7,861	8,699
Silicon/Oxide or others	3,088	5,346	8,910	11,858	14,527	17,812	21,095	24,076
Memory								
Tungsten slurry	38%	38%	40%	43%	45%	50%	50%	50%
Copper slurry	10%	10%	10%	10%	10%	10%	10%	10%
Silicon/Oxide or others	52%	52%	50%	47%	45%	40%	40%	40%
Memory (tons)								
Tungsten slurry	1,538	3,579	6,973	12,399	20,523	35,527	55,954	71,673
Copper slurry	405	942	1,743	2,883	4,561	7,105	11,191	14,335
Silicon/Oxide or others	2,105	4,898	8,716	13,552	20,523	28,421	44,764	57,338

Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 278: CMP slurry - ASP assumptions and TAM in China

Year	2019	2020E	2021E	2022E	2023E	2024E	2025E	2026E
ASP (Rmb k per ton)								
Copper	38	37	36	36	35	34	33	33
Tungsten	90	88	86	85	83	81	80	78
Others	35	35	35	35	35	35	35	35
ASP deflation								
Copper	-2%	-2%	-2%	-2%	-2%	-2%	-2%	-2%
Tungsten	-2%	-2%	-2%	-2%	-2%	-2%	-2%	-2%
TAM (Rmb mn)								
Logic/Foundry	820	1,140	1,610	1,997	2,389	2,761	3,096	3,410
Copper slurry	539	712	959	1,163	1,381	1,566	1,730	1,888
Tungsten slurry	173	241	339	419	499	571	627	680
Silicon/Oxide or others	108	187	312	415	508	623	738	843
Memory	227	522	971	1,627	2,581	4,128	6,402	8,077
Tungsten slurry	138	316	603	1,050	1,704	2,890	4,461	5,600
Copper slurry	15	35	63	103	159	243	375	470
Silicon/Oxide or others	74	171	305	474	718	995	1,567	2,007
Total (Rmb mn)	1,048	1,662	2,581	3,624	4,970	6,889	9,498	11,488
Total (US\$ mn)	150	237	369	518	710	984	1,357	1,641

Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 279: Semi materials peers comp table

	Ticker	Rating	Analyst	Pricing currency	PX (LCY)	TP (LCY)	Upside (%)	Market cap (US\$m)	EV (US\$m)	LTM PX move (%)	LTM ADTV (USD\$m)	EPS growth			Trading P/E			Trading P/B			ROE			Div Yield		
												2020E	2021E	2022E	2020E	2021E	2022E	2020E	2021E	2022E	2020E	2021E	2022E	2020E	2021E	2022E
Semi materials																										
Local																										
Anji	688019.SS	Buy	Allen Chang, Jin Guo	CNY	455.0	647	42%	3,452	3,380	1,062	41	31%	101%	86%	240.3	119.5	64.2	25.2	22.0	17.8	11%	20%	31%	0.1%	0.3%	0.5%
Dinglong	300054.SZ	NC	NA	CNY	19.2	NA	NA	2,696	2,547	140	47	593%	38%	42%	69.4	50.3	35.4	4.7	4.4	4.0	7%	8%	10%	0.8%	1.1%	1.4%
Konifong	300666.SZ	NC	NA	CNY	72.8	NA	NA	2,311	2,362	98	59	15%	48%	24%	218.0	149.2	120.7	20.7	18.2	15.7	11%	12%	13%	NA	NA	NA
Sinyang	300236.SZ	NC	NA	CNY	81.3	NA	NA	3,374	3,359	256	122	-63%	22%	45%	300.9	246.2	169.3	14.7	13.9	NA	5%	6%	8%	0.1%	0.1%	NA
Grish	Private	NC	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
Sonyung	Private	NC	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
Xinanna	Private	NC	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
Times Live	Private	NC	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
Global																										
Dow	DOW	Buy	Robert Koort	USD	40.8	48	18%	30,272	47,366	(9)	223	-67%	81%	19%	35.4	19.6	16.4	2.5	2.7	2.9	7%	13%	17%	7.6%	7.6%	8.3%
Cabot	COBP	Sell	Toshiya Hari	USD	135.8	117	-14%	3,947	4,713	24	36	2%	-17%	7%	19.8	23.8	22.2	3.9	3.7	3.5	NM	NM		1.3%	1.4%	1.5%
Versum	Private	NC	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
Hitachi	6501.T	NR	Yuichiro Isayama	JPY	3,342	NA	NA	30,256	44,282	(15)	123	375%	-12%	NA	5.8	6.6	NA	0.9	0.8	NA	16%	13%	13%	3.3%	3.4%	NA
JSR	4185.T	NC	NA	JPY	2,110	NA	NA	4,463	5,175	34	23	-34%	68%	NA	29.2	17.4	NA	1.1	1.1	NA	4%	6%	NA	2.8%	2.9%	0.0%
Fujimi	5384.T	NC	NA	JPY	3,415	NA	NA	917	661	58	2	15%	10%	NA	18.4	16.7	NA	1.5	1.5	NA	9%	9%	NA	2.8%	3.0%	0.0%
Fujibo	3104.T	NC	NA	JPY	3,055	NA	NA	335	320	35	1	-2%	9%	NA	12.3	11.3	NA	NA	NA	NA	8%	NA	NA	3.3%	3.3%	0.0%
KPX	025000.KS	NC	NA	KRW	46,350	NA	NA	187	97	(16)	0	-15%	5%	-2%	6.4	6.1	6.2	0.5	0.4	0.4	7%	7%	7%	5.1%	5.4%	5.4%
SK Siltron	Private	NC	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
Average											152	62	77%	32%	66.9	60.6	62.0	7.8	6.9	7.4	8%	11%	14%	2.7%	2.8%	2.1%
Median											35	41	2%	22%	29.2	19.6	35.4	3.2	3.2	3.8	8%	9%	13%	2.8%	2.9%	0.9%

(Prices as of July 10, 2020. NC = Not Covered)

Source: Bloomberg, Goldman Sachs Global Investment Research, Gao Hua Securities Research, Gao Hua Securities Research

China semiconductor supply chain overview

Bottom line: Among the 6 sub-sectors in the China semiconductor industry, **we are more positive on Foundry and Equipment** given their technology migration and production expansion, as well as the significant upside to enjoy stronger growth from a small base. We also see integrated device manufacturing (IDM) as a growing trend in China, especially for power semiconductors. In the Fabless sector, we prefer names with a leading position among domestic suppliers and those who have upside to gain share in the China market. We are more cautious on OSAT given the lower technology entry barriers and increasing competition from Foundry/IDM in advanced packaging market.

6 sub-sectors of the supply chain: Foundry, Fabless, IDM, OSAT, Equipment, Materials

The semiconductor industry is usually divided into 6 sub-sectors: Foundry, Fabless, OSAT, IDM, Equipment, and Materials. Below is an introduction of each sub-sectors and key names in China.

Foundry

- **What is it?** A foundry is a semiconductor company that focuses on wafer processing (fabrication) for its customers based on each customer's design, and a foundry usually does not have its own design products. A foundry focuses its resources on manufacturing process technologies, and usually needs to migrate its technologies every few years; for example, SMIC migrated from 28nm to 14nm in late-2019, and is migrating to 12nm this year. Fabless are the main customers for foundries, and some IDMs also outsource part of their products to foundries.
- **Key names in China:** SMIC, Hua Hong.

Fabless (IC design)

- **What is it?** A fabless semiconductor company mainly focuses on designing chips that can meet its customers' needs, and outsources the wafer processing/packaging/testing to foundries and OSATs. The benefits of the fabless business model is that it can focus on the design without the capex burden to build its own capacity.
- **Key names in China:** Goodix, GigaDevice, Maxscend, SG Micro, Will Semi, StarPower, Montage.

IDM

- **What is it?** IDMs (integrated device manufacturers) are semiconductor companies who design and manufacture chips with in-house wafer processing, packaging, and testing capacity. Some IDMs also outsource part of their products to foundries and OSATs considering the resources and capex burdens.
- **Key names in China:** CR Micro, Wingtech (Nexperia), Silan, SiEn, YMTC, Innotron.

OSAT

- **What is it?** An OSAT (outsourced semiconductor assembly and testing) company mainly undertakes packaging, assembly, and testing for its customers' products. Compared to foundries, the technology entry barriers of OSATs are lower, which is evident in the higher profitability of foundries (GM typically at 20-50%) vs OSATs (GM typically at 10-20%). Fabless firms are the main customers to OSATs, and some IDMs also outsource part of their products to OSATs.
- **Key names in China:** JCET, Huatian, TongFu, China WLCSP.

Equipment

- **What is it?** Equipment makers provide the equipment for semiconductor manufacturing, packaging, and testing. This sector can be further divided into front-end and back-end: front-end refers to the equipment for foundries/IDMs wafer processing, while back-end refers to the equipment for OSATs/IDMs IC packaging/assembly/testing.
- **Key names in China:** NAURA, AMEC, ACM Research, ASMPT.

Material

- **What is it?** Material suppliers provide direct materials such as silicon wafers, and indirect materials that are used during the semiconductor manufacturing process, such as CMP slurry, photoresists, electronic gases, etc.
- **Key names in China:** NSIG, Anji Micro.

IDM vs fabless + foundry business model

Historically, the semiconductor industry started from the IDM business model, and many leading semiconductor companies retain that IDM business model. In 1987, TSMC was founded as the first dedicated semiconductor foundry to manufacture customers' products based on customers' designs. Due to the increasing complexity and capex requirements of advanced technologies, the foundry industry has been outgrowing the overall semiconductor industry in recent years. There is a growing trend of IDMs outsourcing part of their manufacturing to foundries/OSATs, as the IDMs would like to save on capex and focus their resources on core products and technologies, as well as manage their operational volatility through the cycles. Some IDMs also use part of their capacity to serve external fabless customers' demand in order to better utilize their capacity. However, there could be a conflict of interest if the IDMs and fabless customers are competing in the same market.

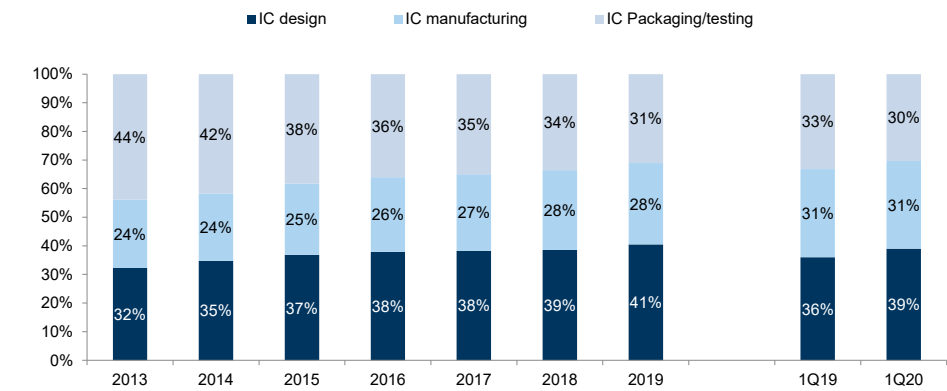
China semiconductor industry structure: IC design the largest sub-sector

China semiconductor industry revenue grew by 16% YoY to Rmb756bn

(c.US\$100bn+) in 2019, according to CSIA (China Semiconductor Industry Association), including IC design revenue of Rmb306bn (+22% YoY), IC manufacturing (including foundries and IDMs) revenue of Rmb215bn (+18% YoY), and IC packaging/ testing revenue of Rmb235bn (+7% YoY). However, the revenue data from CSIA includes some overseas companies' subsidiaries in China, so the actual revenue from companies headquartered in China is likely lower than these numbers.

IC design and manufacturing are outgrowing IC packaging/testing in China: In China’s semiconductor industry, IC packaging/testing was the largest sub-sector and contributed 44% of the total industry revenue in 2013, followed by IC design at 32% and IC manufacturing at 24%. Over the past 6 years, IC design / IC manufacturing revenue has grown faster, at a 25% / 24% CAGR in 2013-19, while IC packaging/testing grew at a 13% CAGR in the same period. This resulted in IC design becoming the largest sector with a 41% contribution in 2019 (vs. 32% in 2013), followed by IC packaging/testing at 31% (vs. 44%) and IC manufacturing at 28% (vs. 24%). We attribute the relatively slower growth for IC packaging/testing vs the other two sub-sectors to a higher base and a higher market share for Chinese suppliers.

Exhibit 280: IC design’s growing contribution in China’s semiconductor industry
Mix of China semiconductor industry revenue



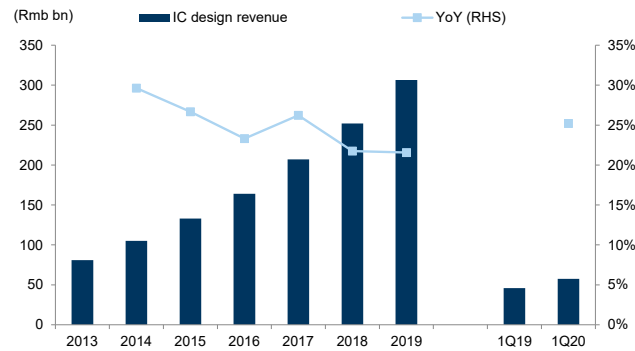
Source: CSIA (China Semiconductor Industry Association)

Exhibit 281: China semi industry revenue maintained solid growth at +16% YoY in 1Q20

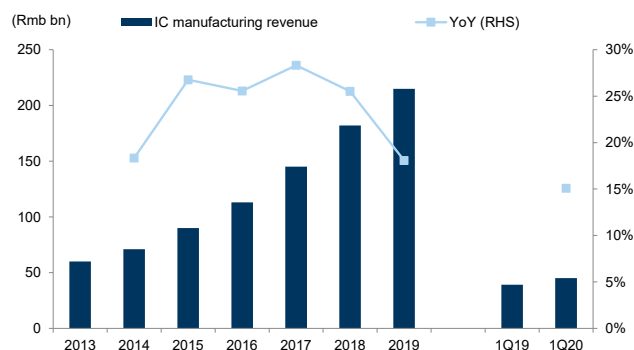


Source: CSIA

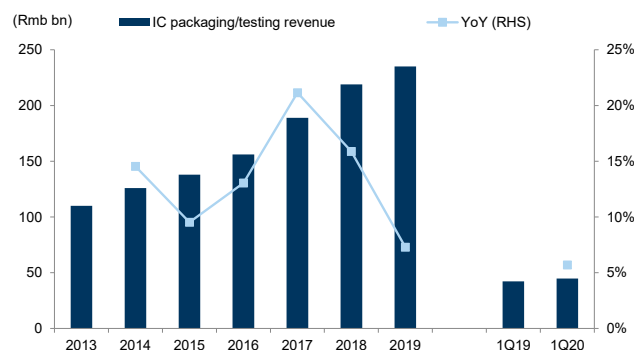
Exhibit 282: China IC design revenue growth accelerated to +25% YoY in 1Q20



Source: CSIA

Exhibit 283: China IC manufacturing revenue maintained solid growth at 15% YoY in 1Q20

Source: CSIA

Exhibit 284: China IC packaging/testing revenue growth slowed to +6% YoY in 1Q20

Source: CSIA

Greater China semiconductor monthly data

The monthly data we track in the Greater China semiconductor space includes: IC production volume in China, IC import value in China (including sub-segments of processors/controllers, memory, amplifiers), SPE import value in China, and monthly revenue of Taiwan-listed semiconductor names. The IC production volume in China has been showing stronger growth than the IC import value in China since September 2019, which echoes our constructive view on China semiconductors — as the domestic supply chain keeps improving its technology capabilities and continues to expand capacity. Although IC production growth slowed down in May 2020, we believe this was only a short-term adjustment post the COVID-19 impact, and we expect IC production in China to resume strong growth in coming months.

China IC production/import data and TW semi revenue data in May:

- China IC production volume grew 3% YoY to 21.5bn units in May (vs. +29% YoY in April 2020, +33% YoY in May 2019).
- China IC import value grew 11% YoY in May to US\$26.6bn (vs. +11% YoY in April 2020, -11% YoY in May 2019).
- The aggregate revenue for major Taiwan-listed semiconductor companies grew 17% YoY in May (vs. +22% YoY in April 2020, -1% YoY in April 2019). By sub-sector, OSAT grew at +19% YoY in May 2020, followed by foundries at +18% YoY and IC design at +13% YoY.

China import data by sub-segments in May:

The import data by sub-segment (announced in late-Jun) showed YoY growth among processors/controllers, amplifiers, and semiconductor production equipment, while memory remained YoY decline.

- Processors/controllers import value was US\$13.1bn in May 2020, +20% YoY (vs. +24% YoY in April 2020, +3% YoY in May 2019).
- Memory import value was US\$7.5bn in May 2020, -6% YoY (vs. -11% YoY in April 2020, -28% YoY in May 2019).

- Amplifiers import value was US\$0.7bn in May 2020, +5% YoY (vs. +19% YoY in April 2020, vs. +1% YoY in May 2019).
- Semiconductor production equipment import value was US\$1.0bn in May 2020, +31% YoY (vs. +27% YoY in April 2020, -27% YoY in May 2019).

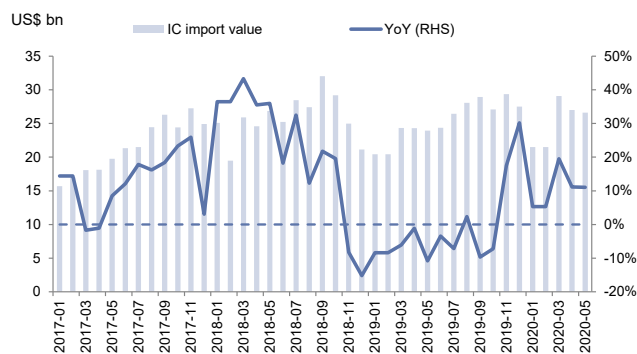
Exhibit 285: IC production growth at +3% YoY in May

Semiconductor monthly data in Greater China

	Mar-19	1Q19	Apr-19	May-19	Mar-20	1Q20	Apr-20	May-20
IC production in China (bn units)	17.7	44.9	17.0	20.8	21.2	50.8	22.0	21.5
IC import in China (US\$bn)	24.3	65.2	24.3	24.0	29.1	72.1	27.0	26.6
Processors/controllers	11.1	29.3	10.6	10.9	14.4	35.8	13.1	13.1
Memory	8.5	22.3	8.5	8.0	8.2	20.4	7.6	7.5
Amplifiers	0.7	1.9	0.7	0.7	1.1	2.3	0.9	0.7
SPE import in China (US\$bn)	0.7	1.8	1.0	0.8	1.1	2.9	1.2	1.0
TW semi revenue (NT\$bn)	165.1	460.5	161.3	167.2	218.0	594.8	196.7	195.7
MoM/QoQ	Mar-19	1Q19	Apr-19	May-19	Mar-20	1Q20	Apr-20	May-20
IC production in China	-	-2%	-4%	22%	-	-10%	4%	-2%
IC import in China	-	-13%	0%	-1%	-	-14%	-7%	-1%
Processors/controllers	-	-8%	-4%	3%	-	-12%	-9%	0%
Memory	-	-24%	1%	-6%	-	-13%	-8%	-1%
Amplifiers	-	-21%	8%	-2%	-	-10%	-20%	-13%
SPE import in China	-	-9%	35%	-21%	-	-6%	11%	-18%
TW semi revenue	25%	-20%	-2%	4%	21%	-5%	-10%	-1%
YoY	Mar-19	1Q19	Apr-19	May-19	Mar-20	1Q20	Apr-20	May-20
IC production in China	18%	8%	18%	33%	20%	13%	29%	3%
IC import in China	-6%	-8%	-1%	-11%	20%	11%	11%	11%
Processors/controllers	2%	0%	2%	3%	30%	22%	24%	20%
Memory	-16%	-18%	-14%	-28%	-3%	-9%	-11%	-6%
Amplifiers	-9%	-16%	-7%	1%	60%	21%	19%	5%
SPE import in China	-28%	-33%	7%	-27%	54%	57%	27%	31%
TW semi revenue	-12%	-4%	-2%	-1%	32%	29%	22%	17%

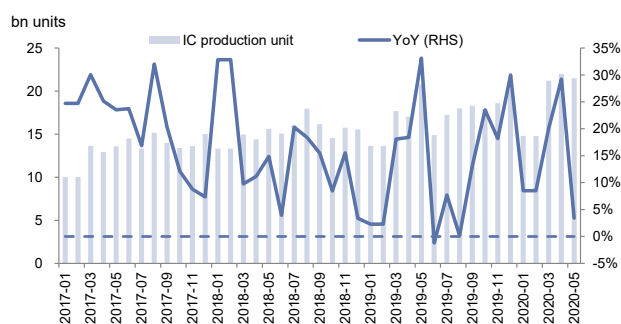
Color highlights data announced over the past month. SPE: semiconductor production equipment.

Source: National Bureau of Statistics (NBS), China Customs, Company data

Exhibit 286: IC import value in China up 11% YoY in May

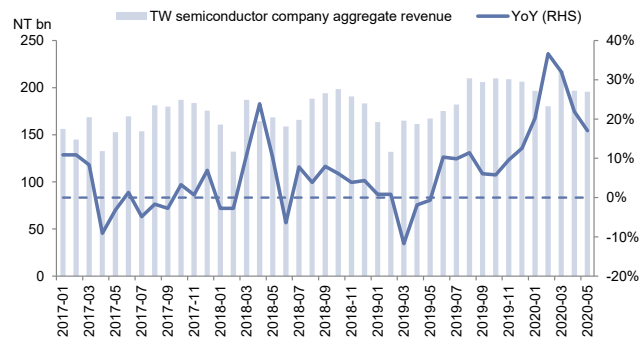
Aggregate Jan-Feb data reported in 2020. Jan, Feb data is the average of the aggregate value

Source: China Customs

Exhibit 287: IC production units in China up 3% YoY in May

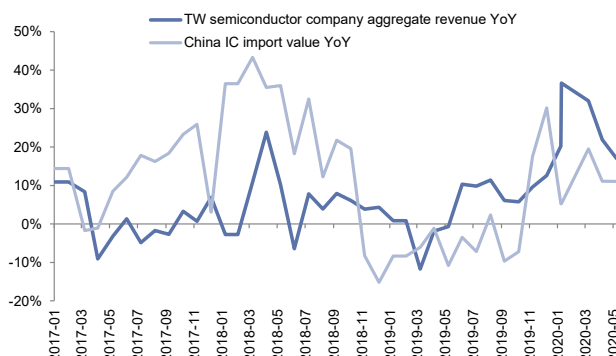
NBS reported aggregate units for Jan and Feb. The chart shows average units for Jan and Feb.

Source: NBS

Exhibit 288: Major TW semiconductor company aggregate revenue grew 17% YoY in May

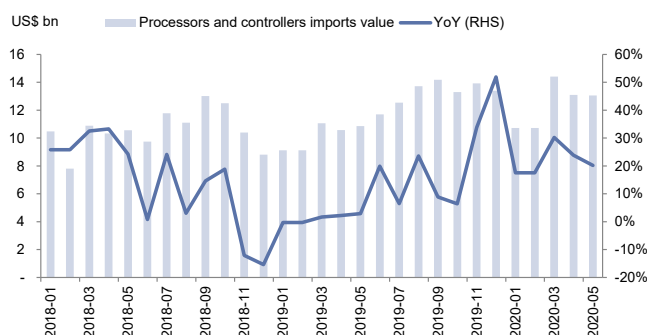
Aggregate revenue of TSMC, UMC, Vanguard, Win Semi, MediaTek, Novatek, Silergy, Parade, Realtek, ASEH, Powertech, KYEC, and Chipbond.

Source: TEJ

Exhibit 289: TW semiconductor company aggregate revenue YoY vs. China IC import value YoY

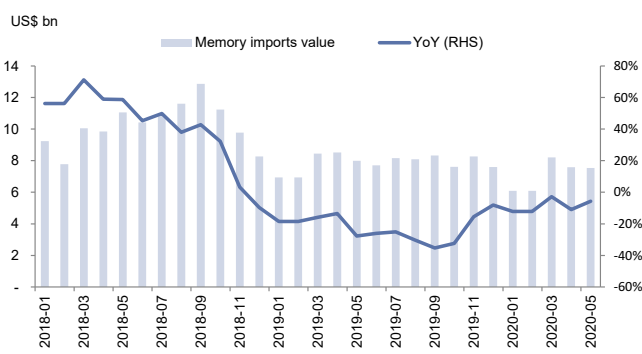
TW semiconductor aggregate revenue of TSMC, UMC, Vanguard, Win Semi, MediaTek, Novatek, Silergy, Parade, Realtek, ASEH, Powertech, KYEC, and Chipbond.

Source: TEJ, NBS

Exhibit 290: Processor and controller import value up 20% YoY in May

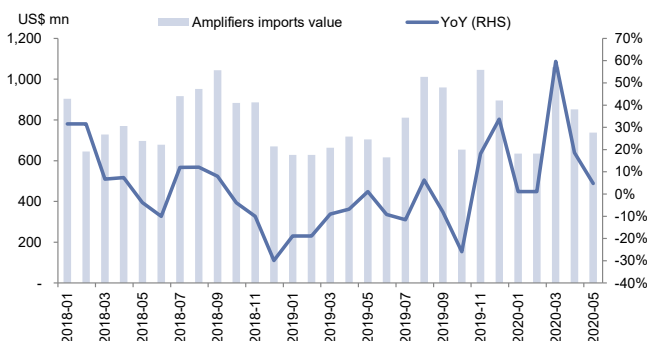
China Custom reported aggregate value for Jan and Feb since 2020. The chart showed average value for Jan and Feb.

Source: China Customs

Exhibit 291: Memory import value down 6% YoY in May

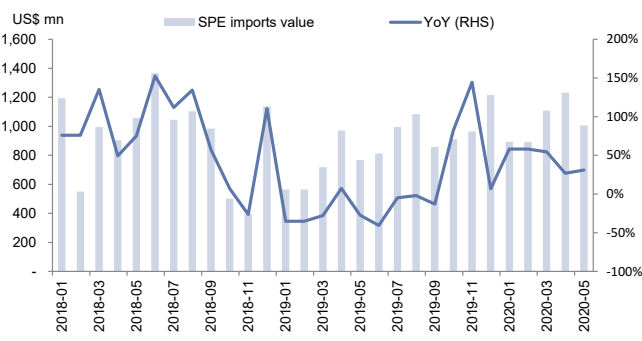
China Custom reported aggregate value for Jan and Feb since 2020. The chart showed average value for Jan and Feb.

Source: China Customs

Exhibit 292: Amplifier import value up 5% YoY in May

China Custom reported aggregate value for Jan and Feb since 2020. The chart showed average value for Jan and Feb.

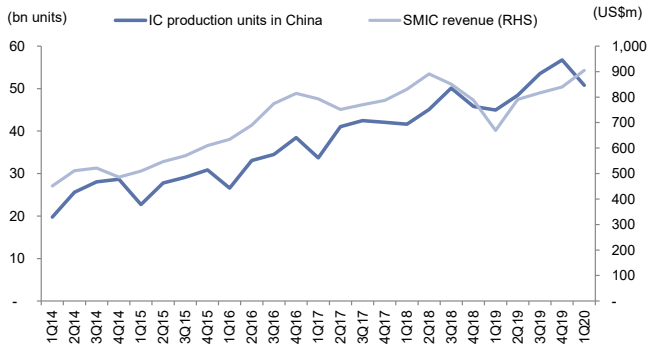
Source: China Customs

Exhibit 293: Semiconductor production equipment import value grew 31% YoY in May

China Custom reported aggregate value for Jan and Feb since 2020. The chart showed average value for Jan and Feb.

Source: China Customs

Exhibit 294: SMIC’s revenue has 86% correlation with IC production units in China



Source: NBS, Company data

Exhibit 295: Hua Hong’s revenue has 91% correlation with IC production units in China



Source: NBS, Company data

Valuation: Discounted P/E as our primary valuation methodology

Bottom line: China semiconductor stocks tend to trade at a higher valuation than global peers given their strong earnings growth from a low base in market share, product portfolio, and end application markets exposure.

Market rewards strong earnings growth

Our regression analysis of China semiconductor stocks shows that the market values stocks based on earnings growth; those with stronger earnings growth enjoy a higher P/E multiple. We therefore derive our target P/E multiple based on each company's future earnings growth. In addition, given China semiconductors are at an early stage of development — with upside in technology migration, market share expansion, and product lines extension — we use a discounted P/E as our primary valuation methodology to better capture their long-term opportunities. To derive our 12-month target prices we apply target multiples to 2025 EPS, then discount back to 2022E at the company's cost of equity.

In summary, we have Buy ratings on all 11 stocks on which we initiate coverage in this report (StarPower and ACM Research are also on the Conviction List), with target P/E multiples ranging from 14-80x on 2025E EPS (implying a 2022E P/E of 36-475x), with average EPS growth in 2023 and 2024E of 36%-102% YoY.

10-year DCF methodology as a cross-check

We also use a 10-year DCF to cross-check our target prices where appropriate, with second stage FCF until 2030E and 3% terminal growth discounted back to 2022E via a WACC ranging between 8-9%. These six DCF cross-checks provide valuations pretty much in line with our primary valuation methodology.

Exhibit 296: New coverage earnings growth and valuation summary

Segment	Company	2017	2018	2019	2020E	2021E	2022E	2023E	2024E	2025E	Target multiple	Rating	TP (RMB)	Upside	Implied 2022E PE
Power semi	Starpower	146%	84%	40%	27%	59%	82%	71%	58%	56%	40x (2025E)	Buy*	402	52%	130x
	CR Micro	nm	511%	-7%	17%	74%	65%	55%	45%	39%	33x (2025E)	Buy	88	57%	80x
	Silan	77%	1%	-91%	269%	292%	88%	58%	50%	31%	30x (2025E)	Buy	21.5	26%	71x
	Wingtech	586%	-81%	1954%	143%	54%	18%	18%	14%	13%	33x (2025E)	Buy	189	18%	39x
	Wingtech - semi				13%	57%	44%	48%	39%	49%	38x (2025E)				
Memory interface chip	Montage	274%	112%	27%	33%	43%	51%	43%	39%	38%	32x (2025E)	Buy	161	37%	68x
PA	Sanan	46%	-11%	-54%	15%	40%	42%	38%	36%	32%	29x (2025E)	Buy	40	41%	55x
CMP slurry	Anji	7%	13%	46%	53%	101%	86%	66%	72%	49%	30x (2025E)	Buy	647	42%	91x
Wafer	NSIG	nm	-95%	nm	nm	nm	319%	88%	87%	117%	80x (2025E)	Buy	60	25%	475x
SPE	AMEC	nm	204%	108%	66%	97%	78%	105%	99%	99%	30x (2025E)	Buy	382	42%	186x
	ACM Research	nm	nm	187%	21%	111%	57%	53%	48%	53%	14x (2025E)	Buy*	150	84%	36x
	AccoTest	28%	72%	12%	52%	74%	79%	82%	38%	37%	22x (2025E)	Buy	469	48%	60x

*Denotes for stocks in our AEJ Conviction List. Upside as of July 10, 2020. ACM Research TP in US\$.

Source: Bloomberg, Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 297: New coverage valuation snapshot

Company	Ticker	Rating	12M TP (Rmb)	Upside / Downside	Discount PE assumption	2025E EPS YoY	Implied 2022E PE	Avg. EPS YoY in 2023E & 2024E	Current trades at x 2022E PE	DCF valuation per share	DCF assumption	DCF implied 2022E PE
ACM Research	ACMR	B*	150	84%	14x 25E COE: 11%	53%	36x	51%	20x	-	-	-
CR Micro	688396.SS	B	88	57%	33x 25E COE: 9%□	39%	80x	45%	51x	89.7	WACC: 8.8% Terminal GR: 3%	81x
Sanan	600703.SS	B	40	41%	29x 25E COE: 9%	32%	55x	36%	39x	40.9	WACC: 8.6% Terminal GR: 3%	56x
Starpower	603290.SS	B*	402	52%	40x 25E COE: 9%	56%	130x	58%	85x	405	WACC: 9.0% Terminal GR: 3%	131x
AccoTest	688200.SS	B	469	48%	22x 25E COE: 8%	37%	60x	60%	40x	-	-	-
Anji	688019.SS	B	647	42%	30x 25E COE: 12%	49%	91x	69%	64x	-	-	-
AMEC	688012.SS	B	382	42%	30x 25E COE: 9%	99%	186x	102%	131x	-	-	-
Wingtech	600745.SS	B	189	18%	33x 25E COE: 9%	49% semi	39x	44% semi	33x	190	WACC: 8.2% Terminal GR: 3%	39x
Montage	688008.SS	B	161	37%	32x 25E COE: 9%	38%	68x	39%	50x	166	WACC: 9.0% Terminal GR: 3%	70x
NSIG	688126.SS	B	60	25%	80x 25E COE: 9%	117%	475x	88%	381x	-	-	-
Silan	600460.SS	B	21.5	26%	30x 25E COE: 9%	31%	71x	50%	57x	22.2	WACC: 8.1% Terminal GR: 3%	74x

*Denotes stocks on our AEJ Conviction List. Upside as of July 10, 2020. ACM Research TP in US\$.

Source: Bloomberg, Goldman Sachs Global Investment Research, Gao Hua Securities Research

In the correlation between earnings growth and P/E valuation, we see a clear positive slope line in the semiconductor space, across the sub-sectors of semiconductor devices, SPE, and material. For example, in the power semiconductor space, Chinese suppliers trade at 178x 2020E P/E on average vs. global peers at 29x 2020E P/E; however, we forecast Chinese suppliers will deliver stronger average earnings growth in 2021-22E of 72% YoY vs. global peers at 38% YoY. In terms of PEG, Chinese suppliers PEG is at 2.4x on average based on 2021-22E average earnings growth, while for global peers PEG is at 1.0x for the same period.

Exhibit 298: Power semi peers comp table

	Ticker	Rating	Analyst	Pricing currency	PX (LCY)	TP (LCY)	Upside (%)	Market cap (US\$m)	EV (US\$m)	LTM PX move (%)	LTM ADTV (USDmm)	NI growth			Trading P/E			Trading P/B			ROE			Div Yield				
												2020E	2021E	2022E	2020E	2021E	2022E	2020	2021	2022	2020	2021	2022	2020E	2021E	2022E		
Power Semi																												
Local																												
CR Micro	688396.SS	Buy	Allen Chang, Jin Guo	CNY	56.2	88	57%	9,415	9,512	340	163	17%	74%	65%	145.9	84.0	50.9	6.8	6.3	5.7	6%	8%	12%	0.1%	0.1%	0.2%		
StarPower	603290.SS	Buy*	Allen Chang, Jin Guo	CNY	264.6	402	52%	6,049	6,048	1,981	108	27%	59%	82%	247.3	155.2	85.5	37.1	31.8	25.2	20%	22%	33%	0.1%	0.2%	0.4%		
Wingtech	600745.SS	Buy	Verena Jeng, Jin Guo	CNY	160.0	189	18%	25,699	27,689	347	281	143%	54%	18%	59.1	38.5	32.6	7.6	6.5	5.5	14%	18%	18%	0.2%	0.3%	0.4%		
Silan	600460.SS	Buy	Lynn Luo, Jin Guo	CNY	17.0	21.5	26%	3,194	3,615	12	115	269%	202%	88%	416.9	106.2	56.5	6.5	6.3	5.8	2%	6%	11%	0.1%	0.3%	0.5%		
SG Micro	300661.SZ	Buy	Lynn Luo, Jin Guo	CNY	337.0	353	5%	7,484	7,425	453	69	38%	87%	70%	215.2	115.1	67.7	39.8	31.0	22.5	20%	30%	38%	0.1%	0.2%	0.3%		
Yangjie	300373.SZ	NC	NA	CNY	36.4	NA	NA	2,452	2,447	154	57	27%	28%	35%	59.6	46.5	34.4	6.0	5.4	4.7	10%	12%	14%	0.6%	0.7%	NA		
Jiejie	300623.SZ	NC	NA	CNY	33.2	NA	NA	2,313	2,131	182	52	12%	27%	26%	67.5	53.2	42.1	6.5	5.8	5.2	10%	11%	13%	0.3%	0.4%	0.7%		
Sino-Micro	600360.SS	NC	NA	CNY	10.4	NA	NA	1,428	1,386	76	67	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA		
Good-Ark	002079.SZ	NC	NA	CNY	14.0	NA	NA	1,459	1,389	101	75	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA		
Jinglai	Private	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA		
WeEn	Private	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA		
CNR Yongdian	Private	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA		
Macmic	Private	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA		
NCE Power	Private	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA		
Chinese peers avg.																												
Global																												
ON Semi	ON	Buy	Toshiya Hari	USD	20.5	22	7%	8,401	11,290	4	137	-94%	2333%	87%	42.9	18.0	11.6	2.7	2.5	2.2	6%	14%	20%	0.0%	0.0%	0.0%		
Infineon	IFXGN.DE	Neutral	Alexander Duval	EUR	22.5	22.5	0%	33,210	31,393	43	159	-27%	21%	18%	47.4	37.9	32.4	3.0	2.8	2.7	6%	8%	9%	1.3%	1.3%	1.3%		
Mitsubishi	6503.T	Buy*	Yuichiro Isayama	JPY	1,376.5	1,650	20%	27,646	26,136	(2)	61	-59%	133%	16%	32.6	14.0	12.1	1.2	1.1	1.1	4%	8%	8%	2.9%	2.9%	NA		
Rohm	6963.T	Neutral	Daiki Takayama	JPY	7,030.0	7,200	2%	6,773	4,229	(1)	52	-81%	772%	26%	144.6	16.2	12.5	1.0	0.9	0.9	1%	6%	7%	2.1%	2.1%	2.1%		
Cree	CR	Neutral	Brian Lee	USD	63.0	56	-11%	6,815	6,469	5	73	151%	-37%	-85%	nm	nm	73.5	3.6	3.8	3.7	-11%	-7%	-1%	0.0%	0.0%	0.0%		
ST Micro	STM.PA	Buy	Alexander Duval	EUR	25.4	20.5	-19%	26,112	25,509	63	79	-52%	40%	36%	55.8	39.9	29.4	3.9	3.7	3.4	7%	9%	12%	0.5%	0.6%	0.7%		
Renesas	6723.T	Neutral	Daiki Takayama	JPY	592.0	490	-17%	9,495	15,244	63	65	NM	69%	NA	24.2	14.3	NA	1.6	1.4	NA	7%	10%	NA	0.0%	0.0%	NA		
Litefuse	LFUS	NC	NA	USD	166.6	NA	NA	4,045	4,222	(3)	25	-38%	72%	20%	47.8	27.8	23.1	NA	NA	NA	6%	10%	NA	1.2%	1.3%	NA		
Diodes	DIOD	NC	NA	USD	50.6	NA	NA	2,604	2,519	40	17	-28%	27%	NA	23.4	18.4	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA		
Vishay	VSH	NC	NA	USD	15.1	NA	NA	2,187	2,025	(4)	20	-42%	61%	33%	22.9	14.3	10.7	1.7	1.8	NA	6%	13%	NA	2.5%	2.5%	NA		
Parjit	2481.TW	NC	NA	TWD	29.0	NA	NA	326	478	(4)	4	40%	27%	5%	13.8	10.9	10.4	1.3	1.3	1.2	10%	11%	12%	4.2%	5.9%	6.7%		
Taiwan Semi	5425.TW	NC	NA	TWD	41.0	NA	NA	346	467	(16)	3	-24%	36%	NA	23.5	17.4	NA	1.9	1.8	NA	8%	11%	NA	3.4%	4.6%	NA		
Toshiba	6502.T	CS	NA	JPY	3,510.0	NA	NA	14,938	18,159	3	71	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA		
Fuji	6504.T	NC	NA	JPY	2,781.0	NA	NA	3,884	5,685	(23)	21	-16%	-8%	24%	11.8	12.8	10.3	1.0	1.0	NA	7%	9%	NA	2.9%	3.2%	1.0%		
Microchip	MCHP	Buy	Toshiya Hari	USD	106.6	121	13%	26,155	35,373	21	267	61%	114%	36%	21.5	20.8	15.8	4.9	4.1	3.4	23%	21%	24%	1.6%	1.4%	1.4%		
Global peers avg. excl. outliers																												
Average												160	82	18%	205%	33%	57.8	43.2	34.1	7.8	6.7	6.6	8%	12%	16%	1.2%	1.4%	1.1%
Median												17	68	-2%	59%	30%	47.6	24.3	30.9	3.6	3.7	3.7	7%	11%	13%	0.6%	0.7%	0.6%

1) Outliers: On Semi, Mitsubishi, Rohm, Cree; 2) Prices as of July 10, 2020. NC = Not Covered, CS=Coverage suspended; 3) *Denotes stocks on our AEJ Conviction List

Source: Bloomberg, Goldman Sachs Global Investment Research, Gao Hua Securities Research

We attribute the higher market reward for Chinese suppliers to the higher earnings upside potential over the long term — driven by the low base in technology, product portfolio, and market share, along with Chinese suppliers’ access to their own growing home market, with multiple Chinese brand customers that are seeking to diversify their

supply chains in light of ongoing US-China trade tension — in order to lower single country supplier risks.

The upside we see in China semiconductors:

- **Technology migration from a low base:** not only Chinese suppliers' technology migration, but also the overall industry, is still enjoying technology migration driven by 5G, energy-saving / frequency conversion facilities across vehicles (EVs), home appliances, industrial equipment, etc.
- **Market share from a low base,** especially in its home market, China, which has multiple Chinese brand across vehicles, home appliances, industrial, consumer electronics, etc. but still small market share from Chinese semiconductor suppliers.
- **Product portfolio:** Most Chinese semiconductor suppliers have narrow product lines or focus on certain products or markets, and have fewer SKUs. Take power semiconductors for example, Wingtech / Nexperia SKUs are around 16K vs. global leaders, Infineon at 60K SKUs, On Semi at 30K SKUs, and other Chinese suppliers hardly at 10K SKUs.

Although the technology gap between Chinese semiconductor suppliers and global peers remains wide and the home market cannot simply transform itself overnight to gain market share, we see several positive signs that support Chinese suppliers business expansion / earnings growth, supporting the valuation of China semiconductor stocks:

- **Trade tension has prompted Chinese brand makers to review their supply chain risk:** We have seen ongoing US-China trade tension prompting Chinese brand makers, whether they appear on the US Entity List or not, to review their supply chain risk; and they have become more willing to source from new suppliers to lower their single country supplier risk. We believe this trend towards diversification of supply would be very unlikely to be reversed even if trade tensions were eased, given that supply chain risk could threaten brand makers' business continuity. Take Hikvision for example, the company is still on the US Entity List, but all of its US components suppliers have resumed supply under compliance; nevertheless, Hikvision continues its strategy of diversifying its supply chain and is not planning to reverse its allocation back to its previous high reliance on a single country for supply.
- **Trade tension has made Chinese brand makers more willing to cultivate new suppliers:** Hand in hand with this diversification strategy, brand customers are also cultivating new suppliers to help them raise product quality. At Hikvision for example, management has stated that when they first worked with Chinese suppliers, quality was not as good as their original foreign suppliers, with issues around noise or higher power consumption, etc.; however, after revisions, in generation 2 or 3, quality had significantly improved. This echoes our view that suppliers can accumulate valuable experience with customers, further driving them up the learning curve.
- **R&D small but focus on specific products; supported by government subsidies:** Chinese suppliers' R&D spending is a lot smaller than global leaders. Take power

semiconductors for example. Infineon R&D spending in 2019 was at US\$1.1bn vs. Wingtech at US\$191mn vs. CR Micro at US\$70mn. Despite this much smaller investment in R&D, we see that Chinese suppliers' R&D is more focused on specific products or areas, and is being supported by government subsidies. For example, CR Micro's government subsidies were Rmb239mn (US\$34mn) in 2019, or 47% of pretax income.

- **M&A:** Apart from developing technology in house, we also see that Chinese suppliers are willing to pursue M&A to expand their semiconductor business. For example, Wingtech, a global leader in smartphone ODM, completed the acquisition on Nexperia in late 2019, extending its business from smartphone to semiconductors, and illustrating Chinese companies' interest in investing in the semiconductor business. With the acquisition, Nexperia could win a larger market share in China, which is currently only 10% — driven by synergies with Wingtech, and Nexperia's leading technology and larger SKUs vs. other Chinese peers.

Ultimately, we believe the market will reward China semiconductor companies with higher valuation given their promising long-term opportunity and strong earnings growth (especially for leaders in each subsector) and their scarcity in the A-share market. Leading stocks are trading at 1.3x-4.3x PEG based on 2022E P/E and 2023-24E average EPS YoY.

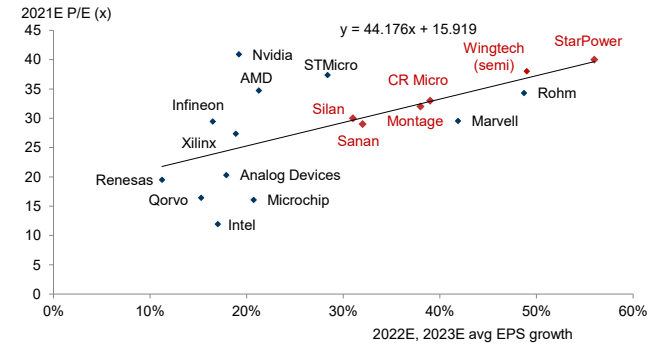
For example:

- **Starpower:** Chinese leader in IGBT, 4% market share in China in 2019. Currently trades at 85x 2022E P/E with EPS to grow at 58% YoY on average in 2023-24E, or PEG at 1.5x.
- **Montage:** Global leader in memory interface IC, 38% global market share in 2019. Currently trades at 50x 2022E P/E with EPS to grow at 39% YoY on average in 2023-24E, or PEG at 1.3x.
- **AMEC:** Chinese leader in SPE, qualified for TSMC 5nm. Currently trades at 131x 2022E P/E with EPS to grow at 102% YoY on average in 2023-24E, or PEG at 1.3x.
- **NSIG:** Chinese leader in silicon wafer. Currently trades at 381x 2022E P/E with EPS to grow at 88% YoY on average in 2023-24E, or PEG at 4.3x.

Discounted P/E captures long-term opportunities

We use a discounted P/E to derive our 12-month target prices for the 11 stocks we initiate coverage on in China semiconductors — to capture these companies' long term opportunities in market share, technology migration, and product portfolio expansion. We divided the 11 stocks' earnings growth into two stages in general, with the first stage (2020-2022E) growing on market share with existing products or existing target end markets (e.g. MOSFET for consumer electronics), and a second stage (2023-25E) of expanding product portfolios, target end markets (e.g. MOSFET for auto, industrial), or product specification upgrades. Based on these assumptions, we derive our 2025E EPS and apply a target PE multiple to this year. We derive the target PE multiple based on the stock's sector (including global peers) correlation between EPS growth and PE - as seen in the scatter plots below.

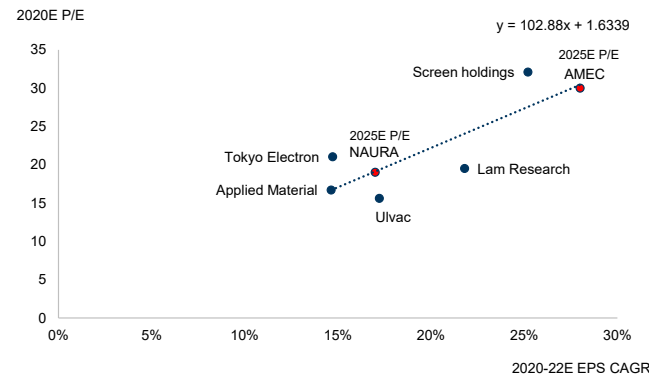
Exhibit 299: Global semi scatter chart



Red names are 2025E P/E and 2025E EPS YoY

Source: Bloomberg, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 301: Global etcher valuation scatter chart



Source: Goldman Sachs Global Investment Research, Gao Hua Securities Research, Bloomberg

Exhibit 300: Global semi peers P/E vs EPS growth

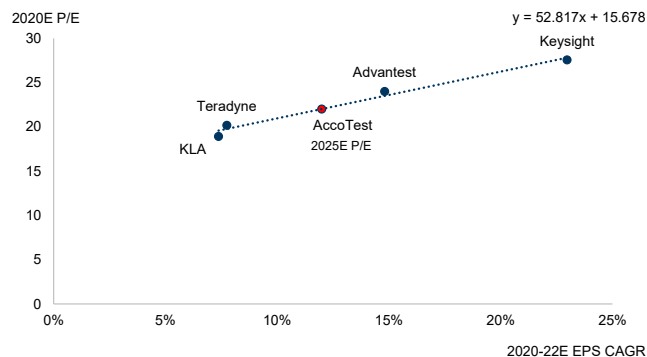
	2021E PE	Avg. 2022/23E EPS growth
STMicro	37	28%
Infineon	29	16%
Microchip	16	21%
AMD	35	21%
Analog Devices	20	18%
Intel	12	17%
Marvell	30	42%
Nvidia	41	19%
Qorvo	16	15%
Xilinx	27	19%
Renesas	19	11%
Rohm	34	49%
	2025E PE	2025E EPS growth
StarPower	40	56%
Montage	32	38%
CR Micro	33	39%
Sanan	29	32%
Silicon	30	31%
Wingtech (semi)	38	49%

Source: Bloomberg, Goldman Sachs Global Investment Research, Gao Hua Securities Research

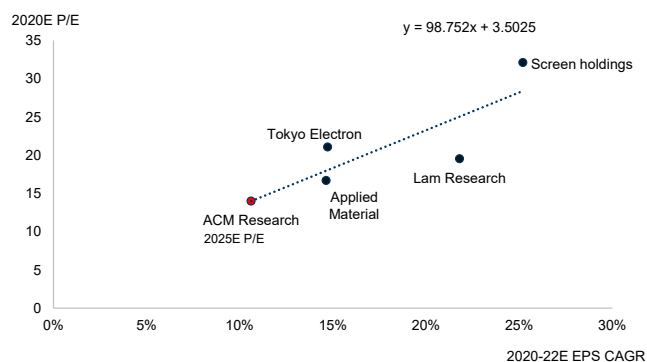
Exhibit 302: Global etcher companies PE vs earnings CAGR

Global majors	2020 P/E	2020-22E CAGR
Tokyo Electron	21.1	15%
Screen holdings	32.1	25%
Ulvac	15.6	17%
Applied Material	16.7	15%
Lam Research	19.5	22%
Average	21.0	19%
	2025E	Avg 2025-26E
AMEC	30.0	28%
NAURA	19.0	17%

Source: Goldman Sachs Global Investment Research, Gao Hua Securities Research, Bloomberg

Exhibit 303: Global testing equipment valuation scatter chart

Source: Bloomberg, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 305: Global cleaning equipment companies valuation scatter chart

Source: Bloomberg, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 304: Global testing equipment P/E vs EPS CAGR

Global majors	2020 P/E	2020-22E CAGR
KLA	18.9	7%
Keysight	27.6	23%
Teradyne	20.2	8%
Advantest	24.0	15%
Average	22.7	13%
	2025 P/E	Avg 2025-26E
AccoTest	22	12%

Source: Bloomberg, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 306: Global cleaning equipment P/E vs earnings CAGR

Global majors	2020E PE	2020-23E CAGR
Tokyo Electron	21.1	15%
Screen holdings	32.1	25%
Applied Material	16.7	15%
Lam Research	19.5	22%
Average	22.3	19%
	2025 P/E	Avg 2025-26E
ACM Research	14.0	11%

Source: Bloomberg, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 307: SPE companies EPS YoY growth

Ticker		EPS YoY		
China		2020E	2021E	2022E
AMEC	688012.SS	59%	97%	78%
AccoTest	688200.SS	27%	52%	79%
ACM Research	ACMR	9%	117%	57%
Kingsemi	688037.SS	25%	69%	53%
Changchuan	300604.SZ	nm	16%	33%
PNC	603690.SS	66%	46%	24%
Naura	002371.SZ	52%	108%	96%
Jingsheng	300316.SZ	46%	25%	21%
Wanye	600641.SS	5%	-8%	-26%
Average		36%	58%	46%
Global				
ASML	ASML.AS	10%	55%	20%
Tokyo Electron	8035.T	16%	22%	8%
Advantest	6857.T	2%	28%	3%
Screen holdings	7735.T	108%	36%	15%
Ulvac	6728.T	5%	31%	na
Applied Material	AMAT	13%	6%	34%
Lam Research	LRCX	4%	7%	43%
KLA	KLAC	21%	-6%	27%
Keysight	KEYS	-24%	27%	19%
Teradyne	TER	31%	0%	13%
Entegris	ENTG	4%	2%	45%
Nanometrics	ONTO	nm	45%	33%
Cohu	COHU	nm	nm	47%
Average		17%	21%	26%

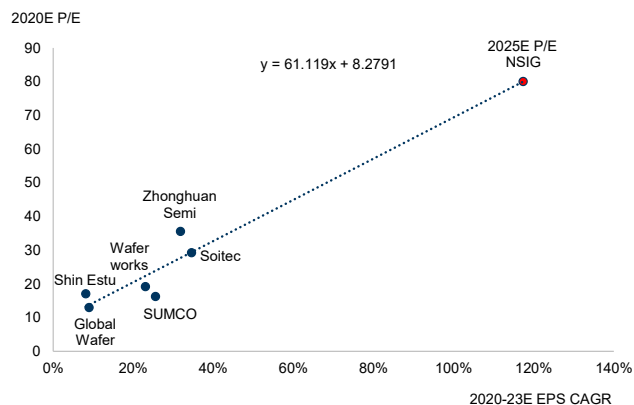
Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 309: Global silicon wafer peers P/E vs EPS CAGR

Global majors	2020 P/E	2020-23 EPS CAGR
Global Wafer	13	9%
Wafer works	19	23%
Soitec	29	35%
Shin Estu	17	8%
SUMCO	16	26%
Zhonghuan Semi	36	32%
Average	22	22%
	2025 P/E	2025 EPS YoY
NSIG	80	117%

Source: Bloomberg, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 308: Global silicon wafer valuation scatter chart



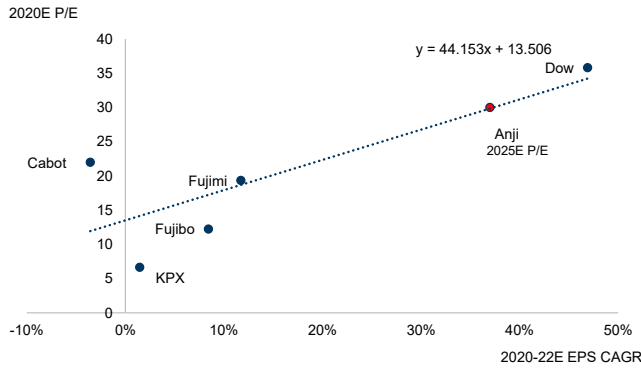
Source: Bloomberg, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 310: Global silicon wafer peers EPS YoY

Ticker		EPS YoY		
China		2020E	2021E	2022E
NSIG	688126.SS	nm	nm	319%
Zhonghuan Semi	002129.SZ	64%	33%	22%
Average		64%	33%	171%
Global				
Global Wafer	6488.TWO	-6%	16%	12%
Wafer Works	6182.TWO	-26%	23%	na
Soitec	SOIT.PA	12%	-3%	56%
Siltronic	WAFGn.DE	-38%	33%	19%
Shin Estu	4063.T	0%	14%	3%
SUMCO	3436.T	17%	23%	38%
Average		-7%	18%	25%

Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 311: CMP peers valuation scatter chart



Source: Bloomberg, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 313: CMP peers EPS YoY growth

Ticker		EPS YoY		
China		2020E	2021E	2022E
Anji	688019.SS	31%	101%	86%
Dinglong	300054.SZ	nm	24%	12%
Konfoong	300666.SZ	15%	46%	24%
Sinyang	300236.SZ	-63%	22%	45%
Average		-6%	48%	42%
Global				
Hitachi	6501.T	nm	-10%	3%
JSR	4185.T	-31%	61%	19%
Fujimi	5384.T	13%	10%	14%
Fujibo	3104.T	-2%	9%	8%
KPX	025000.KS	-15%	5%	-2%
Dow	DOW	-67%	81%	19%
Cabot	CCMP	-7%	-13%	7%
Average		-18%	20%	10%

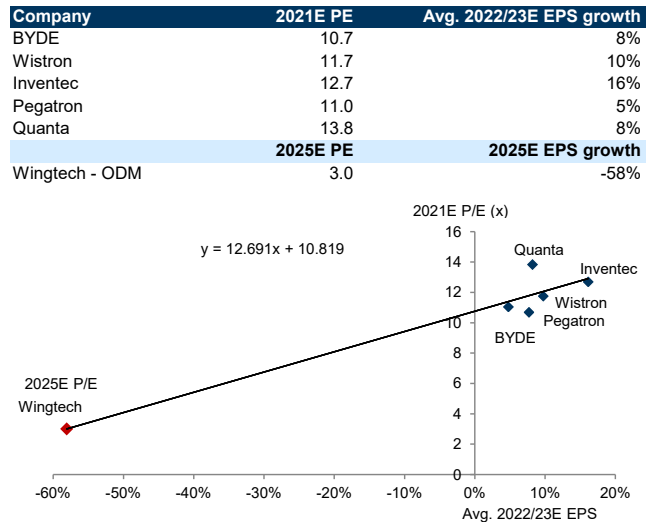
Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 312: CMP peers P/E vs EPS CAGR

Global majors	2020 P/E	2020-22E EPS CAGR
Fujimi	19.3	12%
Fujibo	12.2	8%
KPX	6.6	1%
Dow	35.8	47%
Cabot	22.0	-4%
Average	19.2	13%
	2025E	2026E EPS YoY
Anji	30	37%

Source: Bloomberg, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 314: Smartphone ODM scatter chart



Source: Bloomberg, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 315: Power semi peers comp table

Ticker	Rating	Analyst	Pricing currency	PX (LCY)	TP (LCY)	Upside (%)	Market cap (US\$m)	EV (US\$m)	LTM PX move (%)	LTM ADTV (USDmm)	NI growth	Trading P/E	Trading P/B	ROE	Div Yield											
Power Semi																										
Local																										
CR Micro	688396.SS	Buy	Allen Chang, Jin Guo	CNY	56.2	88	57%	9,415	9,512	340	163	17%	74%	65%	145.9	84.0	50.9	6.8	6.3	5.7	6%	8%	12%	0.1%	0.1%	0.2%
StarPower	603290.SS	Buy	Allen Chang, Jin Guo	CNY	264.6	402	52%	6,049	6,048	1,981	108	27%	59%	82%	247.3	155.2	85.5	37.1	31.8	25.2	20%	22%	33%	0.1%	0.2%	0.4%
Wingtech	600745.SS	Buy	Verena Jeng, Jin Guo	CNY	160.0	189	18%	25,699	27,689	347	281	143%	54%	18%	59.1	38.5	32.8	7.8	6.5	5.5	14%	18%	18%	0.2%	0.3%	0.4%
Silan	600460.SS	Buy	Lynn Luo, Jin Guo	CNY	17.0	21.5	26%	3,194	3,615	12	115	269%	292%	88%	416.0	106.2	56.5	6.5	6.3	5.8	2%	6%	11%	0.1%	0.3%	0.5%
SG Micro	300661.SZ	Buy	Lynn Luo, Jin Guo	CNY	337.0	353	5%	7,484	7,425	453	69	38%	87%	70%	215.2	115.1	67.7	39.8	31.0	22.5	20%	30%	38%	0.1%	0.2%	0.3%
Yangjie	300373.SZ	NC	NA	CNY	36.4	NA	NA	2,452	2,447	154	57	27%	28%	35%	59.6	46.5	34.4	6.0	5.4	4.7	10%	12%	14%	0.6%	0.7%	NA
Jiejie	300623.SZ	NC	NA	CNY	33.2	NA	NA	2,313	2,131	182	52	12%	27%	26%	67.5	53.2	42.1	6.5	5.8	5.2	10%	11%	13%	0.3%	0.4%	0.7%
Sino-Micro	600360.SS	NC	NA	CNY	10.4	NA	NA	1,428	1,386	76	67	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Good-Ark	002079.SZ	NC	NA	CNY	14.0	NA	NA	1,459	1,389	101	75	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Jinglai	Private	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Weien	Private	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
CNR Yongdian	Private	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Macmic	Private	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
NCE Power	Private	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chinese peers avg.																										
Global																										
ON Semi	ON	Buy	Toshiya Hari	USD	20.5	22	7%	8,401	11,290	4	137	NM	2333%	87%	42.9	18.0	11.6	2.7	2.5	2.2	6%	14%	20%	0.0%	0.0%	0.0%
Infineon	IFXGn.DE	Neutral	Alexander Duval	EUR	22.5	22.5	0%	33,210	31,393	43	159	-27%	21%	18%	47.4	37.9	32.4	3.0	2.8	2.7	6%	8%	9%	1.3%	1.3%	1.3%
Mitsubishi	6503.T	Buy	Yuichiro Iisayama	JPY	1,376.5	1,650	20%	27,646	26,136	(2)	61	-59%	133%	16%	32.6	14.0	12.1	1.2	1.1	1.1	4%	8%	7%	2.9%	2.9%	NA
Rohm	6963.T	Neutral	Daiiki Takayama	JPY	7,030.0	7,200	2%	6,773	4,229	(1)	52	-81%	772%	26%	144.6	16.2	12.5	1.0	0.9	0.9	1%	6%	7%	2.1%	2.1%	2.1%
Onsemi	CRCE	Neutral	Brian Lee	USD	63.0	58	-11%	6,815	6,469	5	73	151%	-37%	-85%	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ST Micro	STM.PA	Sell	Alexander Duval	EUR	25.4	20.5	-19%	26,112	25,509	63	79	-52%	40%	36%	55.8	39.9	29.4	3.9	3.7	3.4	7%	9%	12%	0.5%	0.6%	0.7%
RENESAS	6723.T	Neutral	Daiki Takayama	JPY	592.0	490	-17%	9,495	15,244	(3)	65	NM	69%	NA	24.2	14.3	NA	1.6	1.4	NA	7%	10%	NA	0.0%	0.0%	NA
Litefuse	LFUS	NC	NA	USD	166.6	NA	NA	4,045	4,222	(3)	25	-38%	72%	20%	47.8	27.8	23.1	NA	NA	NA	7%	12%	NA	1.3%	1.4%	NA
Diodes	DIOD	NC	NA	USD	50.6	NA	NA	2,604	2,519	40	17	-28%	27%	NA	23.4	18.4	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Vishay	VSH	NC	NA	USD	15.1	NA	NA	2,187	2,025	(4)	20	-42%	61%	33%	22.9	14.3	10.7	1.7	1.8	NA	7%	14%	NA	2.8%	2.8%	NA
Parit	2481.TW	NC	NA	TWD	29.0	NA	NA	326	478	(4)	4	40%	27%	5%	13.8	10.9	10.4	1.3	1.3	1.2	12%	13%	13%	4.6%	6.6%	7.5%
Tekwin Semi	5425.TW	NC	NA	TWD	41.0	NA	NA	346	467	(16)	3	-24%	38%	NA	23.5	17.4	NA	1.9	1.8	NA	9%	12%	NA	3.8%	5.2%	NA
Toshiba	6502.T	CS	NA	JPY	3,510.0	NA	NA	14,938	18,159	3	71	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Fuji	6504.T	NC	NA	JPY	2,781.0	NA	NA	3,884	5,685	(23)	21	-16%	-8%	24%	11.8	12.8	10.3	1.0	1.0	NA	8%	10%	NA	3.3%	3.5%	1.1%
Microchip	MCHP	Buy	Toshiya Hari	USD	106.6	121	13%	26,155	35,373	21	66	-14%	46%	24%	29.2	21.5	18.9	2.4	2.2	2.7	10%	12%	14%	2.1%	2.5%	2.4%
Global peers avg. excl. outliers																										
Average																										
Median																										

Prices as of July 10, 2020. 1) NC = Not Covered; 2) CS=Coverage suspended; 3)*Denotes stocks on our AEJ Conviction List

Source: Bloomberg, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Dinglong	300054.SZ	NC	
Konfong	300666.SZ	NC	
Sinyang	300236.SZ	NC	
Grish	Private	NC	
Sonyung	Private	NC	
Xinxina	Private	NC	
Times Live	Private	NC	
Global			
Dow	DOW	Buy	Robert
Cabot	CCMP	Sell	Toshi
Versum	Private	NC	
Hilachi	6501.T	NR	Yuichiro
JSR	4185.T	NC	
Fujimi	5384.T	NC	
Fujibo	3104.T	NC	
KPX	025000.KS	NC	
SK Siltron	Private	NC	
Wenqiang's Median			

(Prices as of July 10, 2020. NC = Not Covered)

Source: Bloomberg, Goldman Sachs Global

Exhibit 318: Silicon wafer pe

Prices as of July 10, 2020. 1) NC = Not Covered; 2) CS=Coverage suspended

Source: Bloomberg, Goldman Sachs Global Investment Research, Gao Hua Securities Research

(Prices as of July 10, 2020. NC = Not Covered, CS=Coverage Suspended. NC estimates are from Bloomberg)

(Prices as of July 10, 2020. NC = Not Covered, CS = Coverage Suspended, NR = Not Rated. NC stock estimates are from Bloomberg)

Source: Bloomberg, Goldman Sachs Global Investment Research, Gao Hua Securities Research

13 July 2020

(Prices as of July 10, 2020. NC = Not Covered, CS=Coverage Suspended. NC estimates are from Bloomberg)

Source: Bloomberg, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 319: SPE peers comp table

SPE	Local	Ticker	Rating	Analyst	Pricing currency	PX (LCY)	TP (LCY)	Upside (%)	Market cap (US\$m)	EV (US\$m)	LTM PX move (%)	LTM ADTV (USDmn)	EPS growth			Trading P/E			Trading P/B			ROE			Div Yield		
													2020E	2021E	2022E	2020E	2021E	2022E	2020E	2021E	2022E	2020E	2021E	2022E	2020E	2021E	2022E
		Local																									
AMEC	688012.SS	Buy	Allen Chang, Jin Guo	CNY	269.2	382	42%	20,570	20,241	828	99	59%	97%	78%	458.8	233.1	130.9	35.4	30.7	24.9	8%	14%	21%	0.0%	0.0%	0.0%	
AccuTest	688200.SS	Buy	Jin Guo	CNY	317.1	466	48%	2,772	2,740	196	52	27%	52%	79%	109.7	72.3	40.3	9.5	8.8	7.7	13%	13%	20%	0.3%	0.5%	0.9%	
ACM Research	ACMR	Buy*	Jin Guo	USD	41.6	150	84%	1,465	1,445	365	15	8%	117%	57%	66.5	30.6	19.5	12.3	8.8	6.1	21%	33%	37%	0.0%	0.0%	0.0%	
Naura	002371.SZ	Buy	Jin Guo	CNY	221.3	307	39%	15,654	15,567	223	179	52%	108%	96%	216.5	104.2	53.1	17.4	15.1	12.0	8%	16%	25%	0.0%	0.1%	0.2%	
Kingsemi	688037.SS	NC	NA	CNY	144.2	NA	NA	1,731	1,652	435	69	25%	69%	53%	250.8	148.7	97.5	15.3	14.3	13.0	6%	10%	13%	NA	NA	NA	
Changchuan	300604.SZ	NC	NA	CNY	34.8	NA	NA	1,564	1,559	76	33	775%	16%	33%	99.5	86.0	64.5	10.2	9.2	8.2	7%	11%	13%	NA	NA	NA	
PNC	603690.SS	NC	NA	CNY	60.5	NA	NA	2,230	2,351	193	38	62%	45%	23%	82.2	56.5	46.0	10.5	9.1	6.6	15%	18%	15%	0.1%	0.1%	0.1%	
Jingsheng	300316.SZ	NC	NA	CNY	28.3	NA	NA	5,193	5,256	143	73	46%	25%	21%	38.7	31.0	25.5	6.8	5.8	4.9	17%	18%	18%	0.4%	0.7%	0.4%	
Wanye	600641.SS	NC	NA	CNY	25.6	NA	NA	2,946	2,350	134	43	5%	-8%	-26%	32.5	35.3	47.4	2.9	2.8	2.7	9%	8%	6%	1.0%	1.0%	NA	
Mattson	Private	NC	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
Hwatsing	Private	NC	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
Piotech	Private	NC	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
Raintree	Private	NC	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
Global																											
Applied Material	AMAT	Buy	Toshiya Hari	USD	62.6	69	10%	57,362	58,717	42	453	25%	-9%	46%	16.4	18.1	12.4	5.7	5.4	4.7	37%	31%	40%	1.4%	1.5%	1.6%	
ASML	ASML.AS	Buy	Alexander Duval	EUR	346.7	366	5%	167,723	167,448	91	328	10%	55%	20%	51.9	33.4	27.8	11.2	10.1	8.8	22%	32%	34%	0.7%	0.7%	0.9%	
Entegris	ENTG	Buy	Toshiya Hari	USD	59.1	65	10%	7,949	8,746	65	47	4%	2%	45%	29.4	28.9	20.0	6.2	6.2	5.9	17%	16%	25%	0.5%	0.6%	0.7%	
Lam Research	LRCX	Buy	Toshiya Hari	USD	340.0	330	-3%	49,352	49,220	88	506	3%	-6%	49%	22.6	24.1	16.2	9.9	9.2	8.2	46%	41%	54%	1.4%	1.4%	1.5%	
Keyight	KEYS	Neutral	Toshiya Hari	USD	97.6	93	-5%	18,262	18,371	10	167	-16%	16%	23%	27.1	23.3	19.0	5.6	5.1	4.7	22%	23%	26%	0.0%	0.0%	0.0%	
KLAC	KLAC	Neutral	Toshiya Hari	USD	202.3	193	-5%	31,360	33,283	73	243	22%	-2%	9%	19.5	20.0	18.3	13.4	12.8	13.0	65%	65%	69%	1.8%	2.0%	2.2%	
Teradyne	TER	Neutral	Toshiya Hari	USD	87.4	84	-4%	14,485	14,044	91	147	31%	0%	13%	23.6	23.6	21.0	7.4	6.7	6.4	37%	31%	32%	0.4%	0.5%	0.6%	
Tokyo Electron	8035.T	CS	NA	JPY	29,610.0	NA	NA	43,541	40,408	86	292	20%	19%	NA	22.5	18.9	NA	5.0	4.5	NA	23%	25%	NA	2.2%	2.6%	4.0%	
Advantest	6857.T	CS	NA	JPY	6,960.0	NA	NA	12,992	11,903	133	157	4%	26%	NA	27.3	21.6	NA	5.3	4.6	NA	20%	23%	NA	1.1%	1.4%	3.0%	
Screen Holdings	7735.T	CS	NA	JPY	5,270.0	NA	NA	2,504	2,762	9	53	103%	37%	NA	16.2	11.9	NA	1.3	1.2	NA	8%	10%	NA	1.5%	2.0%	3.0%	
Ulvac	6728.T	CS	NA	JPY	3,245.0	NA	NA	1,498	1,362	(7)	17	1%	38%	NA	16.4	11.8	NA	1.0	0.9	NA	6%	8%	NA	2.7%	3.1%	2.0%	
Nanometrics	ONTO	NC	NA	USD	35.4	NA	NA	1,720	1,452	6	10	NM	45%	33%	22.9	15.8	11.9	2.9	NA	NA	7%	10%	NA	NA	NA	NA	
Cohu	COHU	NC	NA	USD	16.8	NA	NA	702	920	20	5	NM	625%	49%	105.2	14.5	9.8	1.5	1.5	1.4	2%	12%	17%	0.4%	NA	NA	
Average											151	63%	62%	30%	70.8	48.3	37.8	8.9	8.2	6.2	19%	21%	27%	0.6%	1.0%	1.2%	
Median											89	71	24%	32%	39%	30.9	20.5	23.2	7.1	6.7	6.6	16%	17%	25%	0.5%	0.7%	0.9%

Prices as of July 10, 2020. 1) NC = Not Covered; 2) CS=Coverage Suspended; 3) *Denotes stocks on our AEJ Conviction List

Source: Bloomberg, Goldman Sachs Global Investment Research, Gao Hua Securities Research

M&A Framework

Across our Greater China Technology and Telecom coverage, we examine stocks using an M&A framework, considering both qualitative factors and quantitative factors (which may vary across sectors and regions) to incorporate the potential that certain companies could be acquired. We then assign an M&A rank as a means of scoring companies under our rated coverage from 1 to 3, with 1 representing high (30%-50%) probability of the company becoming an acquisition target, 2 representing medium (15%-30%) probability and 3 representing low (0%-15%) probability. For companies ranked 1 or 2, in line with our standard departmental guidelines we incorporate an M&A component into our target price. M&A rank of 3 is considered immaterial and therefore does not factor into our price target, and may or may not be discussed in research.

We examine a companies' potential as M&A targets based on the assessment of: **1) potential M&A impediments**; such as shareholder structure / free float, industry regulations, and government policies; **2) qualitative factors**, including the attractiveness of technology, the attractiveness of its customer base, and cost synergy potential; and **3) quantitative factors**, including market cap and valuations.

Shareholder structure and potential M&A impediments

We gauge whether there are any impediments to M&A which would prevent a company from becoming an M&A target, even if it ranks 1 or 2 on qualitative/quantitative criteria.

When assessing potential impediments, we take into consideration:

1. Major shareholder preferences/ free float: We assume that shareholders with a 20% or greater stake have significant influence, or a blocking stake, and take into account: any potential actions by major shareholders in the event of a possible acquisition by a third party (including whether they would likely be receptive, or if they may be opposed to selling), or if they have announced a preference to raise their stake in the company;

2. Regulatory; and/or

3. Government policy impediments

We assign a "No" qualification if one or more of the three considerations above are applicable and a "Yes" qualification if these considerations do not apply.

Qualitative assessment criteria

1. Technology: We look at whether a company has attractive technology capable of generating future value, as well as its technological capabilities and intellectual property rights. We assign a rank of "3" if its technology is unattractive, "2" if it is moderately attractive, and "1" if it is very attractive.

2. Customer base: We look at whether a company has an attractive customer base and product applications. We also take customer retention and end-market exposure (including sales channels) into account. We assign a rank of "3" if its customer base and

product applications are unattractive, “2” if they are moderately attractive, and “1” if they are attractive.

3. Cost synergies: We look at prospects for growth in business scale and scope for profit margin/yield improvement via acquisition of an M&A target company. We assign a rank of “3” if there is low possibility of synergies, “2” if there is some possibility, and “1” if there is high possibility.

Two quantitative assessment criteria

1. Market cap: We rank the companies in our Greater China Technology and Telecom coverage in three tiers based on the assumption that the smaller a company is, the easier it is to be acquired. We also take regional qualities (such as differing market cap ranges between regions) into account.

2. Valuation: We look at whether a target company’s three-year average P/E and EV/DACF are below the industry/peer average for the same period, as we believe companies trading at a discount to peers are more likely to be acquired. We assign a rank of “3” if the company appears overvalued relative to its respective industry peer group, “2” if its valuation is in line with the peer average, and “1” if its valuation is discounted. We take into account differing valuation multiple ranges between the companies depending on their region and their peers.

M&A rank of 3 for Starpower

We believe Starpower has a low probability of becoming an M&A target and therefore assign a rank of “3”. Although Starpower has attractive product lines, we see a low probability of it becoming an M&A target given: 1) management holdings at 45%, which could imply higher resistance to the company being acquired, and 2) its higher-than-peers valuation at 86x 2022E P/E (vs. global power semi peers at 34x on average), which could make an acquisition relatively expensive.

M&A rank of 3 for CR Micro

We believe CR Micro has a low probability of becoming an M&A target and therefore assign a rank of “3”. Although CR Micro has a leading position in China IDM, we see a low probability of it becoming an M&A target given: 1) Limited technology attractiveness, 2) higher-than-peers valuation at 60x 2022E P/E (vs global power semi peers at 29x on average), which could make an acquisition relatively expensive.

M&A rank of 3 for Sanan

We believe Sanan has a low probability of becoming an M&A target and therefore assign a rank of “3”. Although Sanan is an early mover in the China compound semiconductor foundry business, we see a low probability of it becoming an M&A target mainly given: 1) Technology lagging behind global peers, 2) Different business segments including LED chip, LED lights, power amplifier, sapphire substrate, which could make it difficult for pure players to consolidate.

M&A rank of 3 for Montage

We believe Montage has a low probability of becoming an M&A target and therefore assign a rank of “3”. Although Montage has comprehensive product lines, we see a low probability of it becoming an M&A target mainly given: 1) Limited technology advantages compared to global memory interface IC peers, 2) Higher-than-peers valuation at 50x 2022E P/E vs global IC design peers average at 42x), which could make an acquisition relatively expensive.

M&A rank of 3 for AMEC

We believe AMEC has a low probability of becoming an M&A target and therefore assign a rank of “3”. Although AMEC has comprehensive product lines, we see a low probability of it becoming an M&A target mainly given: 1) State-owned institutional holdings at 41 % as of 2019, including CDB Innovation Capital and Shanghai Innovation Investment Limited (controlled by Shanghai State-owned Assets Supervision and Administration Commission) etc., 2) Higher-than-peers valuation at 131x 2022E P/E vs global peers average at 32x), which could make an acquisition relatively expensive.

M&A rank of 3 for Anji Micro

We believe Anji has a low probability of becoming an M&A target and therefore assign a rank of “3”. Although Anji Micro has a leading position in China semiconductor materials market, we see a low probability of it becoming an M&A target mainly given: 1) SOE holdings at 24% as of 2019, including China IC fund and Shanghai Zhangjiang Technology Venture Capital (managed by Shanghai State-owned Assets Supervision and Administration Commission) and 2) Limited technology advantages compared to global peers.

M&A rank of 3 for Wingtech

We believe Wingtech has a low probability of becoming an M&A target and therefore assign a rank of “3”. Although Wingtech has a leading position in China smartphone ODM and power semiconductor businesses (acquired Nexperia), we see a low probability of it becoming an M&A target mainly given: 1) Higher-than-peers valuation at 33x 2022E P/E (vs. global peers at 19x on average), and 2) Recent acquisition of Nexperia, which increased the complexity of company’s structure and has raised valuation.

M&A rank of 3 for AccoTest

We believe AccoTest has a low probability of becoming an M&A target and therefore assign a rank of “3”. Although AccoTest has a large customer base, we see a low probability of it becoming an M&A target mainly given: 1) Limited technology advantages compared to global peers, and 2) SOE holdings at 31 % as of 2019 (by China Times Prospect Science and Technology, a subsidiary of China Aerospace Science and Technology Corporation)

M&A rank of 3 for ACMR

We believe ACMR has a low probability of becoming an M&A target and therefore assign a rank of “3”. Although ACMR has comprehensive product lines, we see a low

probability of it becoming an M&A target mainly given: SOE holdings at 22%, including China IC fund, Shanghai Pudong Science and Technology, Shanghai Zhangjiang Technology Venture Capital.

M&A rank of 3 for NSIG

We believe NSIG has a low probability of becoming an M&A target and therefore assign a rank of "3". Although NSIG is a leader in China silicon wafer market, we see a low probability of it becoming an M&A target mainly given: 1) its technology is still lagging compared to global leaders, 2) higher-than-peers valuation with relatively lower earnings, valuation is at more than 100x 2022E P/E vs. global peers average at 18x.

M&A rank of 3 for Silan

We believe Silan has a low probability of becoming an M&A target and therefore assign a rank of "3". Although Silan is one of the major players in China power semiconductors market, we see a low probability of it becoming an M&A target mainly given: 1) limited technology advantages compared to peers and 2) Management holdings of 39%.

Exhibit 320: M&A ranks for Greater China semiconductors initiation

Company name	Shareholders' structure		Qualitative score (1-3)			Quantitative score (1-3)		Total score	M&A Rank
	Freefloat	No regulatory barrier	Technology	Customer base	Cost synergy	Market cap	Valuation		
StarPower	25%	Yes	2	3	3	3	3	2.8	3
CR Micro	18%	Yes	2	3	3	3	3	2.8	3
Sanan	46%	Yes	2	3	3	3	3	2.8	3
Montage	7%	Yes	3	3	3	3	3	3.0	3
AMEC	4%	Yes	2	3	3	3	3	2.8	3
Anji	23%	Yes	2	3	3	3	3	2.8	3
Wingtech	28%	Yes	3	2	3	3	2	2.6	3
AccoTest	23%	Yes	2	3	3	3	3	2.8	3
ACM Research	65%	Yes	2	3	3	3	2	2.6	3
NSIG	19%	Yes	3	3	3	3	3	3.0	3
Silan	52%	Yes	2	3	3	3	3	2.8	3

Source: Gao Hua Securities Research, Goldman Sachs Global Investment Research, Bloomberg

Within our framework, we assign a score of 3 for market cap for the 11 companies as all of them have a current market cap over US\$1bn. For context, in China's electronics/tech hardware space, it has been very rare to see transactions larger than US\$1bn (excluding outbound M&As). Over the past 15 years in A-Share tech/electronics space, there have been only 3 instances where transaction value was above US\$1bn and all of them were stake exchanges among SOEs (not actual M&As).

Milestones for key companies

AccoTest

- **2020:** IPO on the Science and Technology Innovation Board (STAR) in February
- **2018:** 1) Established its Chengdu technical support center, 2) Accumulated equipment shipment exceeded 2,000, 3) Launched STS8300 all-in-one testing equipment
- **2017:** High-end analog and mixed signal testing equipment started mass production
- **2014:** Started shipment of its first STS8250 testing equipment
- **2012:** Launched floating ground STS8200 testing equipment
- **2009:** Launched the first 32-site testing MOSFET testing equipment STS8202
- **2008:** Launched common ground STS8200 testing equipment
- **1993:** AccoTest established

ACM Research

- **2019:** 1) Introduced new Advanced Wafer Level Packaging and Multi Anode Partial Plating tools, 2) Introduced a new DRAM customer in China in 2Q19, 3) Announced it would acquire land rights for an R&D and production center in Shanghai's Lingang Region in Dec 2019
- **2018:** 1) Opened a new factory in Shanghai with 50,000 sqm, 2) introduced new "Ultra-C Tahoe" Wafer Cleaning Tool that uses 20% or less of the sulphuric acid compared to conventional high temperature single wafer cleaning tools, 3) Expanded into a new DRAM manufacturer in China
- **2017:** ACMR listed on the NASDAQ
- **2011:** Established a subsidiary in Wuxi, Jiangsu
- **2008:** ACM Research Shanghai won an R&D grant to develop and commercialize the 65-45nm stress-free Cu polishing technology (SFP)
- **2006:** ACMR expanded operation to Asia and established a subsidiary in Shanghai
- **2001:** Introduced the first product using stress-free copper polishing technology
- **1998:** ACMR established in Silicon Valley

AMEC

- **2019:** IPO on the Science and Technology Innovation Board (STAR) in July
- **2018:** Ranked 3rd in foundry equipment suppliers in Semiconductor Customer Satisfaction Survey by VLSIresearch, the only Chinese SPE suppliers with a ranking
- **2017:** 1) Etching equipment entered 7nm advanced node fab, 2) Developed the first twin-station ICP etching equipment
- **2016:** 1) Started shipment of its first single-station ICP etching equipment, 2) Developed 7nm dielectric etching equipment, 3) Started shipment of 2nd generation MOCVD equipment, 4) Started shipment of VOC equipment, 5) Shipped first 14nm dielectric etch product to key memory fab, and qualified to run 2D NAND flash production for critical contact etch
- **2015:** Installed base reached 400 process units
- **2013:** Shipped first 22nm dielectric etch product to key memory fab, and qualified to run 2D NAND flash production for critical contact etch
- **2012:** 1) Shipped first MOCVD product, 2) Phase II fab in Shanghai with 22,000sqm started operation
- **2011:** Shipped first 45nm dielectric etch product to major foundry, and qualified to run production for passivation and via applications
- **2010:** Shipped first TSV/MEMS/Plasma Dicing product
- **2007:** Shipped first CCP etching equipment
- **2005:** Phase I fab with 6,500sqm started operation
- **2004:** Established in Zhangjiang High Tech Park in Shanghai

Anji Micro

- **2019:** Listed on the SSE STAR Board
- **2018:** Over 190 authorized invention patents, including 140 in mainland China, 42 in Taiwan, 4 in the US, 3 in Singapore, and 1 in South Korea.
- **2017:** Ningbo II manufacturing base began production
- **2016:** Completed shareholding reform
- **2015:** Established Taiwan subsidiary
- **2009:** Entered the international market, expanding from domestic market
- **2008:** Mass production of first product in SMIC's 8" fab
- **2006:** Manufacturing site established in Jinqiao Export Processing Zone, Pudong New District, Shanghai
- **2004:** Established and R&D center founded in Zhangjiang Hi-Tech Park, Pudong New District, Shanghai

CR Micro

2018: 1) Launched mid-power wireless charger receiver IC, 2) Mass production of 600V TRENCH-FS IGBT, 3) Gen-1 6-inch 600V depletion-mode silicon substrate GaN power device chip successfully launched

2017: 1) Launched 6-inch 1200V JBS product, 2) Launched multi-cell lithium battery control IC, 3) Launched programmable photoelectric smoke detector circuit, 4) Mass production of Gen-3 high-voltage super-junction VDMOS products

2015: 1) Mass production of high-performance R series flat VDOMS products, 2) Mass production of low-power wireless pulse transmitting and receiving circuits, 3) Mass production of high-integration networked photoelectric smoke detection circuit

2013: Mass production of 3V low power photoelectric smoke detector circuit

2011: Mass production of 600-1200V NPT-IGBT products

2009: The first BMS achieved mass production

2008: 1) Launched 9V photoelectric and ionic smoke detection circuit products, 2) Mass production of flat VDMOS products, 3) Launched trench MOS products

Montage

- **2019:** 1) Jintide CPU started mass production, 2) High-performance DDR memory buffer controller chip design technology won First Prize in the Shanghai Technical Invention Awards
- **2018:** Montage's voltage stabilization technology won 20th China Patent Excellence Award
- **2017:** Montage's DDR4 Registering Clock Driver (RCD) M88DDR4RCD was awarded the China Chip: Best Market Performance Product Award granted by State Intellectual Property Office of China and WIPO
- **2016:** Launched Jintide CPU with Tsinghua University and Intel and high-performance server platform combining Jintide CPU with Montage's hybrid security memory module (HSDIMM)
- **2004:** Montage established in Shanghai

NSIG

- **2019:** NSIG completed acquisition of Simgui
- **2017:** Zing Semi shipment of 12" test wafer reached 22k in October
- **2016:** 1) NSIG acquired Okmetic and Zing Semi in July 2016, 2) Zing Semi produced its first 12" ingot
- **2015:** 1) NSIG established in Shanghai, funded by Guosheng group, Industry Investment Fund, Shanghai Jiading Development Group, Wu Yuefeng IC Fund and Simich Holdings, 2) Zing Semi launched 12" silicon wafer for 40-28nm project, 3) Okmetic expanded capacity for 8" silicon wafers and advanced SOI wafers, 4) Simgui partnered with Soitec and produced first 8" SOI wafers
- **2014:** subsidiary Zing Semi established
- **2001:** 1) Subsidiary Simgui established, 2) Okmetic's SOI wafer production line started
- **2000:** Okmetic IPO on the Helsinki Stock Exchange
- **1997:** Okmetic started new crystal and wafer plant in Vantaa, Finland
- **1987:** Okmetic's first crystal and wafer plant started in Espoo, Finland
- **1985:** subsidiary Okmetic established, a joint venture of Nokia and Outokumpu

Sanan

- **2019:** 1) VCSEL started mass production, 2) 5G base station PA started trial production, 3) Announced plan to develop high-end GaN LED substrate / epitaxial wafer / chip, high-end GaAs LED epitaxial wafer / chip, high-power GaN laser components and special packaging products
- **2018:** 1) 850nm 25G PD started mass production, 2) 0.15μm pHEMT LNA, P15LN pHEMT started mass production, 3) 650V, 1200V SiC Power SBD started mass production
- **2017:** 1) Wi-Fi 5 PA started mass production, 2) HBT HG for 4G started mass production, 3) 1310nm/1550nm 25G PD started mass production
- **2016:** HBT HR for 2G and HBT HL for 3G started mass production
- **2015:** 1st HL, HR started sampling, 1st MPW tapeout, Sanan IC 6" capacity reached 4k wpm
- **2014:** Established Xiamen Sanan Integrated Circuit (Sanan IC), entered into compound semiconductor market
- **2013:** "High-efficiency GaN-based green light semiconductor laser epitaxial technology" project was included as a key project of the "863" plan
- **2012:** 1) Three-dimensional spatially distributed electrode LED won the China Excellent Patent Award, 2) Concentrated GaInP / GaInAs / Ge triple junction solar cell technology project included in "863" project
- **2011:** Anhui Sanan LED Project Phase I started operation
- **2010:** Ultra-high-brightness LED chip for TFT-LCD backlight won the MIIT 2010 Information Technology Innovation Award
- **2009:** Certified China's first RS-B1 ultra-high brightness power red LED chip
- **2007:** Certified China's first red light power LED product
- **2006:** Power white LED manufacturing technology was included into the "863" plan

Silan

- **2019:** 1) Phase 1 of the first 12" production line completed the construction of the main plant, 2) Compound semiconductor manufacturing production line project began trial production
- **2018:** "High-speed, low-power, multi-chip, high-voltage module (>600V)" project won "2017 Zhejiang Science and Technology Progress First Prize"
- **2017:** 8" production line started operation in 2017, and Silan became the first IDM company in China with an 8-inch production line
- **2016:** Launched the first single-chip six-axis inertial sensor in China
- **2015:** 8" production line started construction in 2015
- **2014:** Epitaxial silicon project put into trial production
- **2013:** Launched IGBT products for welding machines and inverters
- **2011:** Launched the first power module with independent chips applied to inverter motor drive
- **2010:** Entered the power module packaging business
- **2009:** Entered LED packaging business
- **2007:** Launched the first high-efficiency power LED driver circuit manufactured by Silan's integrated BCD process
- **2006:** Shanghai R&D Center established
- **2005:** Silicon Valley R&D Center established
- **2004:** Entered the manufacturing business of high-brightness LED chips
- **2003:** Listed successfully

StarPower

- **2019:** 1) Developed double-sided welding, 2) Developed plastic sealing
- **2017:** Developed design and packaging of multifunctional integrated power components
- **2015:** 1) Developed silver paste sintering, 2) Developed copper wire bonding
- **2013:** 1) Developed ultrasonic welding terminal, 2) Developed copper substrate integrated heat sink
- **2012:** 1) Developed multi-DBC parallel technology, 2) Developed series and parallel, dynamic and static, current-sharing, equalized voltage technology
- **2011:** 1) Developed electromagnetic field distribution simulation, 2) Developed metal terminal housing plug and injection
- **2010:** 1) Optimized electromagnetic field and temperature field distribution inside the module, 2) Connected DBC board to the heat sink directly
- **2007:** Developed Vacuum hydrogen pore-free welding technology, ultrasonic bonding technology, testing and aging technology
- **2005:** StarPower established

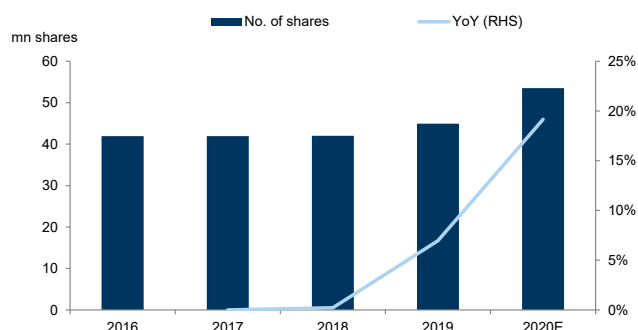
Wingtech

- **2020:** 1) Became the main ODM supplier of global top 10 mobile phone brands, 2) GaN-on-Si began to mass-produce and deliver
- **2019:** Kunming manufacturing base began construction; India and Indonesia manufacturing bases began production
- **2018:** M&A Nexperia
- **2016:** Listed successfully
- **2012:** Became the largest ODM globally
- **2009:** Co-operated with carriers
- **2008:** 1) Jiaxing manufacturing base began production, 2) provided complete machine manufacturing service; transition from IDH to ODM
- **2007:** 1) launched a single chip dual card standby technology, 2) became the largest shipments IDH company in China
- **2006:** Established and engaged in mobile phone solution design

Restricted shares, shareholding structure, and management background

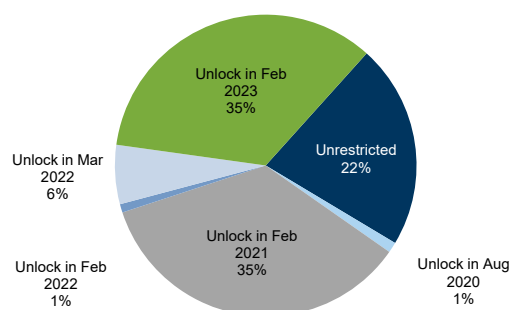
AccoTest

Exhibit 321: AccoTest share count increased by 7% / 19% in 2018 / 19



Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 322: AccoTest free float vs restricted stocks



As of Jun 24 2020

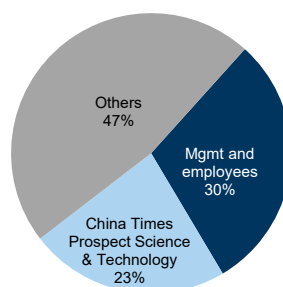
Source: Wind

Exhibit 323: Unlock schedule of restricted shares

Unlock date	Number of shares (mn)			Proportion of the unlocked shares (%)		
	Floating shares before unlocking	Unlocked shares	Floating shares after unlocking	% floating shares before unlocking	% floating shares after unlocking	% total shares
2023-02-20	40.02	21.16	61.19	52.87	34.59	34.59
2022-03-25	36.13	3.89	40.02	10.76	9.72	6.36
2022-02-18	35.58	0.56	36.13	1.57	1.55	0.91
2021-02-18	13.94	21.64	35.58	155.28	60.83	35.37
2020-08-18	13.24	0.69	13.94	5.23	4.97	1.13
2020-02-18	0.00	13.24	13.24	--	100.00	21.64

Source: Wind

Exhibit 324: AccoTest shareholding structure



As of 10/20

Source: Company data

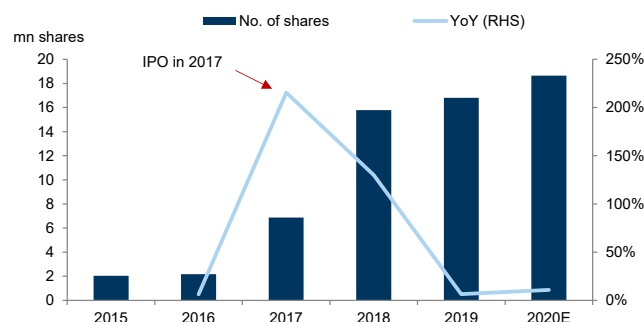
Management team

AccoTest's management and employees have 30% holdings in aggregate through Tianjin Xinhua Investment. Board Secretary has c.3% holding and General Manager has c.2% holdings.

- **Chairman - Zheng Lianying:** served as the General Manager of Hangtian Saide and Party Secretary of China Times Prospect Science & Technology, a subsidiary of Space China Group.
- **Director - Zhang Hongbin:** current director of Hangtian Saide, Vice Minister of Finance at China Academy of Aerospace Electronics Technology, and served as CFO of China Times Prospect Science & Technology.
- **Director, General Manager - Cai Lin:** Joined AccoTest as Manager of Marketing in 1998, obtained master degree in Engineering from Hong Kong Polytechnic University.
- **Director, Deputy General Manager, Board Secretary - Sun Qiang:** Joined AccoTest as R&D Engineer in 1997, obtained master degree in Mechanical Design from Tsinghua University.
- **Director, Deputy General Manager - Fu Weidong:** Joined AccoTest since 1993, obtained Bachelor Degree in Applied Computer Science at Beijing School of Light Industry.
- **Director, Deputy General Manager - Xu Jieshuang:** Joined AccoTest in 2009, served as General Manager of Kejinte Electronics (Shanghai) and engineer at the 809th Institute of Shanghai Space Administration before joining AccoTest.
- **Core technology personnel - Sun Xi:** worked in China Academy of Launch Vehicle Technology factory No. 200, with 30+ years of experience in semiconductor testing industry.

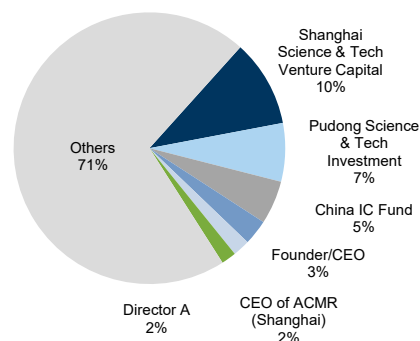
ACM Research

Exhibit 325: ACMR share count increased by 6% in 2019



Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 326: ACMR shareholding structure



As of Jun 2020

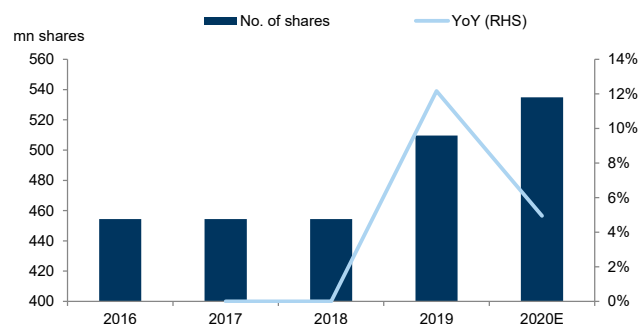
Source: Bloomberg, Company data, Goldman Sachs Global Investment Research

Management team

- **Founder/CEO - David Wang:** ACMR's founder received a Ph.D. and Master of Engineering in Precision Engineering from Osaka University and a Bachelor of Science in Precision Instruments from Tsinghua University. He is the inventor of stress-free Cu polishing technology, and he holds more than 100 patents in semiconductor equipment and process technology. Founder/CEO has 3% holdings in the company as of Jun 2020.
- **CEO of ACMR (Shanghai) - Wang Jian:** served as the Vice President of Research and Development of ACMR (Shanghai) since Jan 2015. He received a Master of Science in Computer Science from Northwestern Polytechnic University, a Master of Science in Marine Engineering from Kobe University and a Bachelor of Science in Mechanical Engineering from Southeast University. CEO of ACMR (Shanghai) has 2% holdings in the company as of Jun 2020.
- **Director - Dun Haiping:** served as an ACM director since 2004. Prior to joining ACMR, he served as Senior Director at Intel and President of Champion Microelectronic. He received his Ph.D. in Materials Science and Engineering from Stanford University, a Master of Science in Physics from the University of Washington and a Bachelor of Science in Physics from National Taiwan University.

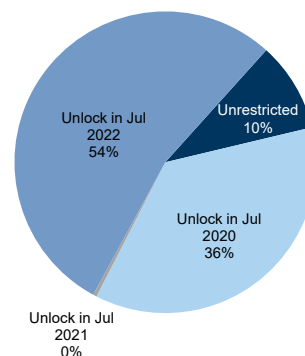
AMEC

Exhibit 327: AMEC share count trend



Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 328: AMEC free float vs restricted stocks



As of Jun 2020

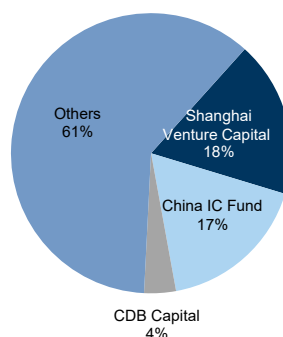
Source: Wind

Exhibit 329: Unlock schedule of restricted shares

Unlock date	Number of shares (mn shares)			Proportion of the unlocked shares (%)		
	Floating shares before unlocking	Unlocked shares	Floating shares after unlocking	% floating shares before unlocking	% floating shares after unlocking	% total shares
2022-07-22	247.47	287.39	534.86	116.13	53.73	53.73
2021-07-22	245.40	2.07	247.47	0.84	0.84	0.39
2020-07-22	51.42	193.98	245.40	377.27	79.05	36.27
2020-01-22	48.43	2.99	51.42	6.18	5.82	0.56
2019-07-22	0.00	48.43	48.43	—	100.00	9.05

Source: Wind

Exhibit 330: AMEC shareholding structure



As of 1Q20

Source: Company data

Management team

- **Chairman and President - Yin Zheyao (Gerald):** Served as CTO of plasma etching equipment at Applied Materials during 1991-2004, R&D Manager at LAM Research during 1986-1991, process technology engineers at Intel during 1984-1986
- **Director, Deputy General Manager - Du Zhiyou:** Served as Manager of Mettler Toledo (Shanghai) during 2001-2004, and Supply Chain Manager of Applied Materials during 1999-2001

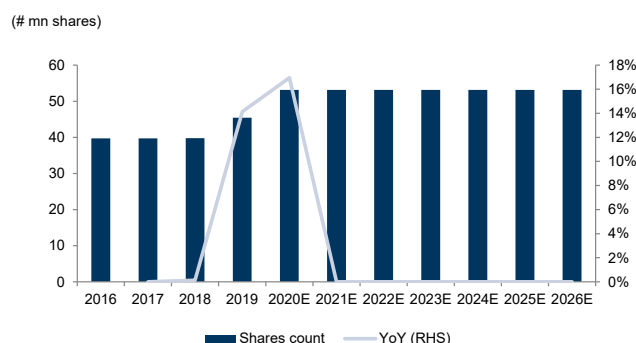
Anji Micro

Exhibit 331: Unlock schedule of restricted shares

Unlock date	Number of shares ('0000 shares)			Proportion of the unlocked shares (%)		
	Floating shares before unlocking	Unlocked shares	Floating shares after unlocking	% floating shares before unlocking	% floating shares after unlocking	% total shares
2022-07-22	3,054.81	2,256.03	5,310.84	73.85	42.48	42.48
2021-07-22	2,988.42	66.39	3,054.81	2.22	2.17	1.25
2020-07-22	1,220.60	1,767.82	2,988.42	144.83	59.16	33.29
2020-01-22	1,157.50	63.11	1,220.60	5.45	5.17	1.19
2019-07-22	0.00	1,157.50	1,157.50	—	100.00	21.79

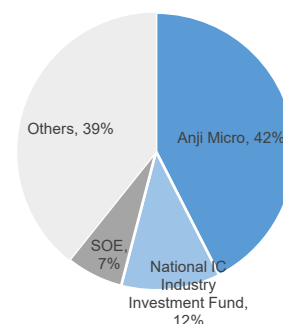
Source: Wind

Exhibit 332: Share count trend



Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 333: Anji shareholding structure



As of 1Q20

Source: Wind

Management team

- **Chairman and CEO - Wang Shumin:** Former postdoctoral fellow in materials chemistry at Rice University, postdoctoral fellow in material chemistry at University of Houston, researcher at the R&D headquarters of IBM, scientist/project manager/technical director in Asia at Cabot Microelectronics. From Sep 2004 to present, she has served as CEO, director, chairman, executive director of Anji. She has a Ph.D. degree in Material Chemistry from Rice University.
- **Vice President - Wang Yuchun:** Former engineer at Applied Materials, technical manager at NuTool, technical expert and project leader at Cabot Microelectronics, global product manager and senior technical manager at Applied Materials. From Jun 2017 to present, he has served as the Vice President of Anji. He has a Ph.D. degree in Material Engineering from University of California, Berkeley.
- **Product management director - Jing Jianfen:** Senior engineer of Shanghai (engineering series) IC major, former director of the technical department of Shanghai Nano New Material. From Jan 2005 to present, she has served as R&D engineer, R&D manager, R&D director, and product management director of Anji. She has a master degree in Materials Science from East China University of Science and Technology.
- **Product management director - Peng Hongxiu:** Senior engineer of Shanghai (engineering series) IC major, former senior associate engineer and manager of SMIC. From Sep 2005 to present, he has served as senior R&D manager and

product management director of Anji. He has a master degree in Materials Science from East China University of Science and Technology.

- **Product quality director - Wang Xucheng:** Former process support supervisor of Applied Materials (China), service engineer of Innovelight. From Sep 2011 to present, he served as the product manager and director of product quality in Anji. He has a master degree in Physical Chemistry from Fudan University.

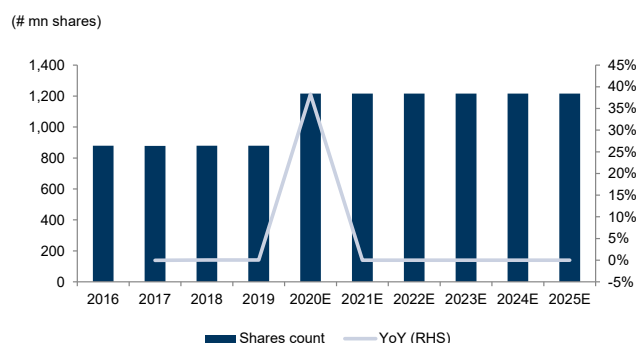
CR Micro

Exhibit 334: Unlock schedule of restricted shares

Unlock date	Number of shares ('0000 shares)			Proportion of the unlocked shares (%)		
	Floating shares before unlocking	Unlocked shares	Floating shares after unlocking	% floating shares before unlocking	% floating shares after unlocking	% total shares
2023-02-27	33,694.30	87,898.21	121,592.52	260.87	72.29	72.29
2022-02-28	32,913.05	781.25	33,694.30	2.37	2.32	0.64
2021-03-01	24,904.48	8,008.57	32,913.05	32.16	24.33	6.59
2020-08-27	23,713.70	1,190.78	24,904.48	5.02	4.78	0.98
2020-02-27	0.00	23,713.70	23,713.70	—	100.00	20.23

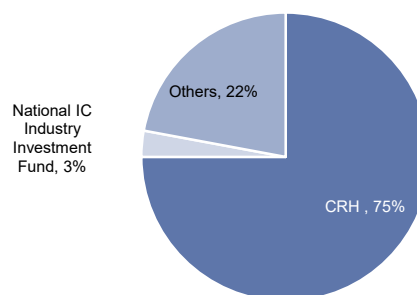
Source: Wind

Exhibit 335: Share count trend



Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 336: CR Micro shareholding structure



As of 1Q20

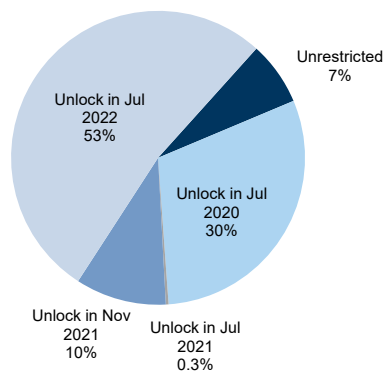
Source: Wind

Management team

- **Chairman - Li Fuli:** From 2010 - 2018, former Vice President and Deputy General Manager in China Minmetals Group; former director and deputy general manager in China Minmetals Corporation. He has an MBA degree from Cheung Kong Graduate School of Business (CKGSB).
- **Executive Vice Chairman, CIO - Chen Nanxiang:** From 2013 - 2014, former general manager of R&D Center in CR Micro. Current Vice President of CSIA, Vice President of ICTIA. He has a Ph.D. degree in Ion Beam Physics and Integrated Circuit Applications from Beijing Normal University.
- **Head of Pioneer Technology R&D Center - Wang Guoping:** From 2014 - 2019, former general manager of R&D Center in CR Micro. He has a master degree in Engineering from Chengdu Institute of Telecommunication Engineering
- **CEO of CR Micro (Chongqing), Head of Power Semiconductor Technology Innovation Center - Li Hong:** From 2014 - 2017, former Executive Deputy General Manager in China Resources Huajing. He has a Ph.D. degree in Physics from University of Wisconsin.
- **Deputy general manager of Wuxi CR Shanghua Semiconductor, deputy head of Pioneer Technology R&D Center - Su Wei:** From 1998 - 2012, Su was the R&D director and Deputy General Manager in Wuxi China Resources Semiconductor. He has a master degree in Software Engineering from Southeast University.

Montage

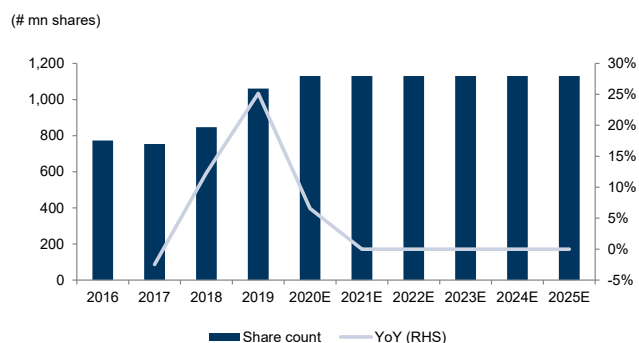
Exhibit 337: Montage free float vs restricted shares



As of Jun 2020

Source: Wind, Company data

Exhibit 338: Share count trend



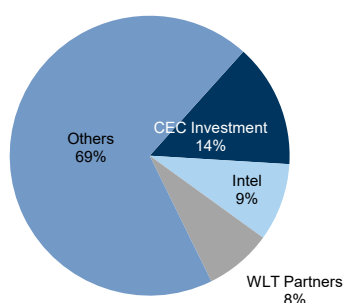
Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 339: Unlock schedule of restricted shares

Unlock date	Number of shares (mn shares)			Proportion of the unlocked shares (%)		
	Floating shares before unlocking	Unlocked shares	Floating shares after unlocking	% floating shares before unlocking	% floating shares after unlocking	% total shares
2022-07-22	536.57	593.24	1,129.81	110.56	52.51	52.51
2021-11-22	423.59	112.98	536.57	26.67	21.06	10.00
2021-07-22	420.20	3.39	423.59	0.81	0.80	0.30
2020-07-22	79.09	341.11	420.20	431.30	81.18	30.19
2020-01-22	74.38	4.70	79.09	6.32	5.95	0.42
2019-07-22	0.00	74.38	74.38	--	100.00	6.58

Source: Wind

Exhibit 340: Montage shareholding structure: 14% by CEC Investment



As of 1Q20

Source: Company data

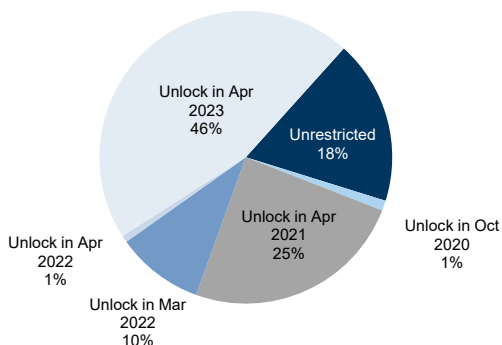
Management team

- **Chairman, CEO, Co-founder - Yang Chonghe:** Worked in National Semiconductor and Shanghai Belling, founded Xintao Technology in 1997, and co-founded Montage with Stephen Kuong-lo Tai in 2004.
- **Director, General Manager, Co-founder - Stephen Kuong-lo:** Served as the design engineer at Sigmax Technology, Director of Engineering at Marvel, and co-founded Montage in 2004

- **Director - Deng Xiangdong:** Served as the General Manager of CEC Investment and Director of Finance Department at 5th Academy of Aerospace Engineering. He is also the current Chairman of CEC Investment.
- **Director - Li Rongxin:** Served as the Product Manager of Shanghai Belling, Director at Intel (Shanghai), General Manager at Hua Hong, Director and Deputy General Manager at HDSC.

NSIG

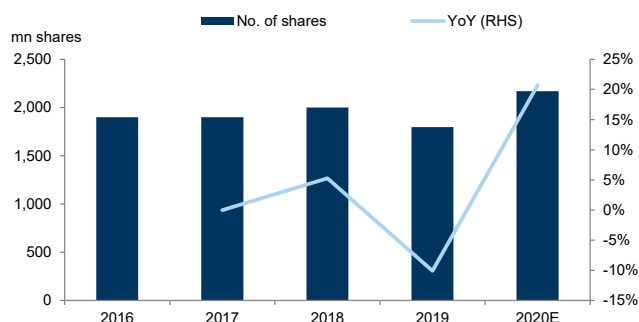
Exhibit 341: NSIG free float vs restricted stock



Data as of Jun 2020

Source: Wind

Exhibit 342: NSIG share count trend



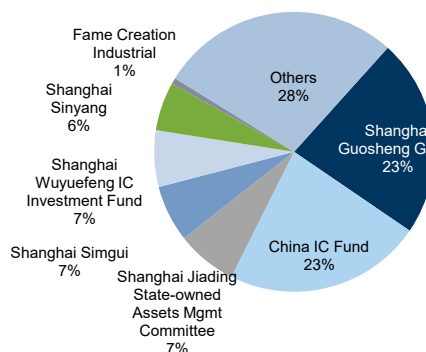
Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 343: Unlock schedule of restricted shares

Unlock date	Number of shares (mn shares)			Proportion of the unlocked shares (%)		
	Floating shares before unlocking	Unlocked shares	Floating shares after unlocking	% floating shares before unlocking	% floating shares after unlocking	% total shares
2023-04-20	1,346.26	1,134.00	2,480.26	84.23	45.72	45.72
2022-04-20	1,327.66	18.60	1,346.26	1.40	1.38	0.75
2022-03-29	1,087.47	240.19	1,327.66	22.09	18.09	9.68
2021-04-20	477.62	609.84	1,087.47	127.68	56.08	24.59
2020-10-20	449.82	27.80	477.62	6.18	5.82	1.12
2020-04-20	0.00	449.82	449.82	--	100.00	18.14

Source: Wind

Exhibit 344: NSIG shareholding structure



As of 10/20

Source: Company data

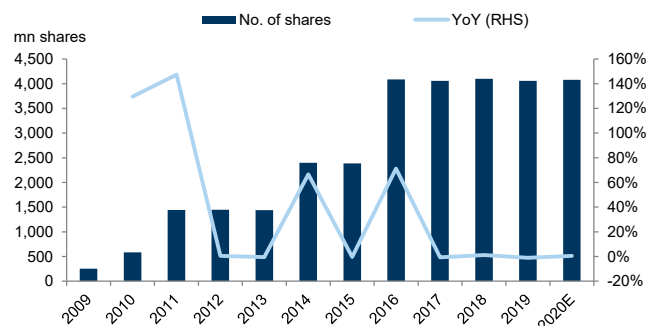
Management team

- **Chairman - Yu Yuehui:** Served as the Deputy General Manager in Simgui Technology during 2002-2005, served as Director of Education, Researcher, Party Secretary at Shanghai Institute of Microsystem and Information Technology Chinese Academy of Sciences since 2006
- **Vice Chairman - Dai Minmin:** Worked in Shanghai Municipal Government Office during 2000-2013, and Shanghai Emergency Office during 2013-2015. Served as the Vice President of Guosheng Group since 2017.

- **Vice Chairman - Ren Kai:** Worked in China Development Bank during 1995-2014, and served as Vice President of Huaxin Investment Management.
- **Director - Sun Jian:** Worked in Shanghai No.2 Optical Instrument Factory during 1985-2002, D'Long International Strategic Investment during 2002-2009, Yangtze River Computer during 2009-2016, Guosheng Investment since 2009, and is the current CIO of Guosheng Group.

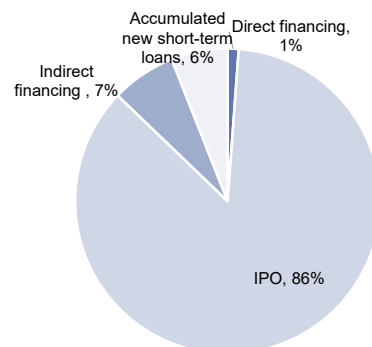
Sanan

Exhibit 345: Share count trend



Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 346: Funding composition in history



Data as of Jun 2020

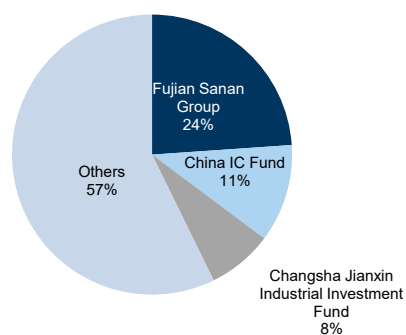
Source: Wind

Exhibit 347: Unlock schedule of restricted shares

Unlock date	Number of shares (mn shares)			Proportion of the unlocked shares (%)		
	Floating shares before unlocking	Unlocked shares	Floating shares after unlocking	% floating shares before unlocking	% floating shares after unlocking	% total shares
2017-02-03	4,042.09	36.33	4,078.42	0.90	0.89	0.89
2016-12-15	3,792.61	249.49	4,042.09	6.58	6.17	6.12
2015-01-28	2,166.02	204.36	2,370.38	9.43	8.62	8.54
2014-08-22	2,024.26	141.76	2,166.02	7.00	6.54	5.92
2013-07-09	1,277.31	72.20	1,349.51	5.65	5.35	5.00
2013-03-20	1,205.11	72.20	1,277.31	5.99	5.65	5.00
2011-10-13	982.91	222.20	1,205.11	22.61	18.44	15.39
2011-07-12	477.15	505.76	982.91	106.00	51.46	35.02
2010-09-29	153.89	63.00	216.89	40.94	29.05	11.34
2010-07-21	149.89	4.00	153.89	2.67	2.60	0.72
2009-09-07	70.34	4.60	74.94	6.55	6.14	1.87
2008-07-08	58.62	11.72	70.34	20.00	16.67	4.76

Source: Wind

Exhibit 348: Sanan shareholding structure



As of 1Q20

Source: Company data

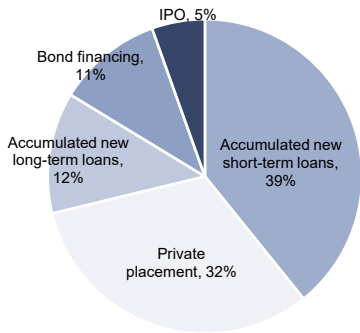
Management team

- **Chairman - Lin Zhiqiang:** Served as the Chairman of Hunan Sanan Mining, Director and Deputy General Manager of Fujian Sanan Group, Chairman of Xiamen Guoguang Industry and Trade, and Deputy of 16th NPC in Xiamen Siming district.

- **Vice Chairman, General Manager - Lin Ke Chuang:** Served as the Deputy General Manager of Fujian Sanan Group.
- **Director - Ren Kai:** Served as a member of the Judging Board in China Development Bank. He is the current Vice President of Huaxin Investment Mgmt., Director of JCET (Suzhou), and Suzhou Changdian Xinpeng Investment.
- **Director - Kan Hongzhu:** Worked as an official in the government of Shitang, Anhui, served as the Deputy Director of Longcheng Towel Factory in Feidong, Anhui, Deputy General Manager of Xiamen Aidi Electronics, and General Manager of Fujian Jianchenglong Industrial Development before joining Sanan.
- **Director, Deputy General Manager - Wei Daman:** Served as the General Manager of Sangang Machinery Manufacturing, Assistant General Manager of Sangang Group, Deputy General Manager of Sangang (Minguang), and Director & Deputy General Manager of Sangang Group.

Silan

Exhibit 349: Funding composition in history



Data as of Jun 2020

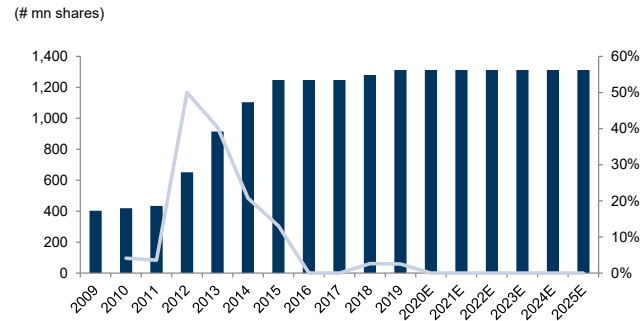
Source: Wind

Exhibit 350: Unlock schedule of restricted shares

Unlock date	Number of shares ('0000 shares)			Proportion of the unlocked shares (%)		
	Floating shares before unlocking	Unlocked shares	Floating shares after unlocking	% floating shares before unlocking	% floating shares after unlocking	% total shares
2019-01-14	124,716.80	6,489.36	131,206.16	5.20	4.95	4.95
2014-09-03	112,860.80	11,856.00	124,716.80	10.50	9.51	9.51
2011-09-14	40,408.00	3,000.00	43,408.00	7.42	6.91	6.91
2008-11-03	21,692.74	18,715.26	40,408.00	86.27	46.32	46.32
2007-11-02	19,672.33	2,020.40	21,692.74	10.27	9.31	5.00
2007-03-06	17,651.94	2,020.40	19,672.33	11.45	10.27	5.00
2006-11-02	14,144.00	3,507.93	17,651.94	24.80	19.87	8.68
2005-11-02	5,200.00	1,872.00	7,072.00	36.00	26.47	9.27

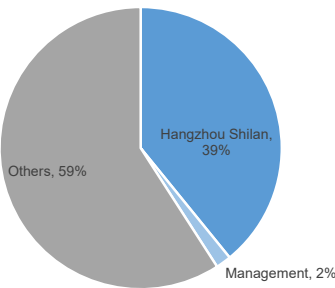
Source: Wind

Exhibit 351: Share count trend



Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 352: Silan shareholding structure



Data as of Jun 2020

Source: Bloomberg

Management team

- **Chairman - Chen Xiangdong:** From 1997 to present, Chen has worked in multiples roles including the Chairman of Silan, Silan Integration, Silan Jixin, Silan Mingxin and Silan Optoelectronics.

- **Vice Chairman, CEO - Zheng Shaobo:** From 1997-present: Vice Chairman of Silan. From 2005 to present: CEO of Silan, supervisors of Silan Integration, Silan Jixin, Silan Mingxin, etc.
- **Vice President - Li Zhigang:** From 2000 to present: Vice President of Silan. From 2003 to present: CEO of Shenlanwei. From 2004 to the present: CEO of Shigang Technology.
- **Vice President - Wu Jianxing: Current Vice President.** From 2000 to present: Vice Director of design institute.
- **Director of Design Institute - Song Weiquan:** Current chairman of Board of Supervisors, Director of Design Institute.

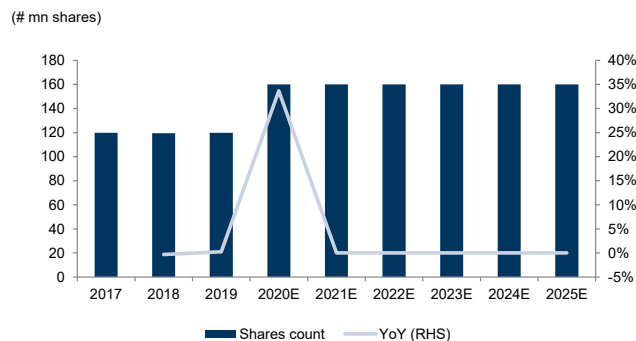
StarPower

Exhibit 353: Unlock schedule of restricted shares

Unlock date	Number of shares ('0000 shares)			Proportion of the unlocked shares (%)		
	Floating shares before unlocking	Unlocked shares	Floating shares after unlocking	% floating shares before unlocking	% floating shares after unlocking	% total shares
2023-02-06	7,895.72	8,104.28	16,000.00	102.64	50.65	50.65
2021-02-04	4,000.00	3,895.72	7,895.72	97.39	49.34	24.35
2020-02-04	0.00	4,000.00	4,000.00	--	100.00	25.00

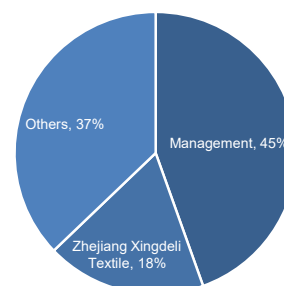
Source: Wind

Exhibit 354: Share count trend



Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 355: StarPower shareholding structure



Data as of Jun 2020

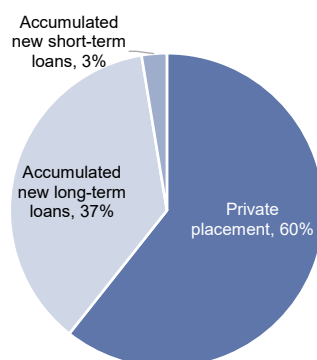
Source: StarPower

Management team

- **Chairman, CEO - Shen Hua:** From 1999 - 2006: Former senior project manager in XILINX. Shen founded StarPower in 2005. He has a Ph.D. degree in Materials Science, MIT.
- **Director, Vice President - Hu Wei:** From 1995 - 2001: Former marketing director, Executive Senior Vice President's assistant, strategic planning manager in Provident Financial. Co-founded StarPower in 2005. She has a Masters degree in Engineering Economic System from Stanford University.
- **Vice President - Tang Yi:** From 2003 - 2015: Former senior supervisor engineer, senior manager for IGBT design in International Rectifier. From 2015 to present, responsible for IGBT chip technology R&D in StarPower. He has a Ph.D. degree in Electronic engineering from Rensselaer Polytechnic Institute (RPI).
- **Vice President - Dai Zhizhan:** From 2002 - 2009: Former manager of R&D Department, senior manager of power supply application department in Qiankun Technology. He has a master degree in Electronic engineering from National Tsinghua University.
- **Vice President - Xu Haoping:** From 2001- 2009: Former senior manager of business department in Huateng Electronic Technology (Suzhou). He has a bachelor degree from Nanjing University.

Wingtech

Exhibit 356: Funding composition in history



Data as of Jun 2020

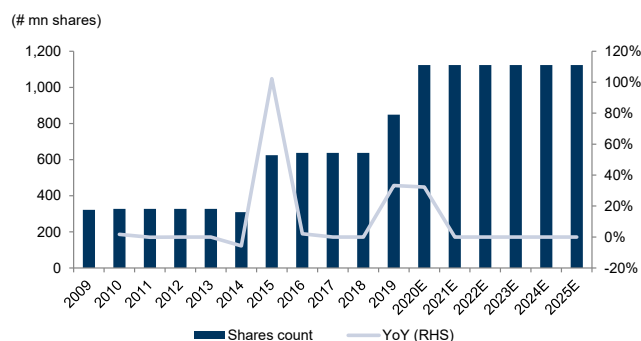
Source: Wind

Exhibit 357: Unlock schedule of restricted shares

Unlock date	Number of shares ('0000 shares)			Proportion of the unlocked shares (%)		
	Floating shares before unlocking	Unlocked shares	Floating shares after unlocking	% floating shares before unlocking	% floating shares after unlocking	% total shares
2022-10-31	81,970.12	30,433.25	112,403.37	37.13	27.08	27.08
2020-12-21	73,633.45	8,336.67	81,970.12	11.32	10.17	7.42
2020-11-02	63,726.64	9,906.81	73,633.45	15.55	13.45	8.81
2018-12-28	48,332.04	15,394.60	63,726.64	31.85	24.16	24.16
2015-09-18	32,737.49	15,594.55	48,332.04	47.64	32.27	32.27
2011-10-19	32,229.09	508.40	32,737.49	1.58	1.55	1.55
2011-07-08	9,366.14	22,862.95	32,229.09	244.10	70.94	69.84
2010-07-08	8,148.69	1,217.45	9,366.14	14.94	13.00	3.72
2010-05-04	7,539.97	608.72	8,148.69	8.07	7.47	1.86
2010-01-08	7,444.47	95.50	7,539.97	1.28	1.27	0.29
2009-09-29	6,835.74	608.72	7,444.47	8.91	8.18	1.86
2009-07-08	5,352.74	1,483.00	6,835.74	27.71	21.69	4.53
2008-07-08	4,675.94	676.80	5,352.74	14.47	12.64	2.07

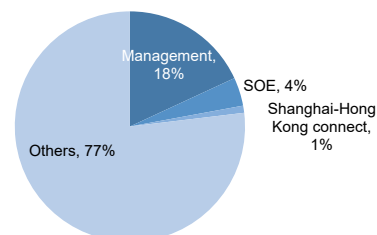
Source: Wind

Exhibit 358: Share count trend



Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 359: Wingtech shareholding structure



Data as of Jun 2020

Source: Bloomberg

Management background

- **Chairman and CEO - Zhang Xuezheng:** Former Chairman and CEO of Wingtech Communications. He has a Master degree from Tsinghua University.
- **Director - Zhang Qihong:** Former Deputy General Manager of Jiaxing Jingsu Communication. Current CEO of Jiaxing Electronics and supervisor of Wentianxia.
- **Independent Director - Wang Yanhui:** Former Secretary General of China Communications Industry Association (CCIA). Founder of Jiwei website.
- **Vice Chairman of Wingtech Communications - Xiao Xuebing:** Former sales manager of ZTE.

An ESG blueprint for China's developing semiconductor sector

This section was contributed by the Head of GS SUSTAIN research for Asia, Sharmini Chetwode

Limited data disclosure makes it challenging to assess China Semiconductors' ESG performance on the GS SUSTAIN framework. Of the 11 companies we initiate on in this report, three (Hangzhou Silan, Wingtech and Sanan) are included in MSCI ACWI but still have low ESG disclosure rates of 0-4% versus the global Semiconductor average disclosure rate of 57% and 49% in AEJ. The Resource Intensity and Waste & Emissions categories house the bulk of the 28 measurable datapoints we analyze for E&S performance in the sector, and where we believe global investors are focused.

We therefore need a qualitative approach to begin to assess ESG performance in this sector. We highlight some key areas where we think focus is warranted at the end of this section. Even with qualitative analysis, ESG assessment needs to be considered against a range of business models that exist in the semi peer group: foundry (wafer manufacturing), fabless (chip-design only), IDM (design to end-user). The last two have significantly smaller environmental footprints than foundries.

In China, much of Environmental ESG risk is managed through State and provincial regulations. Below we discuss waste water and air pollution regulations which at first glance don't seem to put an immediate burden on semiconductor companies, but could create reputational and legal challenges if investments are not made in order to comply over time. We also see potential talent shortages as a risk which companies and other stakeholders will need to consider as human resource management will be key to driving the industry's growth.

Longer term, we expect that these companies will disclose more data in order to better attract investment. Disclosure momentum should accelerate once [China's ESG disclosure requirements](#) for listed companies are launched, potentially this year. We also see potential spillover effects to global companies from regulations like the EU Taxonomy. China may also introduce a green taxonomy in the future to equip investors to objectively assess the sustainability of a company.

Regulations

Addressing waste water and air pollution has been core to China's environmental agenda. Semiconductor companies fall within the scope of waste water and air pollution regulations which were set specifically for the sector in March 2018, in anticipation of major growth in the industry.

While this new set of sector-specific regulations is more stringent than the general standard that came before it, the Ministry of Ecology and Environment (MEE) believes that compliance costs (e.g. purchase and maintenance of environmental equipment) should not be a significant cost burden to semiconductor companies. The regulations came into effect for new companies in 2019. Existing companies will fall under it from 1st Jan 2021.

Failure to comply with the specific thresholds set for **waste water pollutants** (e.g. biochemical & heavy metal contamination), **air pollutants** (e.g. volatile organic

compounds (VOCs) & particulate matter (PM)), and on-site monitoring requirements will result in environmental penalties. Certain local governments (e.g. Beijing and Jiangsu Province) have since released their own standards with even more stringent guidelines. For companies looking for financing through international banks that follow Equator Principles¹, the **energy efficiency** of their manufacturing processes and **employee health and safety** will be another two areas to address.

From a human capital management perspective, the semiconductor industry in China has long struggled with talent shortages as the industry continues to grow. In 2021, the integrated circuit sub-sector alone will be faced with a talent shortage amounting to 261,000 (according to a White Paper by China Center for Information Industry Development on China Integrated Circuit Industry Talent Management). The lack of talent is especially evident when it comes to design and leadership functions which are key to companies' competitiveness. Employee compensation will be critical, as the industry competes with high-paying tech sectors, who share a similar talent pool. In 2017, the average monthly compensation for the semiconductor industry was around CNY 9,120 (China Center for Information Industry Development) vs CNY 10600 for IT (according to a White Paper by Zhipin, a recruitment platform on Internet Talent Trends). The gap is even bigger for senior positions, causing the semiconductor industry to lose some college graduates to IT and software industries.

Key sustainability considerations

Below we highlight what we see as key sustainability-related issues for semiconductor companies. For an example of a case study, please see [TSMC](#).

Environmental

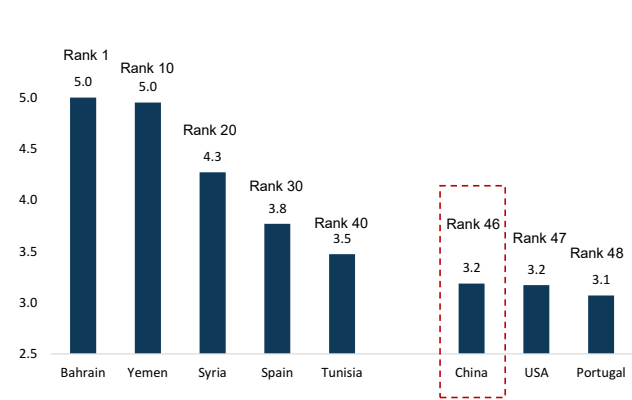
- **Strategy to reduce Scope 1 and perfluorinated compound (PFCs) emissions.** PFCs are a major component of the industry's emissions which occur from the chamber cleaning process in semiconductor manufacturing. For context, fluorinated greenhouse gases (F-GHG) represent 80% of TSMC's emissions. Although foundries and equipment manufacturers have a higher emissions intensity, it is important to take emissions strategies into consideration as PFCs have 6,000x the global warming effect of CO₂.
- **Management of energy consumption.** Due to the energy intensive manufacturing process, it is also important to understand how companies are managing energy consumption and whether they are able to increase usage of renewable energy.
- **Strategies to minimize potential water supply disruptions or cost increases, particularly in water stressed regions.** As issues of water scarcity become more severe in certain pockets of the world, it is important for companies to have contingency measures to respond to shortages in water supply. The semiconductor sector has the 10th highest median water intensity in our GS SUSTAIN framework (among 38 sectors), highlighting the importance of proper water management

¹ 105 financial institutions in 38 countries as of today have adopted Equator Principles, which apply environmental and social considerations to new financial products including project finance advisory services, project finance, project-related corporate loans and bridge loans.

strategies and water recycling practices. China Water Risk highlights 11 provinces (“Dry 11”) including Jiangsu, Shanghai and Shanxi that face risks from high water stress. Some of these regions are also among the largest semiconductor hubs in China.

Exhibit 360: China is the 46th most water stressed country (out of 167), based on estimates from WRI

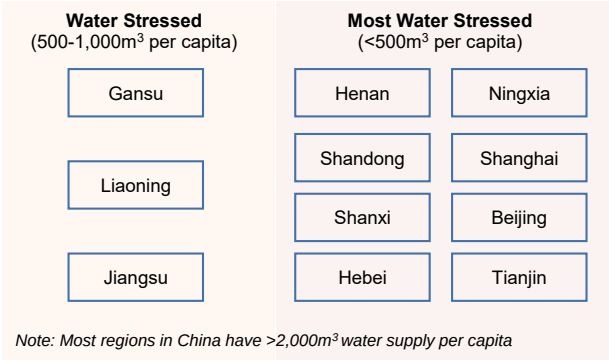
Water stress score and rank by countries (2020)



Source: World Resources Institute

Exhibit 361: Major regions with large semiconductor production capacity such as Shanghai and Jiangsu are water stressed

China’s most water stressed regions (“Dry 11”)



Source: China Water Risk, China Statistical Yearbook, UN FAO

- **Primary sources of hazardous waste, and strategies to reduce these waste streams.** Semiconductors is the 5th most intensive sector in terms of hazardous waste in the MSCI ACWI, as the manufacturing process creates a host of toxic by-products such as hydrogen fluoride (HF), hydrochloric acid (HCl) and nitrate compounds (NOx). Some foundries, particularly intensive in hazardous waste, have been increasing their recycling rate (~95% for TSMC). Gaining context on waste management strategies can help better size future risk from hazardous spills or potential health implications to communities where foundries operate.
- **Product lifecycle management strategies and materials sourcing processes.** Lifecycle management strategies give some insight into a company’s ESG risks and opportunities, starting from its raw materials to end products. Key topics include:
 - a. Use of raw materials with toxic chemicals which may harm end-users (e.g. perfluorooctanesulfonic acids)
 - b. Improvements in energy efficiency of products
 - c. Management of end product waste disposal and recyclability
 - d. Sourcing of rare minerals such as gold, tungsten and tantalum

Social

- **Attraction, recruitment and retention of qualified technical candidates.** Due to the skill intensive nature of the technology industry, having access to a pool of qualified technical candidates can help a company sustain its competitive advantage and drive innovation. Having facilities in government designated industrial complexes can also help recruit more candidates. However, we note that semiconductor companies in Asia also generally have lower employee compensation (11% lower vs.

global peers on average), which may pose challenges in retaining top talent. Attracting and retaining key talent will play a critical role in driving the industry's growth.

- **Exposure to health and safety risks in the workplace.** Disclosure of employee safety measures can help investors manage worker safety as a social risk. As the semiconductor manufacturing process involves hazardous materials, weak safety management can lead to operating risks (e.g. lost time due to injuries and accidents), as well as legal and social consequences.

Exhibit 362: Summary of major pollutants for our initiated names

NSIG		CR Micro		Sanan	
Classification	Pollutants	Classification	Pollutants	Classification	Pollutants
Waste water	Fluoride Chloride Acid and alkali wastewater Grinding wastewater Polishing wastewater Sewage	Waste water	COD Suspended material Ammonia nitrogen Fluoride Total nitrogen	Waste water	COD BOD5 Ammonia nitrogen Total phosphorus Fluoride Total arsenic SS Petro Total silver Total copper
Waste gas	HCl HF NH3 NOx NO2 Isopropanol	Waste gas	Fluoride Hydrogen chloride NMHC Sulphuric acid mist Nitrogen oxides Ammonia Total phosphorus		
Solid waste	Sludge Mortar Unqualified products Waste quartz crucible Waste graphite thermal field Waste grinding wheel Waste King Kong line Waste grinding wheel	Solid waste	Waste acid Waste solvent Unqualified products Waste wafer Waste active carbon Waste packaging materials and sludge	Waste gas	AsH3 PH3 Hydrogen chloride NH3 Fume Particulates NMHC Nitrogen oxides
Silan		Wingtech		Anji	
Classification	Pollutants	Classification	Pollutants	Classification	Pollutants
Waste water	PH COD Ammonia nitrogen Total phosphorus Fluoride SS Total copper	Waste water	COD BOD5 NH3-N Total phosphorus SS Ammonia nitrogen Tin Total copper	Waste water	PH Suspended material Petro BOD5 CODCr Ammonia nitrogen
Waste gas	Fluoride ammonia Nitrogen oxides Sulphuric acid mist NMHC Hydrogen chloride Chlorine Particulates	Waste gas	Particulates NMHC Tin and its compounds Hydrogen chloride Styrene Vinyl chloride Sulphuric acid mist VOC	Waste gas	NOx

Source: Company data

More on the Semis bookshelf

- [SPE; framing the TAM in China](#) (26 Feb 2020)
- [Silicon wafer; supply chain survey and implications for China Semiconductors](#) (15 Jan 2020)
- [IDM trends in China: Implications from more players and increased capacity](#) (30 Jan 2020)
- [SMIC \(0981.HK\): Assessing long term trajectory and opportunities. Raising TP to HK\\$42 on new valuation methodology; CL-Buy](#) (2 Jul 2020)
- [Hua Hong \(1347.HK\): Power Semis and 12" ramp-up to drive long term growth; raising TP to HK\\$38 on new valuation methodology; Buy](#) (3 Jul 2020)
- [ACMR conference call; reaffirming the long-term uptrend in China semiconductors](#) (8 Apr 2020)
- [AMEC earnings conference; product R&D, COVID-19 impact and customer progress were the focal points](#) (20 Apr 2020)
- [CR Micro conf call: positive on IGBT, MOSFET, and power IC market in China](#) (14 Mar 2020)
- [Sanan: GaAs/GaN PA updates; read-across to China Semiconductors](#) (5 Mar 2020)
- [StarPower: IGBT diversification; positive implications for Hua Hong and China semiconductors](#) (28 Feb 2020)
- [Silan conf call: IGBT, MCU, and COVID-19 potential impact](#) (26 Feb 2020)
- [GC Tech Tour: Montage Tech visit; long-term server demand remains robust; positive for Lenovo, Shennan](#) (30 Sep 2019)
- [China 5G Corporate Day: Wingtech: Positive tone on semiconductor and ODM; expansion in power semi SKU, GaN FET, SiC, PMIC](#) (17 Jun 2020)
- [Memory; YMTC launches 128-layer 3D NAND](#) (13 Apr 2020)
- [SiEn updates; first CIDM; 8" fab readies for production](#) (22 Jun 2020)
- [Beken: Bluetooth and WiFi ICs; read-across to China foundries](#) (2 Apr 2020)
- [Changchuan: Testing equipment supplier; read-across to China Semiconductors](#) (5 Mar 2020)

Company analysis

AccoTest (688200.SS): Domestic specialist in ATE; expanding to SoC testing

Primary analysts:

Jin Guo, Allen Chang

Initiate at Buy with a 12-month TP of Rmb469: AccoTest (also known as Beijing Huafeng Test) is the largest local supplier by revenue (2019) in the testing equipment space and provides Automated Test Equipment (ATE) used in the testing of analog and mix-signal IC. The company is also expanding into SoC testing equipment, an area with higher technological barriers but a larger addressable market. Testing equipment is used by IC design, IC manufacturing and chip packaging companies to measure and evaluate the capability/performance of the device under test (to sort out defects). The demand for ATE is mainly driven by capex for capacity expansion/upgrade and the ATE space is primarily dominated by global leading suppliers - Advantest (6857.T, Coverage Suspended), Teradyne (TER, Neutral, covered by Toshiya Hari) and Cohu (COHU, Not Covered). AccoTest supplies testing equipment to major OSAT companies in China (including JCET, Tongfu and Huatian) and IC design companies such as SG Micro and Hisilicon.

Our constructive view on AccoTest is based on strong growth potential supported by: 1) its new generation of analog testing machines with higher spec and ASP (Rmb2mn vs. Rmb500k for the legacy product); 2) expansion into SoC testing and power semi testing. Within the testing equipment market, analog IC only makes up c.2% of the total while SoC testing represents a much larger percentage (60%+). The company targets sales of 200 units of SoC testing equipment by 2024E (with ASP of c.Rmb3mn, or US\$420k). In addition, AccoTest has generated a high gross margin at 80%+ over the past few years (higher than other local SPE makers' 40-45%). With product expansion and a high margin profile, we expect earnings to grow by 52%/74%/79% in 2020/21/22E and 61% CAGR during 2020-25E.

Valuation and risks: To capture the long-term earnings growth in the local SPE sector, we derive our target price of Rmb469 (48% upside) from a discounted PE valuation model. We apply 22x on 2025E EPS and discount back to 2022E at 8.3% p.a. (cost of equity). Risks are: 1) R&D of SOC test equipment slower than expected; 2) R&D of power semi test equipment slower than expected; 3) utilization of new production base lower than expected.

PM summary: Top five questions

1. What are AccoTest's key products? *Analog and mix-signal IC testing equipment*

AccoTest provides Automated Test Equipment (ATE) used in the testing of analog and mix-signal ICs. It is the largest local supplier by revenue (2019) in the testing equipment space. The company took the lead in launching the multi-site floating ground testing system in China in 2011, a multi-module testing system to support analog/mix-signal, discrete and MOSFET testing. In 2018, the company launched "All-in-one" testing equipment with 64 sites. Testing equipment is used by IC design, manufacturing, and chip packaging companies to measure and evaluate the capability/performance of devices under test (to sort out defects). The company is also expanding into SoC and power semiconductor testing equipment.

2. Who are the customers? *Local OSAT leaders JCET, Tongfu, Huatian, expanding in overseas market*

In the China market, AccoTest's key customers are OSAT suppliers such as JCET, Tongfu, Huatian and GTBF. The company is also penetrating into the Taiwan, US, Europe, Korea, and Japan markets, covering E-Test, ASE, Micro Silicon, ST Micro, Monolithic Power Systems, Sanken Electric. As of 2019, AccoTest's accumulated testing equipment shipments reached 2,600.

3. Why are we positive on AccoTest? *New generation of analog testing machines, expansion into SoC testing and power semi testing*

We are positive on AccoTest's strong growth potential in: 1) its new generation of analog testing machines with higher specs and ASPs (Rmb2mn vs. Rmb500k for the legacy product); 2) expansion into SoC testing and power semi testing. Within the testing equipment market, analog IC only makes up c.2% of the total while SoC testing represents a much larger percentage (60%+). The company targets sales of 200 units of SoC testing equipment by 2024E (with ASP of c.Rmb3mn, or US\$420k). In addition, AccoTest has generated a high gross margin at 80%+ over the past few years (higher than other local SPE makers' 40-45%). With product expansion and a high margin profile, we expect earnings to grow by 52%/74%/79% in 2020/21/22E and 61% CAGR during 2020-25E.

4. Where are we different from the Street? *2021E/22E earnings 31%/56% higher than Bloomberg consensus*

Our earnings estimates are 31%/56% higher than Bloomberg consensus in 2021/22E and our revenue estimates are 16%/23% higher. We are more positive on the volume growth and margins of AccoTest, we model 81.6%/82.0%/81.4% GM for 2020E/21E/22E vs consensus at 83.0%/81.4%/82.5% for the same period. We also expect improving cost control, with the company's opex ratio likely to reduce from 37% in 2019 to 24% by 2022E, leading to operating margin expansion from 45.0% in 2019 to 58.0% in 2022E.

5. How do we value AccoTest? *22x P/E on 2025E EPS, discount to 2022E*

Our 12-month target price of Rmb469 is derived from a discounted PE valuation model to capture the long-term earnings growth in the local SPE sector. We apply 22x on 2025E EPS and discount back to 2022E at 8.3% p.a. COE (cost of equity, based on risk free rate of 3%, beta of 0.9 and market risk premium of 6%). We derive our target multiple of 22x from global peers' PE and their EPS growth correlation, which includes Advantest, Keysight, Teradyne and KLA. Our target price implies 60x 2022E P/E.

Exhibit 363: AccoTest is the leading local ATE supplier, focusing on analog IC test, and is developing SoC testing equipment

Analog IC Test	Teradyne	Advantest	Cohu	AccoTest	Changchuan
SoC Test	√	√	√	R&D	
Memory IC Test	√	√			
RF Test	√	√	√		
Analog IC Test			√	√	√

Source: Company data

Exhibit 364: Comparison of major ATE peers

Companies	2019 rev (US\$mn)	net profit (US\$mn)	Established	#Employee	R&D as % of Revenue
Advantest	2,542	486	1946	4,936	15%
Teradyne	2,295	467	1960	5,400	14%
Cohu	583	-70	1947	3,500	15%
AccoTest	36	15	1993	236	13%
Changchuan	14	2	2008	772	27%

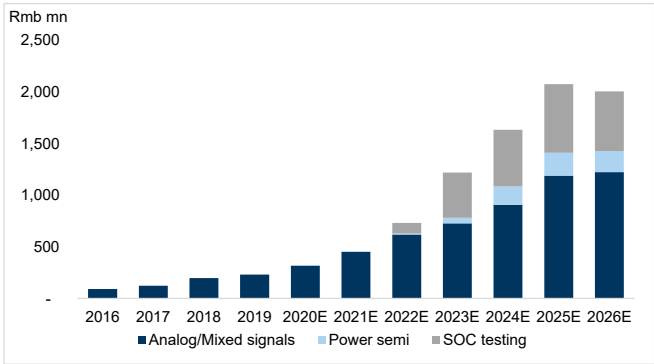
Source: Company data; Teradyne (TER, Neutral, covered by Toshiya Hari, last close US\$87.38)

Expanding into SOC testing and power semi testing

AccoTest's current products are concentrated in analog/mixed signal testing equipment, and the company is investing in SOC and power semiconductor testing equipment. SOC test equipment is a product with a high level of integration and high energy consumption, which has more complexity and a higher entry barrier compared to analog/mixed signal testing equipment. Teradyne, Advantest and Cohu are leaders in the global SOC market, and AccoTest is among the early movers in China in R&D of SOC test equipment. The key technology barriers in SOC test equipment include high-frequency and high-speed digital channel technology, multiple-channel and multiple-site testing technology.

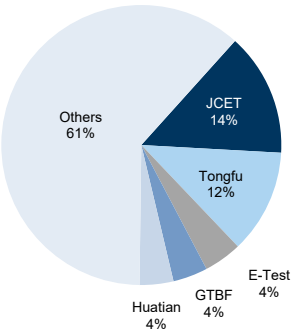
AccoTest targets to achieve a capacity of 200 units of SOC test equipment per year at full production. We model SOC test equipment to start shipment in 1Q22 with a rising revenue contribution from 13% in 2022E to 26% in 2025E.

Exhibit 365: AccoTest expansion into SOC products a key sales growth driver
Revenue by product



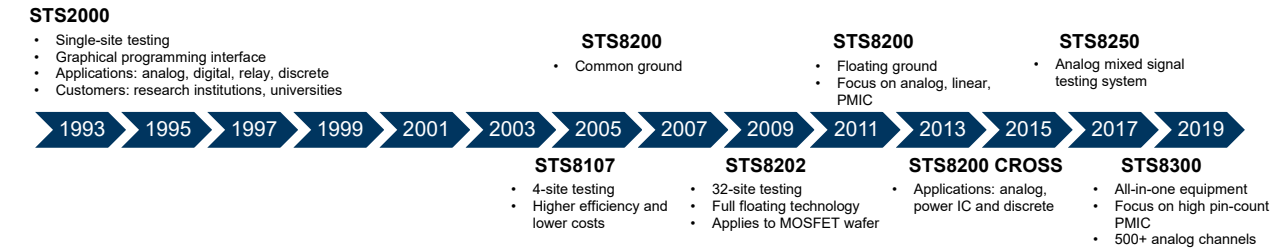
Source: Company data, Goldman Sachs Global Investment Research

Exhibit 366: AccoTest's key customers are local OSAT names (2018)



Source: Company data

Exhibit 367: History of AccoTest's product development: STS8300 is AccoTest's latest platform for analog IC testing with higher ASP at Rmb2mn vs. STS8200 at c.Rmb500k



Source: Company data

Financial analysis

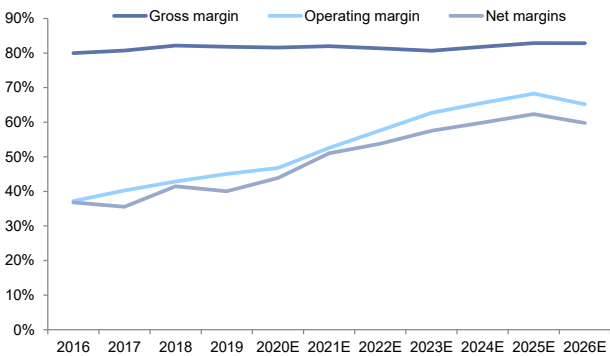
Income Statement

Revenue: we expect AccoTest’s revenue to grow by 38%/49%/70% in 2020/21/22E and 50% CAGR in 2020-25E driven by growth in new generation of analog equipment with higher ASP and expansion into SoC testing equipment. AccoTest’s SoC equipment have not started contributing revenue yet, and we expect it to contribute 13%/26% of total revenue in 2022/25E driven by sales to its existing customers (local OSAT and IC design firms). The company is also launching new generation of analog IC testing equipment with a higher ASP at Rmb2mn vs. legacy ones at c.Rmb500k each.

Margin analysis: gross margin at 83%, higher than wafer fab equipment

companies; AccoTest’s analog/mixed signal testing equipment has a gross margin of c.80-85%, which is higher than the margin level of global testing equipment peers such as Advantest and Teradyne and is largely in line with local peer Changchuan’s GM (at 75%). As analog/mixed signal testing equipment is a relatively mature product for AccoTest with limited competition, we expect the margin to remain stable at c.83% during 2020-25E and operating margin to improve on operating leverage.

Exhibit 368: AccoTest’s overall margin trend: we expect expansion in OPM driven by operating leverage with gross margin remaining stable



Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Earnings analysis: we expect net profit to grow by 52%/74%/79% in 2020/21/22E and 61% CAGR in 2020-25E, mainly driven by increasing shipment of analog/mixed signal testing equipment and new products in SOC and power semiconductor testing. Our earnings estimates are 31%/56% higher than Bloomberg consensus in 2021/22E and our revenue estimates are 16%/32% higher, reflecting our expectation of stronger volume growth and higher margin than consensus.

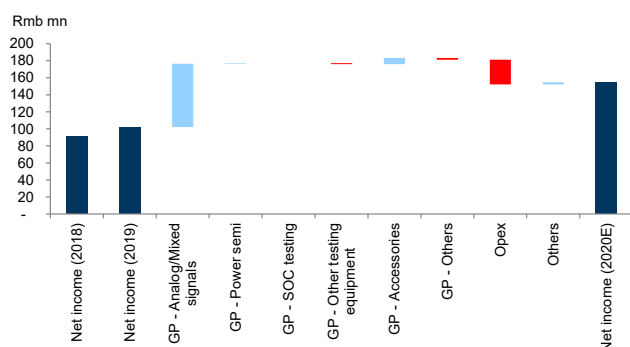
Exhibit 369: Our earnings estimates are 16%/32% higher than Bloomberg consensus in 2021/22E

Rmb mn	2020E			2021E			2022E		
	GS	Cons.	Diff(%)	GS	Cons.	Diff(%)	GS	Cons.	Diff(%)
Revenue	352	328	8%	526	455	16%	896	681	32%
Gross profit	288	272	6%	431	370	17%	729	561	30%
Op. income	165	155	6%	277	208	33%	516	306	69%
Net income	155	141	10%	269	204	31%	482	309	56%
Margins									
GM	81.6%	83.0%		82.0%	81.4%		81.4%	82.5%	
OPM	46.8%	47.3%		52.6%	45.7%		57.7%	45.0%	
NM	43.9%	42.9%		51.0%	44.9%		53.8%	45.4%	

Source: Bloomberg, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 370: AccoTest 2020E profit mainly driven by analog/mixed signal testing equipment

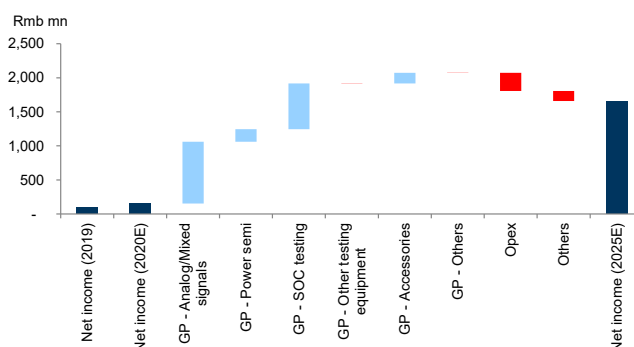
Net profit waterfall chart 2019-2020E



Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 371: Analog/mixed signal testing remains the major driver, SOC and power semi testing to have rising profit contribution

Net profit waterfall chart 2020-25E



Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Balance sheet

AccoTest currently does not have any short-term or long-term debt and is in a net cash position. Similar to other SPE firms, AccoTest has high inventory days (386 days at end of 2019) due to a long production cycle and customer inspection can take a long period before the product is recognized as revenue. AccoTest's ROE was 31% in 2019, and we expect ROE to trend down due to lower financial leverage and higher fixed assets (new manufacturing base), which lowers the asset turnover in the near term. As the company's profitability improves, we expect ROE to recover to 38% by 2025E.

Exhibit 372: We expect ROE to improve to 38% in 2025E vs. c.31% in 2019 (vs. global majors' ROE at 35-45%)

Dupont analysis	2016	2017	2018	2019	2020E	2021E	2022E	2023E	2024E	2025E
	2016	2017	2018	2019	2020E	2021E	2022E	2023E	2024E	2025E
Asset turnover	1.4	0.8	0.9	0.7	0.3	0.2	0.4	0.5	0.6	0.6
Leverage (assets/equity)	1.2	1.2	1.2	1.2	1.1	1.0	1.0	1.0	1.0	1.0
Net margin	37%	36%	41%	40%	44%	51%	54%	58%	60%	62%
ROE (common equity)	59%	33%	44%	31%	13%	13%	20%	31%	35%	38%
ROA	50%	28%	37%	26%	12%	12%	20%	30%	34%	37%

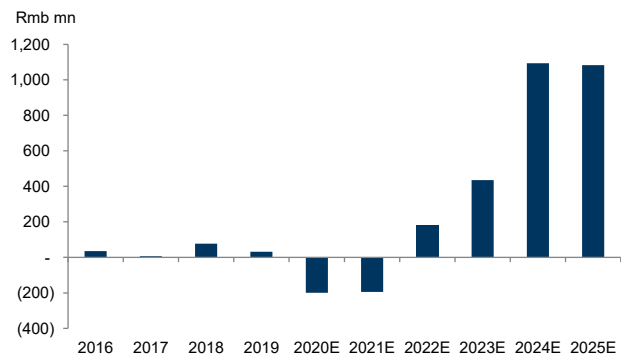
Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Cash flow

AccoTest's cash flow from operations was positive in 2016-19 and remained at Rmb60mn in 2019. Given the strong revenue growth and well-managed working capital, we expect its cash flow from operations to continue improving. Fixed assets capex will mainly include the construction of its new production base with an investment budget

of Rmb650mn and R&D of new products. Cash investment in intangible assets mainly includes land use rights and patents. Given the investment in a new production site during 2020-21E, we expect free cash flow to be negative (-Rmb200mn and -Rmb195mn in 2020E and 2021E, respectively) before turning positive in 2022E.

Exhibit 373: We expect AccoTest’s free cash flow to turn positive in 2022E



Source: Company data, Goldman Sachs Global Investment Research

Valuation and risks

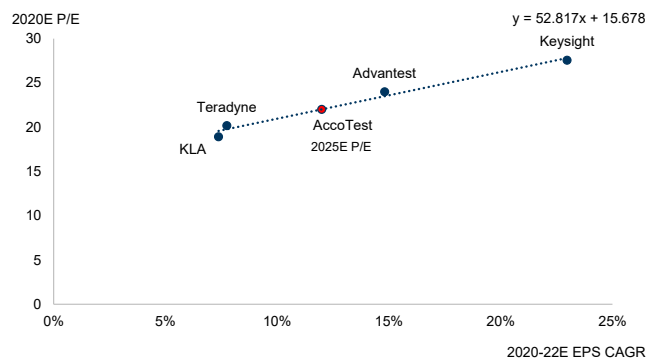
Our target price of Rmb469 is derived from a discounted PE valuation model to capture the long-term earnings growth in the local SPE sector. We apply 22x on 2025E EPS and discount back to 2022E at 8.3% p.a. (cost of equity). Our target multiple of 22x is based on global peers’ PE and their EPS growth correlation.

Exhibit 374: We use 22x on 2025E EPS and discount back to 2022E at 8.3% p.a. to get our 12-month TP of Rmb469

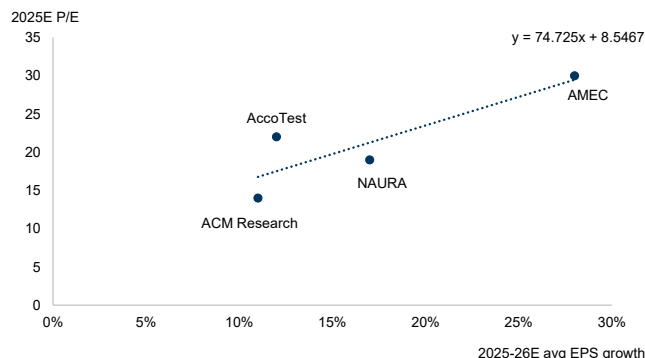
Rmb mn	2018	2019E	2020E	2021E	2022E	2023E	2024E	2025E	2026E
Revenue	219	255	352	526	896	1,522	2,020	2,660	2,526
Analog/Mixed signals	198	235	318	471	691	831	1,060	1,409	1,458
Power semi	0	0	1	6	9	55	177	223	204
SOC testing	0	0	0	0	116	508	616	810	657
Accessories	19	17	25	41	70	119	158	209	198
Others	1	3	9	9	9	9	9	9	9
Gross margin	82.2%	81.8%	81.6%	82.0%	81.4%	80.7%	81.8%	82.9%	82.9%
Gross profit	180	208	288	431	729	1,228	1,652	2,205	2,094
Opex	86	94	123	155	213	273	328	388	447
Sales tax	4	3	4	5	9	16	21	28	26
Marketing expenses	33	35	43	54	69	79	90	102	116
Admin	24	23	31	35	41	49	57	65	75
R&D	24	33	45	60	93	130	160	193	229
Operating income	94	115	165	277	516	954	1,325	1,816	1,647
Non-op	9	4	12	22	19	19	20	27	31
Pre-tax profit	103	119	177	298	535	973	1,345	1,843	1,678
Minority	0	0	0	0	0	0	0	0	0
Net profit	91	102	155	269	482	876	1,210	1,658	1,511
EPS (Rmb)	2.16	2.27	2.89	4.39	7.87	14.31	19.78	27.11	24.69
YoY Growth		12%	52%	74%	79%	82%	38%	37%	-9%
Peer avg multiple x EPS								596.3	
Discounted back to 2022E								469	
2025E P/E								22x	
Target price (Rmb)								469	
Implied 2022E P/E								60	

COE assumption	
Beta	0.9
Risk free	3.0%
Market risk premium	6.0%
COE	8.3%

Source: Company data, Goldman Sachs Global Investment Research

Exhibit 375: With average earnings growth (geometric average) of 12% in 2025/26E, we derive AccoTest's 2025E target multiple of 22x based on the linear function of global peers' PE and EPS growth

Source: Goldman Sachs Global Investment Research

Exhibit 376: Our SPE coverage's target 2025E P/E

Source: Goldman Sachs Global Investment Research

Downside risks

1) R&D of SOC test equipment slower than expected

We model SOC test equipment to have revenue contribution starting from 1Q21E. SOC test equipment is a product with high level of integration, high complexity and high energy consumption, which makes it a product with higher entry barrier compared to analog/mixed signal testing equipment. If development of SOC equipment is slower than expected, our revenue and earnings estimates from 2021E onward will be lower than expected.

2) R&D of power semi test equipment slower than expected

We expect AccoTest's power semi test equipment to start shipment from 4Q20E. Power semi IC testing requires high voltage, large current, and high power efficiency modules, which bring technology challenges in developing reliable, high-voltage-resistant and large-current-resistant equipment. If development of power semi testing technology is slower than expected, revenue contribution of power semi test equipment could be delayed to 2021E onward, which would affect our revenue and gross profit outlook.

3) Utilization of new production base lower than expected

The company targets to expand capacity to 800 units analog/mixed signal test equipment and 200 units SOC test equipment per year. If capacity utilization is below our estimates, shipment and gross margin will be lower than expected. A lower utilization rate could be caused by weak demand in semiconductor testing or oversupply of test equipment.

Exhibit 377: AccoTest quarterly P&L

(Rmb m)	1Q19	2Q19	3Q19	4Q19	1Q20	2Q20E	3Q20E	4Q20E	2016	2017	2018	2019	2020E	2021E	2022E
Revenue	60	42	99	53	85	63	136	68	112	149	219	255	352	526	896
Gross profit	49	34	82	43	69	51	111	55	90	120	180	208	288	431	729
Operating expense	(22)	(19)	(30)	(23)	(30)	(26)	(34)	(32)	(48)	(60)	(86)	(94)	(123)	(155)	(213)
Operating income	28	15	52	20	39	25	77	23	42	60	94	115	165	277	516
Pre tax profit	27	17	51	24	45	27	79	26	44	60	103	119	177	298	535
Net income	23	15	43	21	36	24	72	23	41	53	91	102	155	269	482
EPS (Rmb)	0.52	0.33	0.97	0.46	0.67	0.46	1.34	0.43	0.98	1.26	2.16	2.27	2.89	4.39	7.87
Margins / ratio															
Gross margin	82.5%	80.2%	82.8%	80.4%	81.3%	81.7%	81.6%	81.8%	80.0%	80.7%	82.2%	81.8%	81.6%	82.0%	81.4%
Opex ratio	-36.1%	-44.4%	-30.4%	-43.3%	-35.6%	-41.9%	-24.9%	-47.3%	-42.8%	-40.4%	-39.3%	-36.8%	-34.8%	-29.4%	-23.7%
Operating margin	46.5%	35.9%	52.4%	37.1%	45.8%	39.8%	56.7%	34.5%	37.2%	40.3%	42.9%	45.0%	46.8%	52.6%	57.7%
Net margin	38.9%	34.7%	43.9%	38.6%	41.9%	38.9%	52.4%	33.9%	36.8%	35.5%	41.5%	40.1%	43.9%	51.0%	53.8%
QoQ															
Revenue	61%	-29%	133%	-46%	60%	-26%	117%	-50%							
Gross profit	62%	-31%	140%	-48%	62%	-26%	117%	-50%							
Operating income	147%	-45%	240%	-62%	97%	-36%	209%	-70%							
Pre tax profit	120%	-38%	205%	-53%	87%	-39%	193%	-68%							
Net income	109%	-37%	194%	-52%	74%	-32%	193%	-68%							
EPS	96%	-37%	194%	-52%	46%	-32%	193%	-68%							
YoY															
Revenue				44%	43%	48%	38%	27%		33%	47%	16%	38%	49%	70%
Gross profit				41%	41%	51%	36%	29%		34%	50%	16%	38%	50%	69%
Operating income				76%	41%	64%	49%	18%		44%	57%	22%	44%	68%	87%
Pre tax profit				94%	65%	62%	55%	7%		36%	71%	15%	49%	69%	79%
Net income				86%	54%	66%	65%	11%		28%	72%	12%	52%	74%	79%
EPS				74%	29%	39%	38%	-6%		28%	71%	5%	27%	52%	79%

Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

AccoTest

688200.SS	12m Price Target: Rmb469	Price: Rmb317.13	Upside: 47.9%		
Buy	GS Forecast				
Market cap: Rmb19.4bn / \$2.8bn	Revenue (Rmb mn)	12/19	12/20E	12/21E	12/22E
Enterprise value: Rmb17.9bn / \$2.6bn	EBITDA (Rmb mn)	254.6	352.4	526.0	895.7
3m ADTV :Rmb269.1mn/ \$38.0mn	EPS (Rmb)	117.4	177.0	335.1	620.0
China	P/E (X)	2.27	2.89	4.39	7.87
Greater China Technology	P/B (X)	NM	109.7	72.3	40.3
	Dividend yield (%)	NM	9.5	8.8	7.7
M&A Rank: 3	Net debt/EBITDA (X)	NA	0.3	0.5	0.9
	CROCI (%)	(1.9)	(8.4)	(3.6)	(1.9)
	FCF yield (%)	38.7	13.5	14.6	23.3
		NA	(1.2)	(1.0)	0.9
		12/19	3/20E	6/20E	9/20E
	EPS (Rmb)	0.46	0.67	0.46	1.34

Source: Company data, Goldman Sachs Research estimates, FactSet. Price as of 10 Jul 2020 close.

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ACM Research (ACMR): Cleaning growth story with 10X revenue opportunity; initiate at Buy and add to CL

Primary analysts:

Jin Guo, Allen Chang

Initiate at Buy and add to Conviction List: ACMR is the leading local wafer cleaning tool maker with major manufacturing and R&D operations in Shanghai. Its key customers include memory makers (SK Hynix, YMTC) and local foundries (SMIC, Huali, Hua Hong). Wafer cleaning is used in multiple points during wafer fabrication such as post-etch, post-photoresist, post-CMP, etc. which are among the most repeated processes in wafer fabrication. Leading suppliers in this space include SCREEN Holdings, Lam Research, and Applied Materials; ACMR however is the leader among domestic peers in China with c.20% of share allocation in YMTC's cleaning tool purchase. In recent quarters, the company has been aggressively expanding its product offerings and launched a new line of semi-critical cleaning tools, copper plating equipment, and furnaces. Its products are used in both front-end fabrication and back-end packaging. These product additions provide scope to expand ACMR's SAM (serviceable available market) from US\$1.5bn (single wafer cleaning tools only) to US\$5bn per year ([Exhibit 380](#), [Exhibit 381](#)).

Our constructive view on ACMR is based on: 1) its technological strength and proven track record with a high quality customer base (e.g. SK Hynix), allowing the company to capture more share of local fabs; 2) increasing demand driven by China's massive investment into semiconductor manufacturing (see the SPE industry section in this report for details). We expect net profit to grow at a 63% CAGR in 2020E-25E, mainly driven by the strong demand for cleaning tools and increasing equipment share allocation at local fabs. Our earnings estimates are 66%/54% higher than the Bloomberg consensus in 2021E/2022E while our revenue estimates are 36%/50% higher, reflecting our more positive view in China's SPE demand and ACMR's growing market share locally. We initiate on ACMR with a Buy rating and add the shares to our Conviction List with 84% implied upside to our 12-month TP of US\$150 (vs. 4% for our China Semiconductors coverage). We expect ACMR to enjoy a similarly strong earnings growth profile with the sector (63% CAGR in 2020-25E vs. China Semi avg. at 57% CAGR), yet the stock is trading at 31x/20x our 2021/22E EPS estimates (vs. its China A-Share local SPE peers at above 100x/50x for 2021/22E), and we therefore view ACMR's current valuation as attractive.

Valuation and key risks: To capture ACMR's long-term earnings growth in the local SPE sector, we derive our 12m target price of US\$150 using a discounted P/E valuation model. We apply a 14X target multiple on our 2025E EPS and discount it back to 2022E at 10.6% p.a. (cost of equity, beta of 1.26, risk free rate of 3%, and risk premium of 6%). Risks include: 1) fiercer-than-expected competition in learning equipment, 2) slower R&D new cleaning technology, 3) single-supplier risks; and 4) China/US trade.

PM Summary: Top five questions

1. What are the products and who are the key customers of ACM Research? *Wafer cleaning tools, key customers are YMTC, Huali, SK Hynix, SMIC, Hua Hong*

ACMR provides wafer cleaning tools for wafer fabrication, which are used in processes such as post-etch, post-photoresist, post-CMP, etc. ACMR's proprietary megasonic technology in single wafer cleaning systems improves cleaning effectiveness without damaging the critical structures in the wafer fabrication process. ACMR is the leader among domestic peers in China with c.20% of share allocation in YMTC's cleaning tool purchases. In recent quarters, the company has been aggressively expanding its product offerings and launched a new line of semi-critical cleaning tools, copper plating equipment, and furnaces. Its products are used in both front-end fabrication and back-end packaging. These product additions provide scope to expand ACMR's SAM (serviceable available market) from US\$1.5bn (single wafer cleaning tools only) to US\$5bn per year. ACM Research's key customers include memory makers (SK Hynix, YMTC) and local foundries (SMIC, Huali, Hua Hong). In 2019, YMTC, Huali, and SK Hynix contributed 28%, 27%, 20% of revenue respectively.

2. Why are we positive on ACM Research? *Technological strength, increasing demand for SPE driven by rising local foundries*

We are positive on ACMR given: 1) its technological strength and proven track record with a high quality customer base (e.g. SK Hynix), allowing the company to capture more share of local fabs; 2) increasing demand driven by China's massive investment into semiconductor manufacturing (see the SPE industry section in this report for details). We expect net profit to grow at a 63% CAGR in 2020E-25E, mainly driven by the strong demand for cleaning tools and increasing equipment share allocation at local fabs.

3. Where are we different from the Street? *2021E/22E earnings 65%/54% higher than Bloomberg consensus*

Our earnings estimates are 65%/54% higher than the Bloomberg consensus in 2021E/2022E and our revenue estimates are 36%/50% higher, reflecting our more positive view on China SPE demand and ACMR's growing local market share. We are also more positive on margins, we model 44.3% for 2021E vs. consensus at 43.6%.

4. How do we value ACM Research?

To capture its long-term earnings growth in the local SPE sector, we derive our 12m target price of US\$150 for ACMR is derived from a discounted P/E valuation model. We apply a 14x target multiple on our 2025E EPS and discount it back to 2022E at 10.6% p.a. (cost of equity, beta of 1.26, risk free rate of 3%, and risk premium of 6%). Our target multiple is based on global peers' P/Es and their EPS growth correlation. For the peer group, we consider select SPE makers globally with a meaningful presence in wafer cleaning equipment; peers include: LAM Research, SCREEN Holdings, Applied Materials, and Tokyo Electron. Our target price implies 36x 2022E P/E.

5. What are the risks?

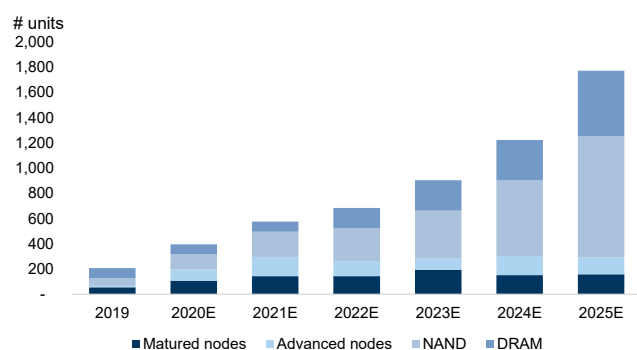
Key risks to our investment thesis include: 1) fiercer-than-expected competition in cleaning equipment, as semiconductor industry in China is growing rapidly with numerous new entrants; 2) delay in R&D of new cleaning tool technology, which could impact ACM Research's market share and revenue; 3) single supplier risks: some of the key components (e.g. megasonic generators, robot arms, valves) of ACM Research's products depend on single suppliers; and 4) China-US trade disputes.

Local cleaning tool leader with 10X revenue opportunity

- **In terms of product and technology**, ACMR's proprietary megasonic technology in single wafer cleaning systems improves cleaning effectiveness without damaging the critical structures in the wafer fabrication process. ACMR captured c.20%+ of share allocation in YMTC's public tenders for cleaning tool purchases in 2019.
- **On the demand side**, we expect demand for cleaning tools to grow eight-fold during 2020E-25E driven by **12" fab capacity expanding by 8.6X to 1.9mn wafers per month (vs. 218k wpm)**, per our estimates. This is primarily driven by China's increasing investments in semiconductor fabs and local players' migration to more advanced process nodes. As the chip geometry continues to shrink (e.g. SMIC from 28nm to 14nm and to 7nm in the future), more cleaning steps are needed in the wafer fabrication process to ensure a robust yield level. ACMR noted each generation migration in the past has increased cleaning steps by 15%. Based on our supply chain channel checks, from 14nm to 7nm, the number of cleaning steps could go up to c.125 in 7nm from c.80 steps in 14nm, which would drive up needed cleaning tools' per unit capacity.

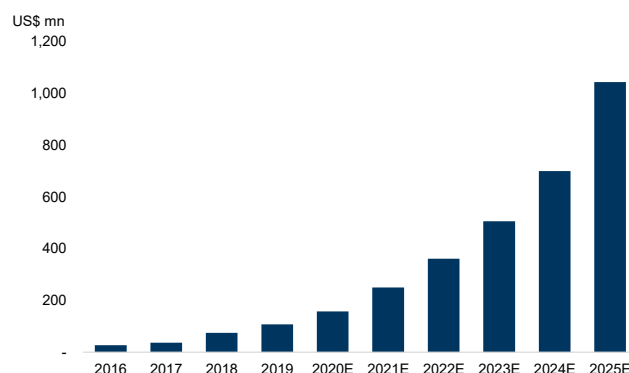
Exhibit 378: Wafer cleaning tool demand to grow 8x during 2020E-25E; NAND as a primary driver given strong capacity expansion plans

China local fab player demand for wafer cleaning tools



Source: Goldman Sachs Global Investment Research

Exhibit 379: ACM Research's revenue to grow at a 46% CAGR during 2020-25E as demand for cleaning tools increases in China



Source: Company data, Goldman Sachs Global Investment Research

ACM Research's Shanghai subsidiary applied for STAR board listing: ACM Research (Shanghai) is a subsidiary controlled by ACM Research (US), the US listed company (ACMR). The Shanghai subsidiary has filed an application for IPO in China's A-Share market (STAR board). ACMR (US) currently has a c.91.7% stake in ACM Research (Shanghai) and is operating its business primarily through the Shanghai subsidiary. Our A-Share SPE coverage group (NAURA, AMEC, AccoTest) trades at 80-200X 2021E EPS (vs. ACMR at 31X) given strong earnings growth profiles. ACM Research's Shanghai listing could drive a valuation re-rating for ACMR (US), in our view.

ACM Research's key wafer cleaning products:

- **SAPS cleaning tool:** Space Alternated Phase Shift (SAPS) equipment is used to clean flat and patterned wafers to 45nm or below. ACMR's SAPS cleaning tool adopts its proprietary Smart Megasonix technologies, which outperforms the

traditional cleaning technology on removing smaller defects in hard-to-reach areas on the wafer surface. The SAPS technology uses alternating phases of megasonic waves to deliver megasonic energy to flat and patterned wafer surfaces in a uniform manner, which enables it to remove random defects across an entire wafer.

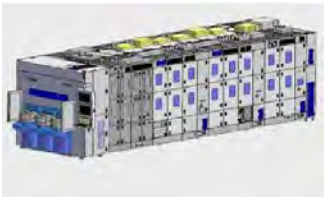
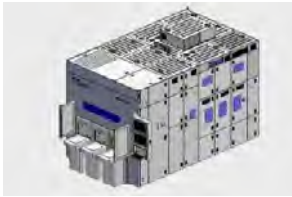
- **TEBO cleaning tool:** Timely Energized Bubble Oscillation (TEBO) equipment provides damage-free cleaning for both conventional 2D and 3D patterned wafers at advanced process nodes. TEBO enables precise and multi-parameter control of bubble cavitation during megasonic cleaning by using a sequence of rapid pressure changes to force bubbles to oscillate in specific sizes and shapes. By using bubbles, TEBO technology avoids the pattern damage often caused by transient cavitation in traditional megasonic cleaning. TEBO is able to provide damage-free cleaning for wafers as small as 16-19nm, thus designed for patterned chips with 3D structures such as FinFET, DRAM, 3D NAND and 3D cross point memory.
- **Tahoe cleaning tool:** Tahoe equipment adopts sulfuric peroxide mix (SPM) cleaning technology that is suitable for advanced node. The Ultra Clean (Ultra C) Tahoe system reduces the amount of sulfuric acid used in cleaning process, which lowers both chemical and post-process waster treatment costs. The traditional SPM cleaning bench tool does not have the capability to process node below 28nm. SPM single wafer processing technology is an alternative solution, but the high usage of chemical and sulfuric acid waste makes this a non-environmentally friendly solution. To solve these challenges, Ultra C Tahoe uses a two-step approach to integrate both wet bench and single wafer cleaning. Compared to prior SPM cleaning methods, Ultra C Tahoe system combines the advantages of wet bench and single wafer cleaning, reducing the damage to the environment and lowering the costs of chemical.

Exhibit 380: ACM Research is expanding its cleaning solutions from single wafer cleaning equipment to semi-critical cleaning tools, adding SAM of US\$0.8bn to US\$2.3bn...

Single wafer cleaning tools			Semi-critical cleaning tools		
SAPS	TEBO	Tahoe	Ultra C b	Ultra C wb	Ultra Cs
					
Megasonic cleaning for flat and patterned wafer surfaces	Bubble Oscillation Cleaning for Patterned Wafers at Advanced Process Nodes	Hybrid Wafer Cleaning With Significant Cost & Environmental Benefits	Backside silicon etching and film removal 200mm or 300mm	Automatic wet bench; Batch cleaning of up to 50 wafers	Scrubber; Advanced dual-fluid (gas and liquid) spray cleaning technique
45nm and below	FinFET; 3D NAND; DRAM	FinFET; 3D NAND; DRAM	Advanced nodes; Power device; Advanced WLP		
SAM: US\$1.5bn			SAM: US\$0.8bn		

Source: Company data

Exhibit 381: ...with expansion into electrochemical plating, polishing, and thermal process equipment further expanding SAM from US\$1.5bn to US\$5bn

Electrochemical plating		Stress free polishing		Thermal process
Ultra ECP ap	Ultra ECP map	Ultra SFP ap		Ultra Furnace
				
Back-end assembly tool used for applying copper, tin and nickel to wafers at the die level before packaging	Multi Anode Partial Plating (Front-End Wafer Fabrication Processes)	Polishing metal film in TSV, 2.5D in advanced package applications		Targets LPCVD, Oxidation, Annealing and ALD
Advanced Wafer Level Packaging	Front-end; Copper interconnect	Advanced Wafer Level Packaging		Front-end fabrication
SAM: US\$1bn				SAM: US\$1.5bn

Source: Company data

Exhibit 382: Wafer cleaning tool makers; ACMR had c.4% of the market share in 2019

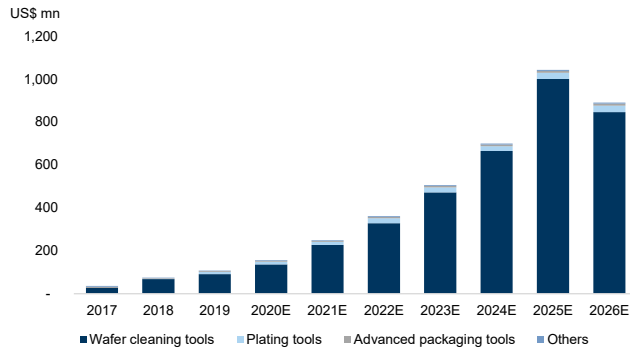
Vendors and technologies	SCREEN	TEL	LAM	ACM Research	NAURA	PNC
Country of origin	Japan	Japan	US	China	China	China
Soaking/dissolving	√	√	√			
Scrubbing	√	√	√	√		
Ultrasonic						
Megasonic				√		
Spin/ Jet spray	√	√	√		√	√
Global market share	45%	29%	16%	4%	<1%	<1%

Source: Company data, Gartner

Financial analysis
Income Statement

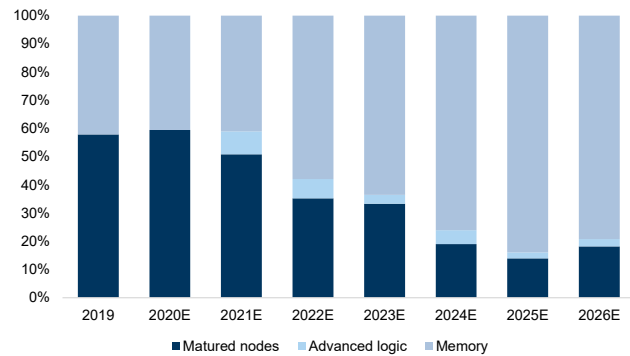
Revenue: We expect ACMR's revenue to grow by 46%/59%/44% in 2020E/2021E/2022E and at a 46% CAGR in 2020E-25E driven by growth in wafer cleaning tools sales. Wafer cleaning tools revenue made up 91%/85% of total sales in 2018/2019, and we expect it to contribute 87%/96% in 2020E/2025E supported by increases in China's semiconductor fab investments and ACMR's growing penetration with local fabs. We model sales volume of wafer cleaning tools to increase by 7X during 2020E-25E. We expect the majority of the volume growth to be contributed by local memory expansion, which makes up 70% of the total capex over 2020E-25E. Another area of growth will come from its new product segment - copper plating equipment (also known as electrochemical deposition, ECD) with applications in front-end fabrication and back-end packaging/testing. Front-end plating equipment has a much higher technological requirement. ACMR delivered the first tool for front-end in 2019. We expect plating equipment sales to grow at an 18% CAGR in 2020E-25E.

Exhibit 383: ACMR's revenue growth trend: wafer cleaning tools remain the primary growth driver



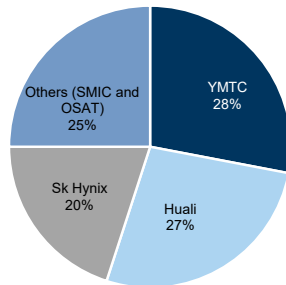
Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 384: We expect a majority of ACMR's cleaning tools shipments to come from memory in 2022-26E
Wafer cleaning tools shipment mix by end-markets



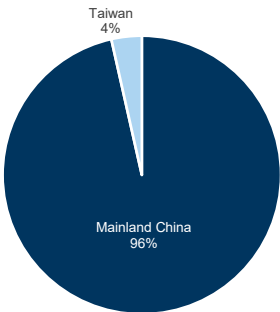
Source: Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 385: Major customers include YMTC, Huali and SK Hynix
Customer mix by revenue contribution (2019)



Source: Company data

Exhibit 386: ACMR primarily generates its sales in Mainland China
Revenue mix by geography (2019)

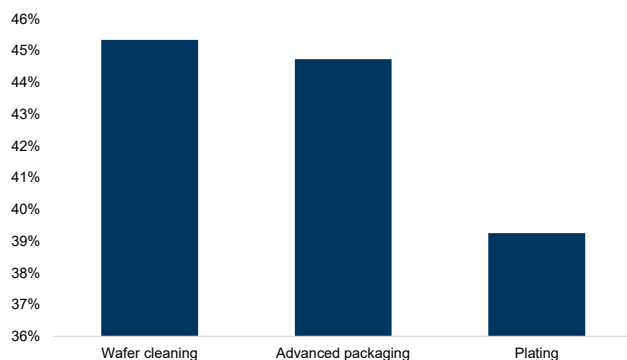


Source: Company data

Margin analysis: Stable margin trend in wafer cleaning tools; improving margin on plating tools; ACMR's wafer cleaning equipment gross margin at c.45%, is in line with the margin level of other cleaning equipment makers such as Tokyo Electron and LAM Research. As wafer cleaning tool's revenue contribution continues to increase over 2020E-25E, we expect blended gross margin to stabilize at c.45%, and operating margin to improve on operating leverage.

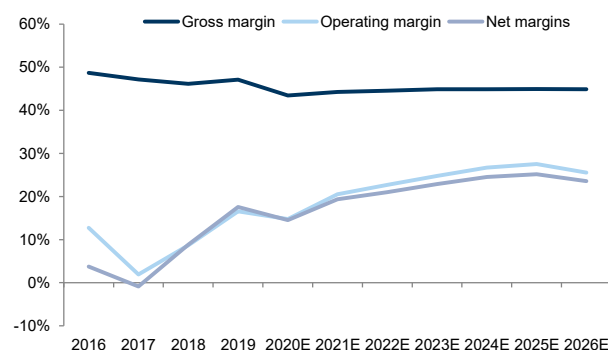
Exhibit 387: Cleaning tool and advanced packaging equipment gross margin is c.45%, while plating tool gross margin is lower as this is a new product with smaller shipments

Gross margin by product in 2019



Source: Company data, Goldman Sachs Global Investment Research

Exhibit 388: ACMR margin trend: We expect OPM expansion, driven by operating leverage and gross margin to remain stable

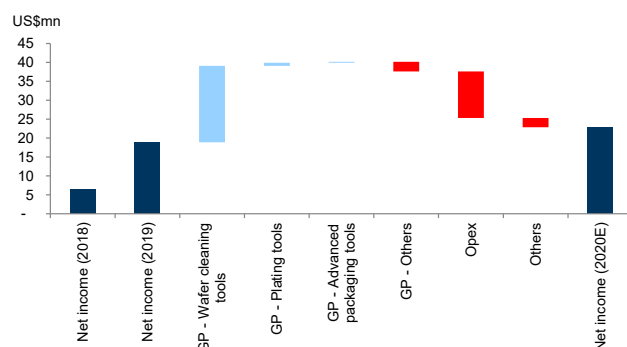


Source: Company data, Goldman Sachs Global Investment Research

Earnings analysis: We expect net profit to grow by 21%/111%/57% in 2020E/2021/2022E and at a 63% CAGR in 2020E-25E, mainly driven by strong demand for cleaning tools and increasing equipment share of local fabs business. Our earnings estimates are 15%/65%/54% higher than the Bloomberg consensus in 2020E/2021E/2022E and our revenue estimates are 12%/36%/50% higher, reflecting our more positive view in China SPE demand and ACMR's growing local market share.

Exhibit 389: Wafer cleaning tool is the main profit driver for ACMR in 2020E

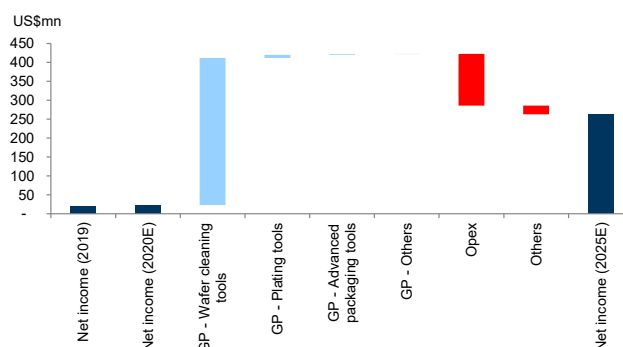
Net profit waterfall chart 2019-20E



Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 390: We expect ACMR's earnings to grow at a 56% CAGR for 2020E-25E

Net profit waterfall chart 2020-25E



Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Balance sheet

ACMR currently does not have any long-term debt and is in a net cash position (US\$104mn net cash as of 2019). Similar to other SPE firms, ACMR has high inventory days (268 days at end of 2019) due to a long production cycle and customer inspection period tends to be long (typically 3-6 months) before the product can be recognized as revenue. ACMR's ROE was 25% in 2019 but as the company's profitability and asset turnover improve, we expect ROE to increase to 40% by 2025E, which is in line with global SPE firms.

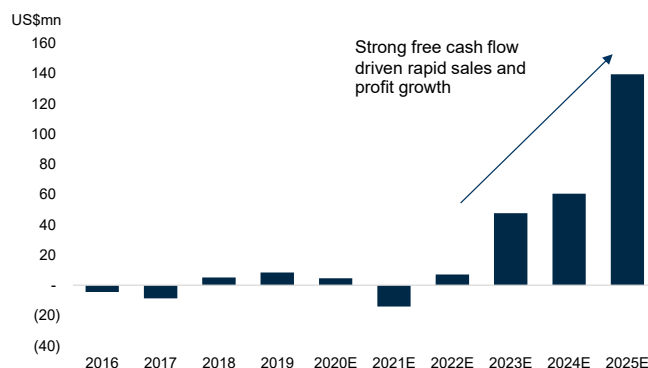
Exhibit 391: We expect ROE to improve to 40% in 2025E vs. c.25% in 2019 (and vs. global majors' ROE at 35-45%)

	2016	2017	2018	2019	2020E	2021E	2022E	2023E	2024E	2025E
Dupont analysis	2016	2017	2018	2019	2020E	2021E	2022E	2023E	2024E	2025E
Asset turnover	0.7	0.6	0.9	0.7	0.7	0.9	1.0	1.0	1.1	1.1
Leverage (assets/equity)	(7.2)	3.0	1.9	2.1	2.2	2.0	1.8	1.6	1.5	1.4
Net margin	4%	-1%	9%	18%	15%	19%	21%	23%	25%	25%
ROE (common equity)	-19%	-2%	14%	25%	21%	33%	37%	38%	39%	40%
ROA	3%	-1%	8%	12%	10%	17%	21%	24%	26%	28%

Source: Company data, Goldman Sachs Global Investment Research

Cash flow

ACMR's cash flow from operations turned positive in 2018 and has remained in surplus; 2018 and 2019 at US\$7mn and US\$9mn (or 9% of total revenue), respectively. Going forward, given its strong revenue and profit growth, we expect CF to remain in positive territory. Fixed assets capex will mainly include the construction of its new production base in Shanghai Liingang with an investment budget of US\$120mn. Given the continued investment in R&D and new construction projects, we expect free cash flow to be negative in 2021E (-US\$11mn) before turning positive in 2022E. As the company is in a fast growing stage, the need for cash reinvestment is high. As such, we believe a dividend in the coming years is unlikely.

Exhibit 392: We expect ACMR's free cash flow to grow from 2022E

Source: Company data, Goldman Sachs Global Investment Research

Valuation and risks

We derive our 12m target price of US\$150 using a discounted P/E valuation model, to capture its long-term earnings growth in the local SPE sector. We apply a 14X target multiple on our 2025E EPS and discount it back to 2022E at 10.6% p.a. (cost of equity, beta of 1.26, risk free rate of 3%, and risk premium of 6%). Our target multiple is based on global peers' P/Es and their EPS growth correlation. For the peer group, we consider select SPE makers globally with meaningful presence in wafer cleaning equipment; peers include: LAM Research, SCREEN Holdings, Applied Materials, and Tokyo Electron.

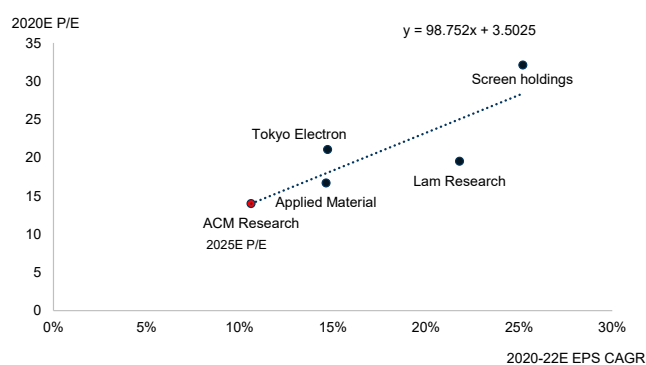
Exhibit 393: We apply a 14X multiple to our 2025E EPS and discount it back to 2022E at 10.6% p.a. to derive our 12-month TP of US\$150

US\$m	2019	2020E	2021E	2022E	2023E	2024E	2025E	2026E
Revenue	108	157	250	361	506	700	1,044	891
Wafer cleaning tools	91	137	228	329	473	665	1,001	847
Plating tools	11	13	15	23	23	23	29	29
Advanced packaging tools	3	4	5	6	7	8	9	10
Others	2	3	3	4	4	4	5	5
Gross margin	47%	43%	44%	45%	45%	45%	45%	45%
Gross profit	51	68	111	161	227	314	469	400
Opex	33	45	59	79	102	127	182	173
Marketing expenses	12	14	17	21	24	26	32	31
Admin	8	14	12	14	18	21	26	27
R&D	13	18	30	43	60	81	123	114
OP income	18	23	51	82	125	187	287	228
Non-op gains	1	3	4	3	3	4	5	6
Pre-tax profit	19	27	55	85	129	191	292	234
Tax expense	(1)	3	5	9	13	19	29	23
Minority interest	1	1	1	1	-	-	-	-
Net profit	19	23	48	76	116	172	263	210
YoY		21%	111%	57%	53%	48%	53%	-20%

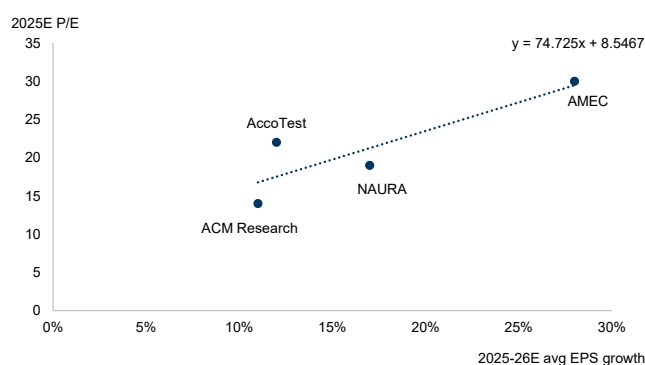
Valuation

Net income (2025E)	263
Target multiple (2025E)	14
Terminal market cap (2025E)	3,679
Discount back to 2022E	2,722
COE	10.6%
Discount factor	0.740
Shares outstanding	18.1
Target price (US\$)	150

Source: Company data, Goldman Sachs Global Investment Research

Exhibit 394: With average earnings growth (geometric average) of 11% in 2025E/2026E, we derive ACMR's 2025E target multiple of 14X based on the linear function of global peer P/E and EPS growth

Source: Goldman Sachs Global Investment Research

Exhibit 395: Our SPE coverage's target 2025E P/E

Source: Goldman Sachs Global Investment Research

Key risks:**1) Competition in cleaning equipment that is fiercer than expected**

The global SPE market is highly competitive and dominated by global leaders. ACMR's products compete directly with global SPE peers such as SCREEN, Tokyo Electron, KLA etc. Global leaders have larger scale, generally stronger R&D, and a solid customer base and manufacturing abilities. In China, the semiconductor industry is growing rapidly with

numerous new entrants. ACMR is facing competition from both global and Chinese peers. If competition in the wafer cleaning tool market were to be more intense than expected, revenue growth and margins for ACMR could be negatively impacted.

2) R&D of new cleaning technology that is slower than expected

The SPE industry is a technology-intensive industry, involving a wide range of technology fields including microelectronics, electrical, machinery, materials, chemical engineering, fluid mechanics, automation, image recognition etc. Semiconductor fabrication technology has undergone rapid technology migration, moving to more advanced process node. This means that any delay in technology development could bring to risks to the company's competitive advantages. If ACMR is unable to maintain its technological edge in existing products or fail to develop differentiated and innovative products, growth at ACMR could be slower than we expect.

3) Single supplier risks

Some key components used in ACMR's equipment depend on a sole supplier. For example, Product Systems is the only supplier of megasonic generators for cleaning equipment, NINEBELL is the main supplier of robot arms in the conveyor system of cleaning equipment, and Advance Electric is a key supplier of valves for cleaning equipment. Any unfavorable changes in ACMR's partnerships with these suppliers, or difficulties in the business of these suppliers could materially impact ACMR's procurement and impact production.

4) China-US trade disputes

ACMR customers include global and Chinese memory makers (SK Hynix, YMTC) and foundries (SMIC, Huali, Hua Hong). Currently there are no restrictions on supply of equipment to customers. Should China-US trade disputes deteriorate more than expected and/or restrictions on equipment exports are imposed, ACMR's sales could be lower than our current estimates.

Exhibit 396: ACMR quarterly P&L

(Rmb m)	1Q19	2Q19	3Q19	4Q19	1Q20	2Q20E	3Q20E	4Q20E	2016	2017	2018	2019	2020E	2021E	2022E
Revenue	20	29	33	25	24	35	50	48	27	37	75	108	157	250	361
Gross profit	9	13	16	12	10	15	22	21	13	17	34	51	68	111	161
Operating expense	(7)	(8)	(9)	(9)	(9)	(11)	(11)	(14)	(10)	(17)	(28)	(33)	(45)	(59)	(79)
Operating income	2	5	7	4	1	4	11	7	3	1	6	18	23	51	82
Pre tax profit	2	5	9	3	2	5	11	8	3	(0)	7	19	27	55	85
Net income	2	4	9	4	2	4	10	7	1	(0)	7	19	23	48	76
EPS (Rmb)	0.11	0.26	0.52	0.23	0.09	0.22	0.53	0.38	0.47	(0.05)	0.42	1.12	1.23	2.67	4.18
Margins / ratio															
Gross margin	43.1%	45.3%	48.6%	50.6%	42.0%	43.8%	44.0%	43.4%	48.7%	47.2%	46.2%	47.1%	43.4%	44.3%	44.5%
Opex ratio	-32.1%	-29.2%	-27.6%	-34.9%	-37.0%	-32.3%	-22.8%	-28.0%	-35.9%	-45.3%	-37.5%	-30.6%	-28.7%	-23.7%	-21.8%
Operating margin	11.0%	16.1%	21.0%	15.6%	5.0%	11.5%	21.2%	15.4%	12.8%	1.9%	8.7%	16.5%	14.8%	20.5%	22.7%
Net margin	9.1%	14.9%	26.3%	16.0%	7.0%	11.9%	20.0%	14.6%	3.8%	-0.9%	8.8%	17.6%	14.5%	19.3%	21.0%
QoQ															
Revenue	-2%	42%	15%	-26%	-1%	43%	42%	-2%							
Gross profit	-14%	49%	24%	-23%	-18%	49%	43%	-4%							
Operating income	-15%	107%	51%	-45%	-68%	228%	163%	-29%							
Pre tax profit	-19%	163%	69%	-66%	-25%	112%	136%	-28%							
Net income	-19%	132%	104%	-55%	-57%	144%	139%	-29%							
EPS	-24%	132%	104%	-55%	-61%	144%	139%	-29%							
YoY															
Revenue	110%	39%	44%	18%	19%	20%	48%	97%	-12%	33%	104%	44%	46%	59%	44%
Gross profit	72%	51%	58%	21%	16%	16%	34%	69%	-6%	29%	100%	47%	35%	62%	45%
Operating income	nm	100%	107%	46%	-46%	-14%	50%	94%	-28%	-80%	824%	175%	30%	121%	60%
Pre tax profit	nm	54%	103%	23%	15%	-7%	29%	169%	-45%	nm	nm	157%	40%	107%	56%
Net income	nm	34%	128%	73%	-8%	-3%	13%	79%	-81%	nm	nm	187%	21%	111%	57%
EPS	nm	26%	114%	62%	-17%	-13%	2%	61%	-82%	nm	nm	170%	9%	117%	57%

Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

ACMR

ACMR		12m Price Target: \$150		Price: \$81.63		Upside: 83.8%	
Buy - CL		GS Forecast					
		12/19	12/20E	12/21E	12/22E		
Market cap: \$1.5bn	Revenue (\$ mn)	107.5	157.3	250.1	361.0		
Enterprise value: \$1.5bn	EBITDA (\$ mn)	18.6	24.0	52.4	85.7		
3m ADTV :\$30.4mn	EPS (\$)	1.12	1.23	2.67	4.18		
China	P/E (X)	13.2	66.5	30.6	19.5		
Greater China Technology	P/B (X)	2.9	12.3	8.8	6.1		
	Dividend yield (%)	0.0	0.0	0.0	0.0		
M&A Rank: 3	Net debt/EBITDA (X)	(8.8)	(7.1)	(3.3)	(3.2)		
Asia ex. Japan Conviction List	CROCI (%)	23.0	14.7	24.4	29.6		
	FCF yield (%)	2.7	0.3	(0.9)	0.5		
		3/20	6/20E	9/20E	12/20E		
	EPS (\$)	0.09	0.22	0.53	0.38		

Source: Company data, Goldman Sachs Research estimates, FactSet. Price as of 10 Jul 2020 close.

AMEC (688012.SS): Category leader in etchers; strong technology with expanding product offerings; initiate at Buy

Primary analysts:

Allen Chang, Jin Guo

Initiate at Buy with 12-month TP of Rmb382: AMEC is a leading local supplier of etching equipment for wafer fabrication specializing in dielectric etchers with products covering IC manufacturing (65nm-5nm process nodes, 3D NAND/DRAM), MEMS manufacturing, and metal-organic chemical vapor deposition (MOCVD) equipment (c.40% of global market share by revenue as of 2018 in GaN LED MOCVD) for LED chip manufacturing. AMEC is the only local SPE maker that has penetrated a global top tier customer's leading edge fab (i.e., TSMC's 5nm). The company competes with Lam Research, Tokyo Electron, and Applied Materials in etching segment as well as Veeco and Aixtron in MOCVD. AMEC is headquartered in Shanghai, with manufacturing sites in Shanghai and Nanchang. Key customers include TSMC, SMIC, Huahong, Huali, and YMTC, etc.

Our constructive view on AMEC is centered on the company's strong technology in etchers and its expanding products in new areas such as high-aspect ratio etch and stair case etch (mainly for 3D NAND) and dual damascene etch, which should allow the company to expand its serviceable available market in the coming years. Similar to other local SPE players, AMEC enjoys growing SPE demand locally and is well-positioned to capture more equipment allocations in local fabs given its strong technological capability. Riding on China's strong SPE spending (GSe 31% CAGR during 2020-25E) and AMEC's expanding local etcher market share to 30% in 2025E, the company is poised to deliver earnings growth of 59%/97%/78% in 2020/21/22E and 95% CAGR in 2020-25E (GSe). Based on 30x our 2025E EPS and discounted back to 2022E, we arrive at our target price of Rmb382, implying 42% upside; initiate at Buy. Risks include delays in investment from China wafer fabs or cancellations of their new capacity expansion projects; 2) loss of access to critical components from overseas suppliers due to trade disputes; and 3) intensifying competition.

PM Summary: Top five questions

1. What does AMEC do and who does it compete with?

AMEC makes etching equipment. Etch processes create chip features by selectively removing dielectric (insulating), silicon and metal (conducting) materials that have been added during deposition. AMEC specializes in dielectric etching equipment that covers 65-5nm process node for foundry/logic and 128-layer 3D NAND. AMEC mainly competes with global leaders such as Lam Research and Tokyo Electron, who have captured the lion's share both globally and in China. In addition, AMEC also makes MOCVD equipment mainly used in LED chip (GaN and GaAs based) manufacturing and has captured c. 40% of the global market share (GaN-based system) as of 2019. AMEC mainly competes with Veeco and Aixtron in MOCVD space.

2. What's the key difference between NAURA and AMEC?

NAURA has broader product offerings that cover thermal processes, silicon etchers, PVD, CVD, and cleaning tools whereas AMEC mainly focuses on dielectric etchers. The two companies do not compete directly given little overlap in product offerings. By technology, AMEC is ahead with its product penetrating into TSMC's leading edge (5nm) production line while NAURA's products can cover up to 14nm (with SMIC). While the two companies focus on different product segments, we expect both names to enjoy strong growth potential as the localization trend in China's SPE space should benefit both companies. We have Buy ratings on both NAURA and AMEC.

3. Why are we positive on AMEC and key catalysts in the next 6-12 months?

We are positive on AMEC's strong technology in etchers and its expanding products in new areas such as high-aspect ratio etch and stair case etch (mainly for 3D NAND) as well as dual damascene etch, which should allow the company to expand its serviceable available market in the coming years. Similar to other local SPE players, AMEC enjoys growing SPE demand locally and is well-positioned to capture more equipment allocations in local fabs given its strong technological capability. Riding on China's strong SPE spending (GSe 31% CAGR during 2020-25E) and AMEC's expanding local market share to 30% in 2025E, the company is poised to deliver earnings growth of 59%/97%/78% in 2020/21/22E and 95% CAGR in 2020-25E (GSe). The key catalysts in the near-term include: 1) YMTC's SPE tender result release where AMEC could see a rise in share allocation and order growth; and 2) breakthroughs in other top-tier customers.

4. Who are AMEC's key customers?

In the etch segment, AMEC's key customers include TSMC, SMIC, Huahong, Huali, and YMTC, etc, with YMTC being the largest one by order amount as of 2019. In the MOCVD segment, key customers are local LED chip manufacturers such as Sanan and Changelight.

5. How we are different from the street?

Our earnings estimates are 64%/100% higher than Bloomberg consensus in 2021/22E and our revenue estimates are 22%/38% higher as we believe AMEC's technology

strength and its potential to gain shares at local fabs are under appreciated by the market. There has been clear intention from local wafer fabs to find local substitutes to mitigate risks of losing access to foreign equipment, and we see strong determination from China to invest into semiconductor supply chain.

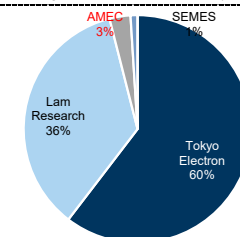
Exhibit 397: Product comparison among local and global major etcher suppliers; AMEC has c.3% market share in dielectric etchers globally

LAM			TEL			AMAT		
Product series	Materials	End applications	Product	Materials	End applications	Product	Materials	End applications
DSIE	Silicon	MEMS, power device, TSV packaging	Tactras Vigus	Silicon/Dielectric	Advanced nodes	CENTRIS SYM3	Silicon	1x /10nm/below
FLEX	Dielectric	Advanced memory, Power devices	Tactras Vesta	Silicon/Dielectric	Advanced memory	CENTRIS AdvantEdge	Silicon	22nm/below
KIYO	Silicon/Dielectric/Metal	Advanced nodes/memory	Tractras RLISA	Silicon/Dielectric	Leading edge logic	CENTURA Avatar	Dielectric	3D NAND
RELIANT	Silicon/Dielectric/Metal	GaN, SiC, AlGaN	Certas LEAGA	Dielectric	Surface etch/cleaning	CENTURA Silvia	Silicon	TSV packaging
SENSE.I	Silicon/Dielectric	Leading edge logic/memory	UNITY ME Ox	Dielectric	4-8" devices	CENTURA TETRA EUV	Photomask	EUV process
SYNDION	Deep silicon	TSV for CIS; HAR for CIS, power/MEMS	UNITY ME Si/SiC	Silicon	4-8", SiC, TSV	CENTURA TETRA Z	Photomask	10nm/below (non-EUV)
VERSYS	Metal	TiN hardmask, Al pad				CENTURA ETCH 200mm	Al metal	Metal interconnect
						PRODUCER ETCH	Dielectric	90nm/below
						PRODUCER SELECTRA	Dielectric	FinFET/NAND/DRAM

NAURA			AMEC		
Product	Materials	End applications	Product	Materials	End applications
NMC508M	Al metal	8", 0.35-0.11um	Primo D-RIE	Dielectric	12", 65-16nm
NMC508C	Silicon	8", 0.35-0.11um	Primo AD-RIE	Dielectric	12", 40-7nm
NMC612C	Silicon	12", 90-40nm	Primo SSC AD-RIE	Dielectric	12", 16nm
NMC612D	Silicon	12", 28-14nm	Primo HD-RIE	Dielectric	12", 3D NAND, DRAM
NMC612M	TiN Metal	12", 40-14nm	Primo IDEA	Dielectric	12", etch/photoresist
NMC612G	Al metal	12" Al etch, Micro OLED	Primo nanova	Dielectric	12", 1x nm memory
HSE200/230	Silicon	MEMS, TSV packaging	Primo TSV	Silicon	Advanced packaging

Currently developing silicon etcher, PVD, ALD for 7nm/5nm

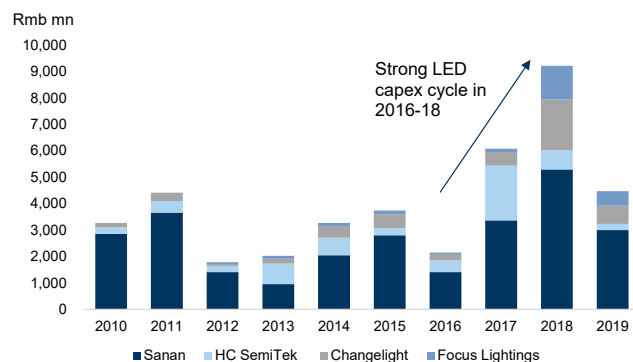
In R&D: Advanced logic (7nm and below) dual damascene etch
Advanced MEMS etcher; and Ether for 128L NAND (high aspect ratio)



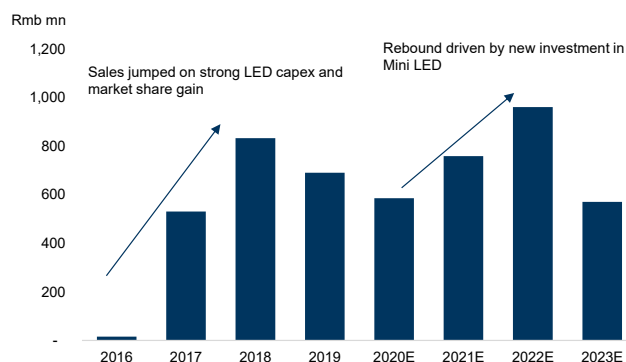
Source: Company data, Gartner

MOCVD demand set to rebound from trough

AMEC's MOCVD equipment is mainly used by LED chip manufacturers in China, e.g. Sanan, Changelight (300102.SZ, Not Covered) and Focus Lightings (300708.SZ, Not Covered), etc. AMEC's MOCVD sales jumped from Rmb16mn in 2016 to Rmb832mn (51% of total sales) in 2018 driven by a strong capex cycle in the LED industry. As capex dropped significantly in 2019 due to oversupply in the LED market and pricing weakness, LED equipment orders in 2019 decreased sharply as well based on our checks across the supply chain. In 2020, we expect MOCVD revenue to remain soft, as sales in the current year are determined by orders received in the prior year due to the long production cycle, with a rebound starting from 2021E driven by new investment starting from 2020 by leading LED companies such as Sanan and the expansion of Mini LED productions. AMEC's MOCVD products compete with Veeco (VECO, Not Covered) and Aixtron (AIXA, Not Covered).

Exhibit 398: China LED chip makers' capex: currently in a capex downtrend after a strong capex cycle in 2016-18

Source: Company data, Wind

Exhibit 399: AMEC's MOCVD sales trend: trough in 2020E; Rebound driven by Mini LED investment

Source: Company data, Goldman Sachs Global Investment Research

Based on our supply chain checks, two-thirds of LED fab capex is spent on equipment, of which c.50% is for MOCVD. AMEC's MOCVD equipment "Prismo A7" can process

220k 2" wafers per year per chamber. Based on Sanan's new capacity projects, we estimate it will need 128 units of MOCVD in the coming 2-3 years. We believe another key driver of MOCVD demand rebound is Mini LED investment. AMEC targets to launch Mini LED MOCVD in 2020, which should allow the company to capture the coming uptrend in Mini LED investment. A number of key companies have announced their plans in Mini LED and launched Mini LED products.

Exhibit 400: Sanan's LED expansion projects under construction could create new MOCVD demand of 128 units in coming 2-3 years

Project	Process	Capacity k wpm (4")	Construction start	#MOCVD needed (units)
Quanzhou 1	GaN	160	2019	36
Quanzhou 1	PSS-substrate	192	2019	43
Quanzhou 1	GaAs	26	2019	6
Hubei	GaN	134	2019	30
Hubei	GaAs	63	2019	14

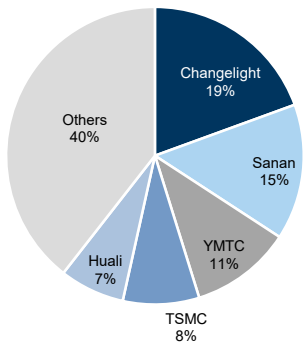
Source: Company data, Goldman Sachs Global Investment Research

Exhibit 401: Mini LED investment gathering momentum; a number of companies are aiming to mass produce Mini LED in 2020

Company	Ticker	Progress	Announced
BMTC	002429.SZ	Cooperating with Korean and Taiwan companies on Mini LED used in high-end displays	Jan, 2020
NationStar	002449.SZ	Mass production of Mini LED IMD-M09T Launched IMD-M05 with a smaller pitch Launched light source display modules for Mini LED backlight, smart home appliances	Apr, 2020
BOE	000725.SZ	Mass production of glass-based Mini LED backlight and Mini LED displays in 2H20	Mar, 2020
Refond	300241.SZ	Ready for mass production of Mini LED and will expand the production line, based on customer orders	May, 2020
Jufei	300303.SZ	Mini LED is a newly-developed business of mass-production capability, and key investment direction in the future. Mini LED modules adopt COB (Chip on Board) or COG (Chip-On-Glass) solutions	May, 2020
Mason	002654.SZ	Small-batch production of Mini LED	Dec, 2019
Coreach	002983.SZ	Mini LED display technology was selected as a major scientific and technological project in Anhui Province, and some technologies have obtained patents and entered into the customer sample stage	May, 2020
Unilumin	300232.SZ	Launched Zhou Ming UMini (Mini LED) in 2020, which adopted full-flip LED chips, mass transfer and integrated packaging technology to achieve high-density and reliable LED display	May, 2020

Source: Company data

Exhibit 402: Customer mix by revenue contribution

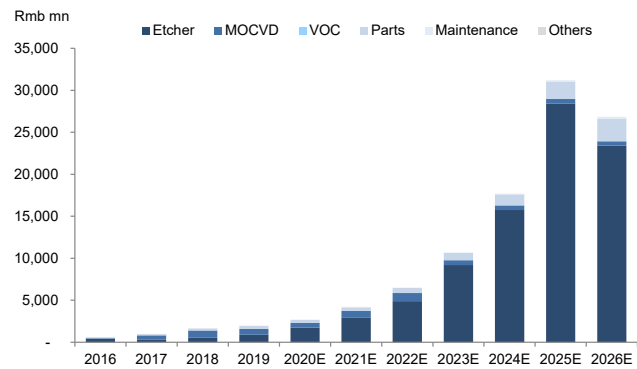


Source: Company data

Financial analysis
Income Statement

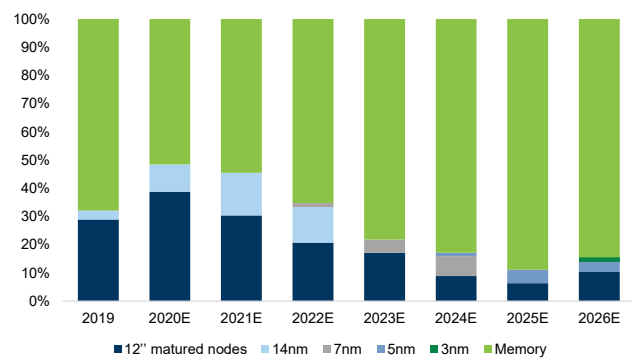
Revenue: we expect AMEC’s revenue to grow by 38%/57%/55% in 2020/21/22E and a 63% CAGR in 2020-25E driven by growth in etcher sales. Etcher revenue made up c.35%/46% of total sales in 2018/19, and we expect it to contribute 65%/91% in 2020/25E supported by an increase in China’s semiconductor fab investment and AMEC’s growing penetration among local customers. Another key area of robust growth is spare parts sales, which is highly correlated to AMEC’s accumulated equipment shipments. As the etcher sales volume increases by 10x during 2020-25E, we expect parts sales to grow by a 44% CAGR in 2020-25E and make up 7% of total sales in 2025E.

Exhibit 403: AMEC’s revenue growth trend: etcher remains the primary growth driver



Source: Company data, Goldman Sachs Global Investment Research

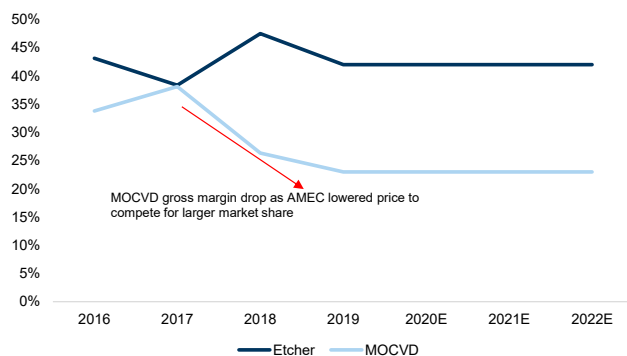
Exhibit 404: In etcher shipment mix, the primary contributor in 2020-25E is local memory demand from YMTC, CXMT, and Unigroup



Source: Goldman Sachs Global Investment Research

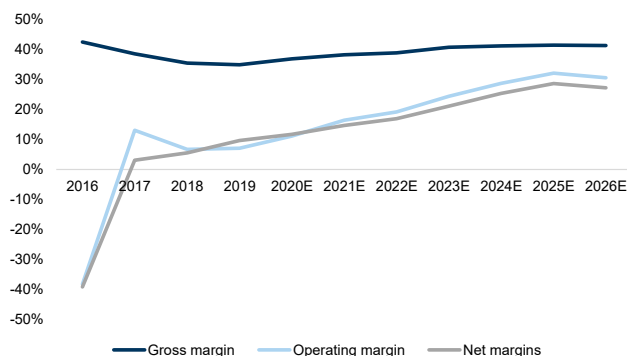
Margin analysis: stable margin trend in etcher; MOCVD margin downtrend to stabilize after price drop; AMEC’s etcher gross margin is c.40-45%, which is in line with the margin level of other SPE makers such as NAURA and ACM Research. As we forecast etcher’s revenue contribution to continue to increase over 2020-25E, we expect the blended gross margin to increase and stabilize at c.41%, and operating margin to improve on operating leverage.

Exhibit 405: Gross margin trends for etcher and MOCVD: we expect both to be stable going forward



Source: Company data, Goldman Sachs Global Investment Research

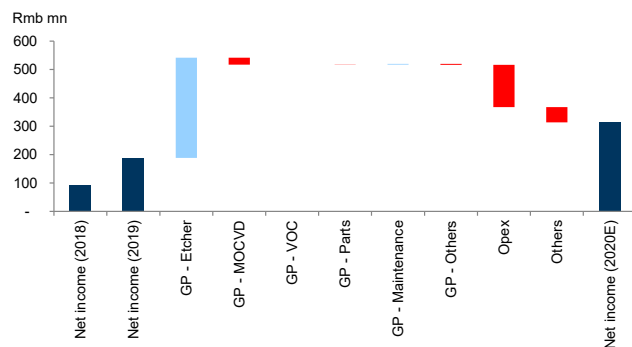
Exhibit 406: AMEC's overall margin trend: we expect expansion in OPM driven by operating leverage while for the gross margin level to remain stable



Source: Company data, Goldman Sachs Global Investment Research

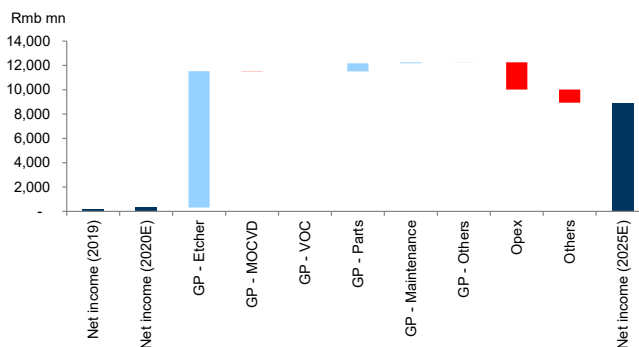
Earnings analysis: we expect net profit to grow by 59%/97%/78% in 2020/21/22E and 95% CAGR in 2020-25E, mainly driven by the strong growth potential in etcher supported by memory investment and an increase in share allocation from local fabs. Our earnings estimates are 64%/100% higher than Bloomberg consensus in 2021/22E and our revenue estimates are 22%/38% higher as we believe AMEC's technology strength and its potential to gain shares at local fabs are under appreciated by the market.

Exhibit 407: Etcher is the main profit driver for AMEC in 2020E
Net profit waterfall chart 2019-20E



Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 408: We expect AMEC's earnings to grow by 21x from low base
Net profit waterfall chart 2020-25E



Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Balance sheet

AMEC current does not have any long-term debt and is in a net cash position. Similar to other SPE firms, AMEC has a high inventory days level (336 days at end of 2019) due to a long production cycle and as customer inspection can take a long period before the product can be recognized as revenue. AMEC's ROE was 6.4% in 2019 but as the company's profitability and asset turnover improves, we expect ROE to increase to c.29% by 2026E.

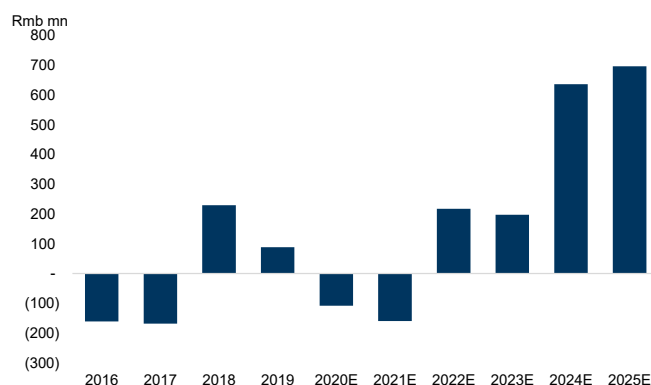
Exhibit 409: We expect ROE to improve to c.53%/29% in 2025/26E vs. c.6% in 2019 (vs. global majors' ROE at 35-45%)

Dupont analysis	2016	2017	2018	2019	2020E	2021E	2022E	2023E	2024E	2025E	2026E
Asset turnover	0.6	0.6	0.6	0.5	0.5	0.7	0.9	1.1	1.2	1.4	0.9
Leverage (assets/equity)	(1.2)	(5.5)	2.4	1.4	1.3	1.4	1.4	1.4	1.4	1.3	1.2
Net margin	-39.2%	3.1%	5.5%	9.7%	11.7%	14.7%	16.9%	21.1%	25.4%	28.7%	27.3%
ROE (common equity)	27.4%	-9.9%	7.6%	6.4%	8.0%	14.1%	21.0%	32.7%	43.7%	52.6%	29.1%
ROA	-22%	2%	3%	5%	6%	10%	15%	23%	30%	39%	25%

Source: Company data, Goldman Sachs Global Investment Research

Cash flow

AMEC's cash flow from operations turned positive in 2018 and remained in surplus in 2018 and 2019, at Rmb261mn and Rmb133mn, respectively. Going forward, given the strong revenue growth and well-managed working capital, we expect it to remain in positive territory. Fixed assets capex will mainly include the construction of its new production base with an investment budget of Rmb401mn and its R&D center upgrade project with a budget of Rmb400mn. Cash investment in intangible assets mainly includes capitalized R&D, which has typically made up c.40% of total R&D spending. Given the continued investment in R&D and new construction projects, we expect free cash flow to be negative (-Rmb109mn and -Rmb160mn in 2020E and 2021E, respectively) before turning positive in 2022E.

Exhibit 410: We expect AMEC's free cash flow to turn positive in 2022E

Source: Company data, Goldman Sachs Global Investment Research

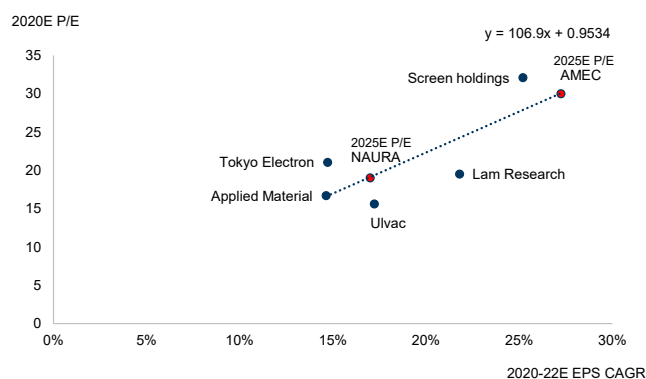
Valuation and risks

Our target price of Rmb382 is derived from a discounted PE valuation model to capture the long-term earnings growth in the local SPE sector. We apply 30x to 2025E EPS and discount back to 2022E at 9% p.a. (cost of equity). Our target multiple of 30x is based on global peer PEs and their EPS growth correlation.

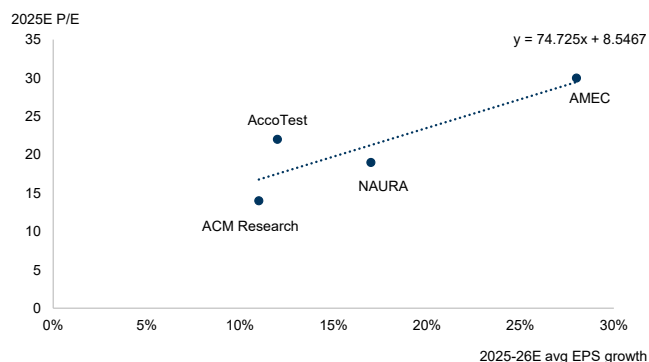
Exhibit 411: We use 30x on 2025E EPS and discount back to 2022E at 9% p.a. to get our 12-month TP of Rmb382

Rmb mn	2019	2020E	2021E	2022E	2023E	2024E	2025E	2026E
Revenue	1,947	2,678	4,199	6,500	10,699	17,704	31,201	26,857
Etcher	897	1,737	2,968	4,892	9,195	15,756	28,443	23,431
MOCVD	690	585	758	960	570	542	515	489
Parts	338	338	441	603	868	1,309	2,087	2,732
Gross margin	35%	37%	38%	39%	41%	41%	41%	41%
Gross profit	680	989	1,606	2,529	4,359	7,293	12,944	11,104
Opex	542	690	916	1,281	1,745	2,202	2,917	2,891
OP income	138	298	690	1,248	2,614	5,091	10,026	8,213
Non-op gains	60	53	(4)	(27)	(104)	(101)	(90)	(77)
Pre-tax profit	198	352	686	1,222	2,510	4,990	9,937	8,136
Tax expense	10	38	69	122	251	499	994	814
Minority interest	0	(0)	(0)	(0)	-	-	-	-
Net profit	189	314	618	1,100	2,259	4,491	8,943	7,322
YoY		66%	97%	78%	105%	99%	99%	-18%
Implied PE		652	331	186	91	46	23	28
Valuation								
Terminal year	2025E							
COE	9%							
Discount period	3							
Discount factor	0.762							
Net income (2025E)	8,943							
Terminal multiple	30x							
Terminal market cap (Rmb mn)	268,289							
Discount back to 2022E	204,456							
Shares outstanding (mn)	535							
Target price	382							

Source: Company data, Goldman Sachs Global Investment Research

Exhibit 412: With average earnings growth (geometric average) of 28% in 2025/26E, we derive AMEC's 2025E target multiple of 30x based on the linear function of global peer PE and EPS growth


Source: Goldman Sachs Global Investment Research

Exhibit 413: Our SPE coverage target 2025E P/E


Source: Goldman Sachs Global Investment Research

Key risks: 1) our forecasts are based on China's semiconductor investment plan. If China wafer fabs delay their investment, or cancel their new capacity expansion projects, it will lead to a lower earnings growth rate than our current forecasts. Each 10% drop in etcher demand in China would lead to a c.14% of drop in our 2025E earnings; 2) AMEC purchases a portion of components overseas. If AMEC loses access to critical components from overseas suppliers due to trade disputes, it could significantly disrupt AMEC's production and deliveries, therefore, leading to earnings downside. 3) Currently, there has been no direct local competitor to AMEC and the competition is mainly against foreign vendors in the China market; if competition

intensifies in the future, it could lead to market share loss and margin pressure for AMEC.

Exhibit 414: AMEC quarterly P&L

	1Q19	2Q19	3Q19	4Q19	1Q20	2Q20E	3Q20E	4Q20E	2016	2017	2018	2019	2020E	2021E	2022E
Revenue	376	425	416	729	413	668	604	993	610	972	1,639	1,947	2,678	4,199	6,500
Gross profit	122	163	188	207	140	250	227	372	259	375	582	680	989	1,606	2,529
Operating expense	(97)	(157)	(115)	(172)	(121)	(159)	(184)	(225)	(492)	(248)	(472)	(542)	(690)	(916)	(1,281)
Operating income	25	6	73	34	18	91	42	147	(233)	127	110	138	298	690	1,248
Pre tax profit	23	12	118	46	32	111	62	147	(236)	49	147	198	352	686	1,222
Net income	14	17	105	54	26	100	56	132	(239)	30	91	189	314	618	1,100
EPS (Rmb)	0.03	0.03	0.21	0.11	0.05	0.19	0.10	0.25	(0.53)	0.07	0.20	0.37	0.59	1.16	2.06
Margins / ratio															
Gross margin	32.5%	38.4%	45.2%	28.3%	33.9%	37.5%	37.5%	37.5%	42.5%	38.6%	35.5%	34.9%	36.9%	38.3%	38.9%
Opex ratio	-25.8%	-37.0%	-27.7%	-23.6%	-29.4%	-23.9%	-30.5%	-22.7%	-80.8%	-25.5%	-28.8%	-27.8%	-25.8%	-21.8%	-19.7%
Operating margin	6.7%	1.4%	17.5%	4.7%	4.5%	13.6%	7.0%	14.8%	-38.3%	13.1%	6.7%	7.1%	11.1%	16.4%	19.2%
Net margin	3.7%	3.9%	25.1%	7.4%	6.4%	14.9%	9.2%	13.3%	-39.2%	3.1%	5.5%	9.7%	11.7%	14.7%	16.9%
QoQ															
Revenue	-43%	13%	-2%	75%	-43%	62%	-10%	64%							
Gross profit	-46%	34%	15%	10%	-32%	79%	-9%	64%							
Operating income	-53%	-76%	1128%	-53%	-46%	394%	-54%	247%							
Pre tax profit	-78%	-50%	920%	-61%	-30%	243%	-44%	138%							
Net income	-78%	19%	532%	-49%	-51%	280%	-44%	138%							
EPS	-81%	19%	532%	-49%	-53%	280%	-44%	138%							
YoY															
Revenue	524%	5%	-18%	10%	10%	57%	45%	36%		59%	69%	19%	38%	57%	55%
Gross profit	447%	1%	10%	-9%	14%	54%	20%	80%		45%	55%	17%	45%	62%	57%
Operating income	nm	-91%	99%	-36%	-27%	1432%	-42%	327%		nm	-14%	26%	116%	131%	81%
Pre tax profit	nm	-76%	147%	-56%	40%	856%	-48%	221%		nm	200%	35%	77%	95%	78%
Net income	nm	-60%	160%	-16%	89%	502%	-47%	147%		nm	204%	108%	66%	97%	78%
EPS	nm	-64%	131%	-25%	81%	474%	-49%	135%		nm	204%	85%	59%	97%	78%

Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

AMEC

688012.SS		12m Price Target: Rmb382		Price: Rmb269.18		Upside: 41.9%	
Buy		GS Forecast					
			12/19	12/20E	12/21E	12/22E	
Market cap: Rmb144.0bn / \$20.6bn		Revenue (Rmb mn)	1,946.9	2,678.3	4,199.5	6,500.3	
Enterprise value: Rmb142.7bn / \$20.4bn		EBITDA (Rmb mn)	166.1	331.6	733.8	1,313.0	
3m ADTV :Rmb826.1mn/ \$116.6mn		EPS (Rmb)	0.37	0.59	1.16	2.06	
China		P/E (X)	NM	NM	NM	130.9	
Greater China Technology		P/B (X)	10.8	35.4	30.7	24.9	
		Dividend yield (%)	0.0	0.0	0.0	0.0	
M&A Rank: 3		Net debt/EBITDA (X)	(8.0)	(3.7)	(1.5)	(1.0)	
		CROCI (%)	0.9	8.0	13.9	20.7	
		FCF yield (%)	0.2	(0.1)	(0.1)	0.2	
			3/20	6/20E	9/20E	12/20E	
		EPS (Rmb)	0.05	0.19	0.10	0.25	

Source: Company data, Goldman Sachs Research estimates, FactSet. Price as of 10 Jul 2020 close.

Anji Micro (688019.SS): Local leader in CMP slurry; Key beneficiary of China memory ramp-up

Primary analysts:

Allen Chang, Jin Guo

Initiate at Buy with a 12-month TP of Rmb647: Anji Micro is the leading local supplier of CMP (chemical mechanical polishing) slurry, which is a chemical consumable used in the wafer fabrication process. The demand for CMP slurry is closely correlated with the number of CMP steps per wafer and the number of wafer starts fabricated. This is the key reason that CMP slurry demand does not fluctuate as much as the SPE sector, chiefly because it is costly for wafer fabs to change production dramatically given high fixed costs, whereas wafer fabs can quickly adjust their capex based on their business outlook.

The bottom line: we are constructive on Anji for 4 key reasons:

1) Strong demand growth from new wafer fabs and capacity expansion in China; we expect China's 12" wafer fab capacity to grow by c.8x to 1.9mn wafers per month (wpm) by 2025E, and 8" wafer fab capacity to double during the same period, based on the new projects we track. With the strong growth in wafer starts, we estimate CMP slurry demand to grow **seven fold by 2025E** vs. 2019;

2) Product expansion to tungsten slurry: the company's current products cover 130-14nm technology nodes in foundry/logic but are expanding to 10nm-5nm. Copper slurry (mainly used by foundry/logic) makes up c.71% of its total CMP slurry sales, while the rest mainly consists of silicon and oxide slurry. The company is ramping up its tungsten slurry products (mainly used by memory makers) to capture demand from local memory expansion (3D NAND/DRAM).

We expect memory to make up 42% of total wafer fab capacity in China by 2025E (vs. 9% in 2019). Revenue from YMTC (3D NAND) doubled in 2019 as tungsten slurry shipments started to ramp up, and we expect tungsten to be a key growth driver going forward. Tungsten slurry has higher gross margin at c.80% vs. copper at c.60% and the increase of tungsten in the product mix should also support margin expansion, in our view.

Cabot is covered by our US analyst Toshiya Hari

3) A high quality customer base including TSMC, SMIC, YMTC; growing opportunities from local customers; by revenue contribution, SMIC made up c.51% of total sales in 2019, TSMC 10% and YMTC 14%. CMP slurry supplies are dominated by US and Japan suppliers, such as Cabot, Dow Chemical, and Fujimi. On the back of US-China trade disputes and China local wafer fabs' concerns over losing access to foreign raw materials and components, there have been growing efforts to search for local replacements to mitigate supply chain risks. On the back of this, we think Anji, as the leading local supplier of CMP slurry, stands to gain more opportunities from its local customers.

4) Strong earnings growth potential: benefiting from strong demand growth and rising market share locally, Anji is well-positioned to capture solid earnings growth opportunities. We expect 53%/101%/86% net income growth in 2020/21/22E and 74%

Anji's product comparison vs. global leaders: less comprehensive offerings but expanding

Anji's current products offerings include a series of CMP (Chemical Mechanical Polishing) slurry and photoresist removers, used in IC manufacturing and advanced packaging. Its CMP slurry products have achieved large-scale sales at 130-14nm technology node, which is mainly used for 8" and 12" wafers; and its CMP slurry at 10-5nm technology node are under development. By materials type, Anji provides Copper slurry, Tungsten slurry, and Silicon/Oxide slurry, etc. Copper slurry (for logic IC) makes up 71% of its total CMP slurry sales, while tungsten slurry (for memory) will be the key growth driver. Photoresist removers are used in semiconductor manufacturing, packaging and LCD/OLED.

Anji's larger global peers have more comprehensive CMP slurry product lineups that cover up to 5nm in logic IC and almost all types of materials ranging from tungsten, copper, cobalt, and other dielectric slurry. Key competitors include **Cabot** (tungsten, dielectrics, metal interconnect), **DuPont** (dielectrics, barrier metals, TSV [Through Silicon Via]), **Hitachi Chemical** (barrier metals, TSV), **Fujimi** (dielectrics, barrier metals), **Fuji Film** (copper, barrier metals), **Versum** (advanced oxide STI barrier, copper strengthening, and Tungsten). See our US analyst Toshiya Hari's Cabot initiation ([link](#)).

Valuation and risks: To capture Anji's long-term earnings growth, we derive our 12-month target price of Rmb647 from a discounted P/E valuation model. We apply 30x to 2025E EPS and discount back to 2022E at 12% p.a. Our target multiple of 30x is based on global peer P/E and EPS growth correlation. Risks include: 1) slower-than-expected Tungsten product development; 2) overseas supply chain risks 3) concentration of customers (c.85% of its revenue in 2019 came from its top 5 customers), and 4) environmental risks.

PM Summary: Top five questions

1. What are the products and who are the key customers of Anji? *CMP (chemical mechanical polishing) slurry, key customers are SMIC, TSMC, YMTC*

Anji supplies CMP (chemical mechanical polishing) slurry, which is a chemical consumable used in the wafer fabrication process. The demand for CMP slurry is closely correlated with the number of CMP steps per wafer and the number of wafer starts fabricated. The new wafer fabs and capacity expansion in China will drive up the demand of CMP slurry. Anji has a high quality customer base including TSMC (c.10% of total sales in 2019), SMIC (c.51% of 2019 sales), YMTC (c.14% of 2019 sales). Key CMP slurry suppliers include Cabot (tungsten, dielectrics, metal interconnect), DuPont (dielectrics, barrier metals, TSV [Through Silicon Via]), Hitachi Chemical (barrier metals, TSV), Fujimi (dielectrics, barrier metals), Fuji Film (copper, barrier metals), Versum (advanced oxide STI barrier, copper strengthening, and Tungsten). Read across to our US analyst Toshiya Hari's Cabot initiation ([link](#)).

2. Why are we positive on Anji? *Strong growth in demand, product expansion, growing opportunities from local customers*

We are positive on Anji's earnings growth given: 1) strong demand growth from new wafer fabs and capacity expansion in China; we expect China's 12" wafer fab capacity to grow by c.8x to 1.9mn wafers per month (wpm) by 2025E, and 8" wafer fab capacity to double during the same period, based on the new projects we track. With the strong growth in wafer starts, we estimate CMP slurry demand to grow seven fold by 2025E vs. 2019; 2) product expansion to tungsten slurry: the company's current products cover 130-14nm technology nodes in foundry/logic but are expanding to 10nm-5nm. Copper slurry (mainly used by foundry/logic) makes up c.71% of its total CMP slurry sales, while the rest mainly consists of silicon and oxide slurry. The company is ramping up its tungsten slurry products (mainly used by memory makers) to capture demand from local memory expansion (3D NAND/DRAM); 3) growing opportunities from local customers: CMP slurry supplies are dominated by US and Japan suppliers, such as Cabot, Dow Chemical, and Fujimi. On the back of US-China trade tensions and concerns among China's local wafer fabs over losing access to foreign raw materials and components, there have been growing efforts to search for local replacements to mitigate supply chain risks. On the back of this, we think Anji, as the leading local supplier of CMP slurry, stands to gain more opportunities from its local customers.

3. Where are we different from the Street? *2021E/22E earnings 62%/126% higher than Bloomberg consensus*

We are positive on Anji's earnings growth driven by its new product ramp up and a growing customer base. Our earnings estimates are 62%/126% higher than Bloomberg consensus in 2021/22E and our revenue estimates are 44%/66% higher as we see a faster ramp-up in the company's tungsten slurry and stronger demand for local substitutes amid US-China trade disputes. We are more conservative on margins and model 50.9%/51.3%/53.0% GM for 2020-22E vs. consensus at 51.5%/52.0%/53.0%.

4. How do we value Anji? *30x on 2025E EPS, discount to 2022E CAGR during 2020-25E.*

Our 12-month target price of Rmb647 is derived from a discounted P/E valuation model to capture the long-term earnings growth. We apply 30x to 2025E EPS and discount back to 2022E at 12% p.a. (the company's cost of equity, based on beta of 1.5, risk free rate of 3% and market risk premium of 6%). Our target multiple of 30x is based on global peer P/E and EPS growth correlation. The peer group includes Dow, Fujimi, Fujibo, Cabot, and KPX, all with meaningful exposure to the CMP slurry business. Our target price implies 170x/91x our 2021/22E EPS (vs. the stock is currently trading at 119x/64x our 2021/22E EPS).

5. What are the risks?

Key risks to our investment thesis include: 1) Slower-than-expected Tungsten product development, which could lead to lower market share than we expect and thus slower revenue growth; 2) Supply chain risks: Anji purchases key raw materials from overseas (e.g. silica sol), and if trade disputes were to lead to a loss of access to its key raw materials, Anji could see significant production disruption which could lead to downside risk to our estimates, 3) Concentration of customers: Anji generates c.85% of its revenue in 2019 from its top five customers and the largest customer contributed c.51% of its total revenue in 2019, 4) Environmental risks: CMP slurry production involves various chemicals and some of them are toxic (e.g. NO₂, waste water).

Exhibit 415: Anji vs. global peers CMP slurry offerings by logic node and memory

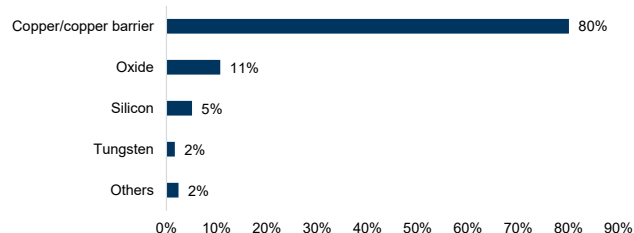
Company	130nm	65nm	45nm	28nm	20nm	16/14 nm	10nm	7nm	5nm	3D NAND	3D DRAM
Anji	✓	✓	✓	✓	✓	✓	R&D	R&D	R&D	✓	✓
Cabot	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Hitachi	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Fujimi	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Source: Company data

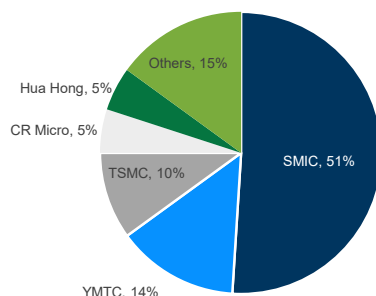
Exhibit 416: Anji vs. global peers CMP slurry offerings by materials

Company	W CMP	Cu CMP	Co CMP	Si CMP
Anji	✓	✓	R&D	✓
Cabot	✓	✓	✓	✓
Hitachi	✓	✓	✓	✓
Fujimi	✓	✓	✓	✓

Source: Company data, Goldman Sachs Global Investment Research

Exhibit 417: Anji's CMP slurry mix (2018)

Source: Company data

Exhibit 418: Anji currently supplying to SMIC, TSMC, YMTC (Sales, 2019)

Source: Company data

Exhibit 419: Anji's product offerings for major customers

Customer	Anji's product offerings
SMIC	CMP slurry, Photoresist remover
TSMC	CMP slurry
YMTC	CMP slurry, Photoresist remover
CR Micro	CMP slurry
Hua Hong	CMP slurry, Photoresist remover

Source: Company data

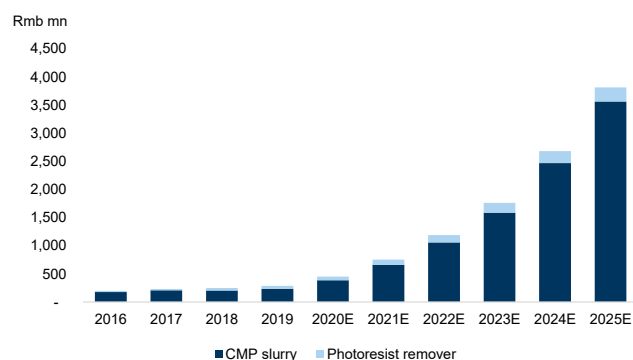
Financial analysis

Income Statement

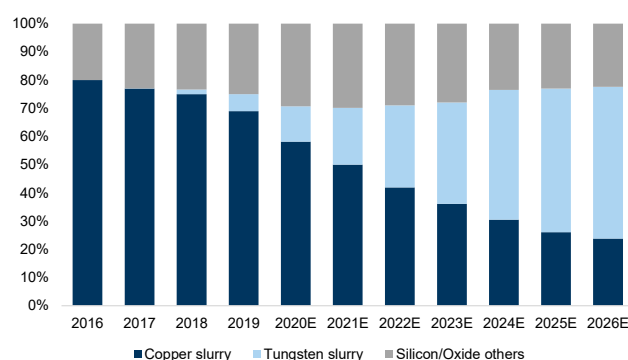
Revenue: we expect Anji's revenue to grow by 60%/66%/57% in 2020/21/22E and post 53% CAGR in 2020-25E driven by growth in CMP slurry sales, especially expansion of tungsten slurry driven by local memory demand. CMP slurry revenue made up c.83% of total sales in 2018/19, and we expect it to contribute 93% in 2025E supported by increase in local demand and Anji's growing market share in local customers.

Exhibit 420: CMP slurry to be the primary driver of revenue growth in coming years

Revenue, 2016-2025



Source: Company data, Goldman Sachs Global Investment Research

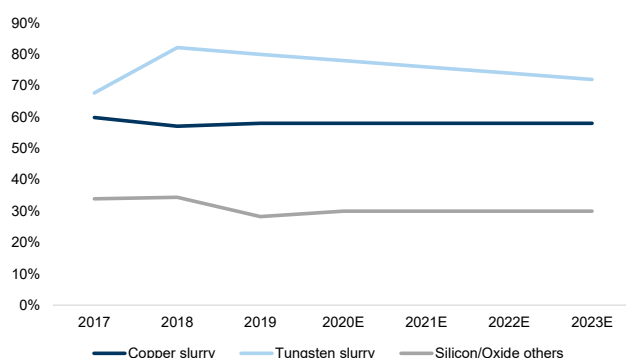
Exhibit 421: Anji's Tungsten slurry (for local memory fabs) will be the key growth driver


Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

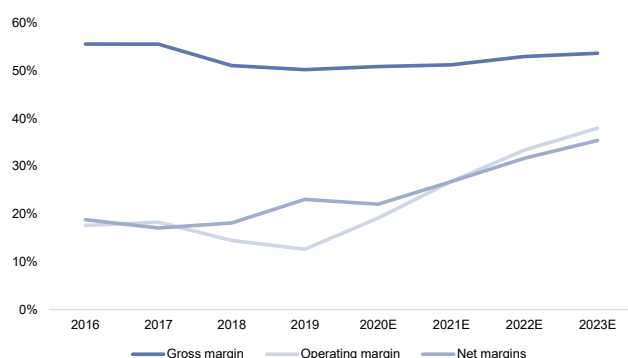
Margin analysis: we expect expansion in tungsten slurry to support gross margin expansion as tungsten has higher GM than copper and silicon/oxide product lines. In addition, as Anji's revenue scale expands, we expect operating margin and net margin to improve driven by operating leverage.

Exhibit 422: Tungsten has higher margin than copper and silicon/oxide slurry

Gross margin by product type



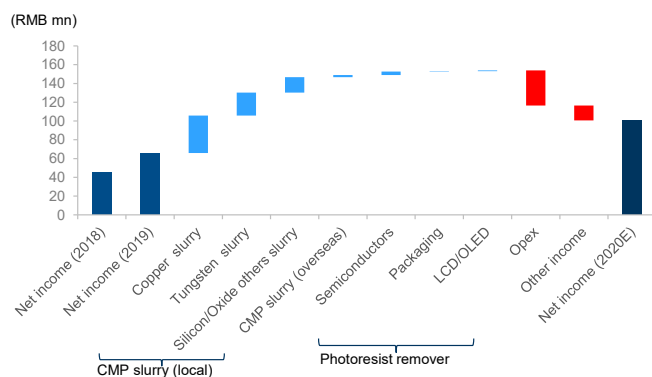
Source: Company data, Goldman Sachs Global Investment Research

Exhibit 423: Overall margin trend: we expect expansion in OPM and net margin driven by operating leverage and gross margin to improve on mix shift to higher margin product


Source: Company data, Goldman Sachs Global Investment Research

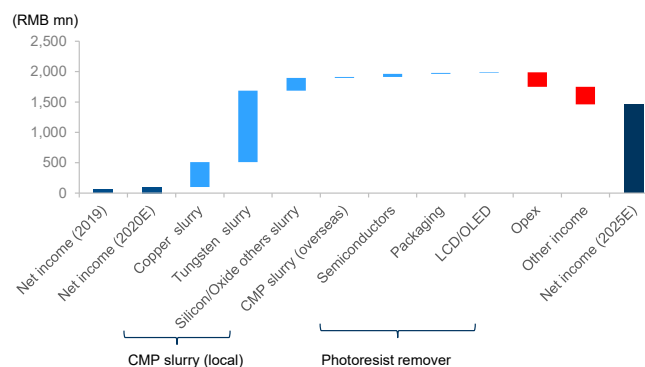
Earnings analysis: we expect net profit to grow by 53%/101%/86% in 2020/21/22E and post 74% CAGR in 2020-25E, mainly driven by the strong growth in CMP slurry supported by memory demand and increase in share allocation from local fabs. Our earnings estimates are 14%/62% higher than Bloomberg consensus in 2020/21E and our revenue estimates are 20%/44% higher as we see a faster ramp-up in the company's tungsten slurry and stronger demand for local substitutes amid US-China trade disputes.

Exhibit 424: Waterfall chart 2019-20E, net profit



Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 425: Waterfall chart 2020-25E, net profit



Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Balance sheet

Anji current does not have any short or long-term debt and is in net cash position. Anji's account receivable days range from 60-75 days, which is in line with local peer average. Inventory days was close to 200 days, which we expect to fall as demand increases and sales growth accelerates. For ROE, we expect it to improve to 52% in 2025E vs. 11% in 2019/20E as its profit margin improves significantly.

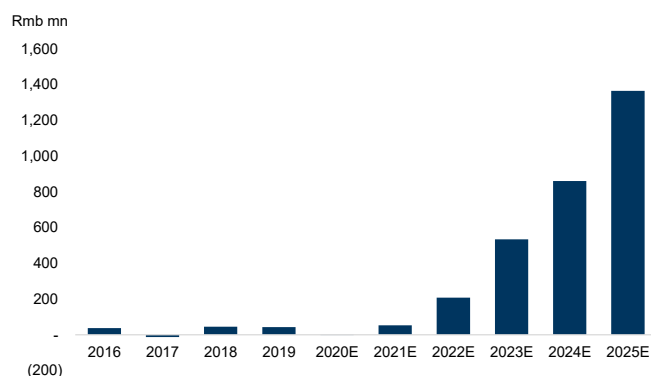
Exhibit 426: We expect ROE to improve to 52% in 2025E vs. c.11% in 2019 driven by higher profitability

Dupont analysis	2016	2017	2018	2019	2020E	2021E	2022E	2023E	2024E	2025E	2026E
Asset turnover	1.3	0.7	0.6	0.4	0.4	0.6	0.8	1.0	1.1	1.1	1.0
Leverage (assets/equity)	1.2	1.2	1.2	1.2	1.1	1.1	1.1	1.1	1.1	1.1	1.1
Net margin	18.9%	17.1%	18.1%	23.1%	22.1%	26.8%	31.7%	35.4%	40.1%	42.0%	43.3%
ROE (common equity)	28.3%	14.1%	13.9%	10.7%	10.9%	19.7%	30.7%	39.6%	49.7%	51.8%	47.8%
ROA	24%	12%	11%	9%	10%	17%	27%	35%	44%	46%	43%

Source: Company data, Goldman Sachs Global Investment Research

Cash flow

Anji's cash flow from operations have remained in positive territory. Going forward, given the strong revenue growth and well-managed working capital, we expect it to remain positive. Fixed assets capex will mainly include the construction of its new production base, capacity expansion and R&D center upgrade, with a total investment budget of Rmb314mn. Given the capex for new construction projects, we expect free cash flow to remain low before turning up in 2022E. Anji's dividend per share was Rmb0.38 for 2019, or a payout ratio of 31%. We model the same payout ratio going forward.

Exhibit 427: We expect strong free cash flow expansion driven by profit growth

Source: Company data, Goldman Sachs Global Investment Research

Exhibit 428: IPO proceeds have supported various projects from 2019

Project	Investment amount (RMB mn)	Construction period (years)
CMP slurry production line expansion project	120	2
Material base project	105	2
Construction project of IC material R&D center	69	2
IT system upgrading project	20	2
Total	314	-

Source: Company data

Valuation and risks

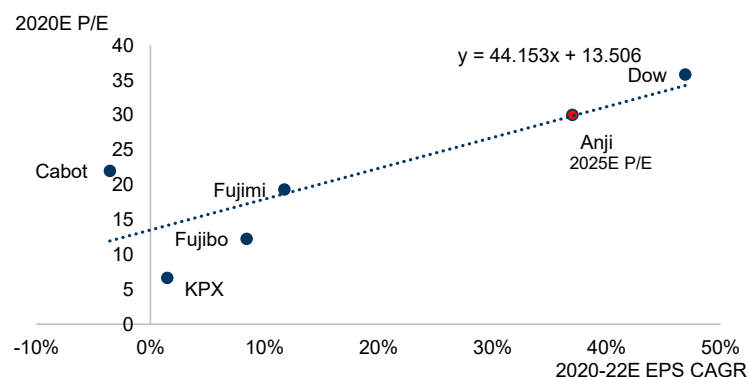
Our 12-month target price of Rmb647 is derived from a discounted P/E valuation model to capture the long-term earnings growth. We apply 30x to 2025E EPS and discount back to 2022E at 12% p.a. (the company's cost of equity). Our target multiple of 30x is based on global peer P/E and EPS growth correlation. The peer group includes Dow, Fujimi, Fujibo, Cabot, and KPX, all with meaningful exposure to the CMP slurry business. Our target price implies 170x/91x our 2021/22E EPS (vs. the stock is currently trading at 119x/64x our 2021/22E EPS).

We have an M&A score of 3 for Anji given its products and technologies are behind overseas peers but the company is the leader among local suppliers, which we think makes the company unappealing as an M&A target for both overseas and local peers.

Exhibit 429: Anji Micro TP at Rmb647

Rmb mn	2019	2020E	2021E	2022E	2023E	2024E	2025E	2026E
Revenue	285	456	755	1,188	1,762	2,681	3,815	4,832
CMP slurry	236	387	661	1,059	1,586	2,469	3,562	4,527
Photoresist remover	49	65	93	130	176	211	253	306
Others	0	4	-	-	-	-	-	-
Gross margin	50%	51%	51%	53%	54%	56%	56%	56%
Gross profit	143	232	387	630	946	1,490	2,118	2,707
Opex	107	145	184	233	277	326	383	448
Sales tax	0	0	0	1	1	2	2	3
Marketing expenses	20	28	37	47	59	74	91	112
Admin	30	36	43	51	60	68	78	87
R&D	58	81	104	134	157	182	212	245
OP income	36	87	203	397	669	1,164	1,735	2,259
Non-op gains	37	23	22	22	24	32	44	64
Pre-tax profit	73	110	225	419	693	1,196	1,780	2,324
Tax expense	8	10	22	42	69	120	178	232
Minority interest	-	-	-	-	-	-	-	-
Net profit	66	101	202	377	624	1,076	1,602	2,091
		53%	101%	86%	66%	72%	49%	31%
Implied PE		342	170	91	55	32	21	16

Valuation	
Terminal year	2025E
Beta	1.5
Market risk premium	6.0%
Risk free rate	3.0%
COE	12%
Discount period	3
Discount factor	0.715
Net income (2025E)	1,602
Terminal multiple	30x
Terminal market cap (Rmb mn)	48,048
Discount back to 2022E	34,365
Shares outstanding	53
Price per share	647.0



Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Key risks:

1. Tungsten product development is slower than expected, which could lead to lower market share than we expect and thus slower revenue growth; We expect tungsten slurry to make up 47% of Anji's total slurry sales in 2025E (vs. 2%/4% in 2018/19) and the growth is mainly driven by ramp-up at China's local memory fab and Anji's expansion of its tungsten product lineup. If its products fail to meet the quality standards or local memory ramp-up progress is significantly delayed, there would be downside risk to our earnings estimates.
2. Supply chain risks: Anji purchases key raw materials from overseas (e.g. silica sol), and if because of trade disputes, Anji loses access to its key raw materials, it could cause significant production disruption and thus lead to earnings downside to our estimates.
3. Concentration of customers: Anji generates c.85% of its revenue in 2019 from its top 5 customers and the largest customer contributed c.51% of its total revenue in 2019. If its key customers switch to other suppliers or any significant disruption takes place in its customers' production, it could result in lower revenue, hence leading to earnings downside.

4. Environmental risks: CMP slurry production involves various chemicals and some of them are toxic (e.g. NO₂, waste water). Missteps in processing the waste could lead to brand damage and financial penalty. If environmental regulations are further tightened, it could increase product costs as more expenditure will be required in processing pollutants.

Exhibit 430: Anji comp table

	Ticker	Rating	Analyst	Pricing currency	PX (LCY)	TP (LCY)	Upside (%)	Market cap (US\$m)	EV (US\$m)	LTM PX move (%)	LTM ADTV (US\$mn)	EPS growth			Trading P/E			Trading P/B			ROE			Div Yield			
												2020E	2021E	2022E	2020E	2021E	2022E	2020E	2021E	2022E	2020E	2021E	2022E	2020E	2021E	2022E	
Semi materials																											
Local																											
Anji	688019.SS	Buy	Allen Chang, Jin Guo	CNY	455.0	647	42%	3,452	3,380	1,062	41	31%	101%	86%	240.3	119.5	64.2	25.2	22.0	17.8	11%	20%	31%	0.1%	0.3%	0.5%	
Dinglong	300054.SZ	NC	NA	CNY	19.2	NA	NA	2,696	2,547	140	47	593%	38%	42%	69.4	50.3	35.4	4.7	4.4	4.0	7%	8%	10%	0.8%	1.1%	1.4%	
Konfoong	300666.SZ	NC	NA	CNY	72.8	NA	NA	2,311	2,362	98	59	15%	46%	24%	218.0	149.2	120.7	20.7	18.2	15.7	11%	12%	13%	NA	NA	NA	
Sonyang	300228.SZ	NC	NA	CNY	81.3	NA	NA	3,374	3,359	256	122	-63%	22%	45%	300.9	246.2	169.3	14.7	13.9	NA	5%	6%	8%	0.1%	0.1%	NA	
Grish	Private	NC	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
Sonyung	Private	NC	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
Xinanna	Private	NC	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
Times Live	Private	NC	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
Global																											
Dow	DOW	Buy	Robert Koort	USD	40.8	48	18%	30,272	47,386	(9)	223	-67%	81%	19%	35.4	19.6	16.4	2.5	2.7	2.9	7%	13%	17%	7.6%	7.6%	8.3%	
Cabot	CCMP	Sell	Toshiya Hari	USD	135.8	117	-14%	3,947	4,713	24	36	2%	-17%	7%	19.8	23.8	22.2	3.9	3.7	3.5	NM	NM	NM	1.3%	1.4%	1.5%	
Versum	Private	NC	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
Hitiachi	6501.T	NR	Yuichiro Isayama	JPY	3,342	NA	NA	30,256	44,282	(15)	123	375%	-12%	NA	5.8	6.6	NA	0.9	0.8	NA	16%	13%	13%	3.3%	3.4%	NA	
JSR	4185.T	NC	NA	JPY	2,110	NA	NA	4,463	5,175	34	23	-34%	68%	NA	29.2	17.4	NA	1.1	1.1	NA	4%	6%	NA	2.8%	2.9%	0.0%	
Fujimi	5384.T	NC	NA	JPY	3,415	NA	NA	917	681	58	2	15%	10%	NA	18.4	16.7	NA	1.5	1.5	NA	9%	9%	NA	2.8%	3.0%	0.0%	
Fujibo	3104.T	NC	NA	JPY	3,055	NA	NA	335	320	35	1	-2%	9%	NA	12.3	11.3	NA	NA	NA	NA	8%	NA	NA	3.3%	3.3%	0.0%	
KPK	025000.KS	NC	NA	KRW	46,350	NA	NA	187	97	(16)	0	-15%	5%	-2%	6.4	6.1	6.2	0.5	0.4	0.4	7%	7%	7%	5.1%	5.4%	5.4%	
SK Siltron	Private	NC	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
Average											152	62	77%	32%	32%	86.9	60.6	62.0	7.6	6.9	7.4	8%	11%	14%	2.7%	2.8%	2.1%
Median											35	41	2%	22%	24%	29.2	19.6	35.4	3.2	3.2	3.8	8%	9%	13%	2.6%	2.6%	0.9%

(Prices as of Jul 10, 2020. NC = Not Covered, NR=Not Rated)

Source: Bloomberg, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Anji Micro

688019.SS		12m Price Target: Rmb647		Price: Rmb454.98		Upside: 42.2%	
Buy		GS Forecast					
Market cap: Rmb24.2bn / \$3.4bn		Revenue (Rmb mn)	12/19	12/20E	12/21E	12/22E	
Enterprise value: Rmb23.7bn / \$3.4bn		EBITDA (Rmb mn)	285.4	455.7	754.8	1,188.3	
3m ADTV :Rmb448.2mn/ \$63.3mn		EPS (Rmb)	44.6	95.9	219.8	427.4	
China		P/E (X)	1.45	1.89	3.81	7.09	
Greater China Technology		P/B (X)	96.1	NM	119.5	64.2	
		Dividend yield (%)	8.3	25.2	22.0	17.8	
M&A Rank: 3		Net debt/EBITDA (X)		0.1	0.3	0.5	
		CROCI (%)	(11.6)	(5.0)	(2.2)	(1.3)	
		FCF yield (%)	13.6	10.5	19.8	30.9	
				(0.0)	0.2	0.9	
			3/20	6/20E	9/20E	12/20E	
		EPS (Rmb)	0.44	0.43	0.51	0.51	

Source: Company data, Goldman Sachs Research estimates, FactSet. Price as of 10 Jul 2020 close.

CR Micro (688396.SS): A domestic major in MOSFETs, expanding into IGBTs and power ICs

Primary analysts:

Allen Chang, Jin Guo

Initiate at Buy with a 12-month TP of Rmb88: CR Micro is the leading power-semiconductor integrated device manufacturer (IDM) in China, with 2%/8% market share in the global/China MOSFET market as of 2019. MOSFETs are used for switching (power on/off) in low-voltage applications such as consumer electronics, power tools, automotives, etc. The company is expanding its MOSFET product offerings from consumer electronics to auto/industrial applications, and expanding into IGBT and power ICs.

As a MOSFET IDM (c.30% of 2020E revs), with foundry and OSAT capabilities (c.50% of revs), we like the company for its improving margin outlook as it ramps up contribution from higher-margin products in the IDM segment and for its strength versus domestic peers in revenue scale (2020E MOSFET rev. Rm1.7bn vs. domestic No. 2 Silan at Rmb0.8bn) as it looks to catch up with global peers in technology and product offerings (expanding into industrial and automotive applications). We expect CR Micro to reach 26% market share in China's MOSFET market by 2025E (vs. 9% in 2020E and current share of 3% for Silan).

We forecast a solid revenue/net profit CAGR of 27%/55% in 2020-25E, and are 26% higher than consensus for 2021E. We expect revenue growth to be mainly driven by MOSFET for automotive/industrial control and power ICs, and forecast these segments to grow at a 43%/54% CAGR in 2020-25E. Meanwhile, we model revenue contribution from IGBTs, power ICs, smart sensors to increase from 10% in 2020E to 29% in 2025E. These products also carry higher GM at 32-43% in 2020E (vs. overall IDM segment GM at 30% in 2020E), driving margin expansion in the coming years.

Valuation and risks: To capture its long-term growth potential, we derive our 12-month Rmb88 TP (57% upside) on a discounted PE (33x 2025E EPS based on sector P/E-EPS YoY correlation; discounted back to 2022E at a COE of 9%). Our target price implies 80x 2022E P/E (vs. a trading P/E of 51x) which we view as reasonable considering its strong earnings growth at a +64% CAGR in 2020-23E (vs. peer avg. 33%). Risks include weaker-than-expected: MOSFET market growth, new design-wins, share gains, and new product (IGBT and power IC) development progress.

PM summary: Top seven questions

1. Why are we positive on the MOSFET market in China? *5% CAGR driven by automotive, industrial, consumer applications; low domestic supply*

We expect China's MOSFET market to grow at a 5% CAGR in 2020-23E, mainly driven by automotive (5% CAGR, 33% of total market), industrial (6% CAGR, 27% of total market), and consumer electronics (4% CAGR, 18% of total market). CR Micro is the MOSFET leader in China with 2%/8% market share in the global/China MOSFET market in 2019, and we see upside for CR Micro in the domestic market given: 1) customers seeking to diversify supply chain risks; and 2) CR Micro can provide customized designs for small volume customers.

2. Where we are different from the market? *Stronger earnings growth in 2021-22E driven by MOSFET and margin expansion*

We model stronger EPS growth at +74%/+65% in 2021E/22E (vs. Wind consensus at +34%/+19%) mainly on stronger revenue growth and margin expansion as we expect CR Micro to expand into MOSFET for automotive and industrial applications. Our net income is 26% higher than Wind consensus for 2021E mainly on higher margins as we expect a more favorable revenue mix toward the IDM segment to drive margin expansion. Our revenue forecasts are lower than consensus for 2020/21E as we are more cautious on a near-term end-demand slowdown due to COVID-19, which does not impact our constructive view on CR Micro's long-term growth outlook.

3. What are CR Micro's near-term and long-term drivers? *MOSFET for automotive/industrial applications, IGBT, power IC, smart sensors*

In the near term, we expect CR Micro to gain further share with new design-wins in MOSFET for consumer electronics, and to penetrate into MOSFET for automotive and industrial applications, driving the company's MOSFET revenue growth at a 31% CAGR in 2020-25E. For the longer term, we expect CR Micro to expand its IGBT, power IC, and smart sensor business by leveraging its BCD (Bipolar digital components and high-voltage transistors) and MEMS (Microelectromechanical systems) manufacturing process, as well as the established customer base in its MOSFET business. We model revenue contribution from IGBTs, power ICs, smart sensors to increase from 10% in 2020E to 29% in 2025E.

4. What are the new design-wins in the near term? *Electric tailgates, air conditioner compressors, UPS, servo drives, welding machines*

CR Micro achieved new design-wins in electric tailgates and automotive air conditioner compressors, UPS, servo drives, and welding machines in 2019, and appears on track to expand its MOSFET products from consumer electronics to automotive and industrial applications. The company has also completed its R&D of the multi-epi Super Junction 650-700V process platform and launched several products for fast-charging, adapters, lighting, and high-power power supply. CR Micro is also developing a new generation of Trench MOS for low-voltage applications such as power tools, smartphone fast charging, new energy batteries, energy storage batteries, etc.

5. Technology gap vs. global leaders? *Similar technology coverage with global peers, but still lags behind in the Super Junction manufacturing process*

CR Micro have similar technology coverage with global peers in terms of different types of MOSFET structure and voltage ranges. In MOSFET device structure, CR Micro covers six types including Super Junction, Planar, Trench, Shielded-gate, Depletion, and P-channel. On the voltage for MOSFET, CR Micro's MOSFET products cover voltages ranging from -100V to 1500V, similar to ranges of global leaders and more comprehensive than domestic peers. However, among the two types of manufacturing processes, CR Micro can only perform the conventional multi-epi process, while global peers can perform the more advanced trench filling process which tends to have better performance. We expect CR Micro to develop more advanced processes to shrink the gap with global peers in the coming years.

6. How do we value the stock? *P/E at 80x our 2022E*

Our 12M target price of Rmb88 is derived from a discounted P/E approach which we believe is appropriate given CR Micro is still in an early growth stage compared to global leaders and the discounted P/E method can better capture its long-term growth. We apply a 33x target P/E multiple to CR Micro's 2025E EPS and discount it back to 2022E at a COE of 9% (1.0 Beta, 3% risk-free rate, and 6% market risk premium). The 33x target P/E multiple is derived from our sector P/E-EPS YoY correlation, and we note that the market has generally rewarded higher EPS growth companies in the semiconductor industry based on our regression analysis. Our target price implies 80x 2022E P/E, or PEG of 1.6x based on the company's average 2023-24E EPS YoY growth (50%). Our DCF valuation crosscheck also shows a similar theoretical share value of Rmb89.7, or 81x 2022E P/E. The stock currently trades at 51x our 2022E EPS and at 1.0x PEG based on average 2023-24E EPS YoY growth, which we believe is attractive considering its strong earnings growth at a +55% CAGR in 2020-25E.

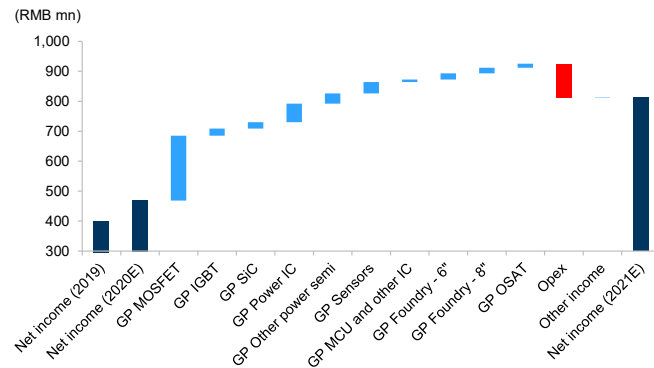
7. Potential downside risks from COVID-19? *Slower revenue growth of -2% YoY in 2H20E*

CR Micro's revenue comes mainly from the domestic market (~80% of 2019 revenue) but its customers' end products are sold globally. We therefore believe CR Micro could be impacted by the macro economic slowdown globally in 2020. We are more cautious on CR Micro's revenue growth in the near term and model -2% revenue YoY in 2H20E (vs. +17% YoY in 1Q20).

PM summary: Top six charts

Exhibit 431: MOSFET is the key driver for 2021E

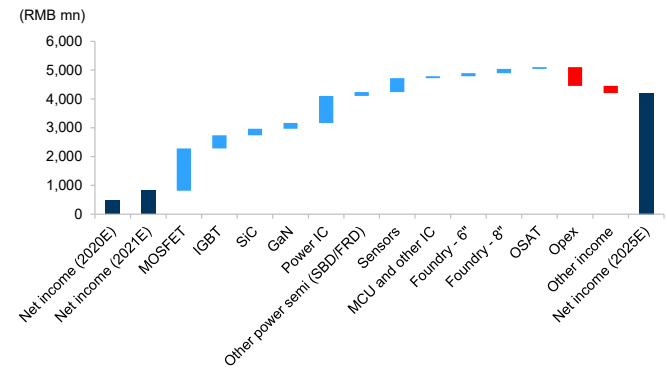
Net income waterfall chart for 2020-21E



Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

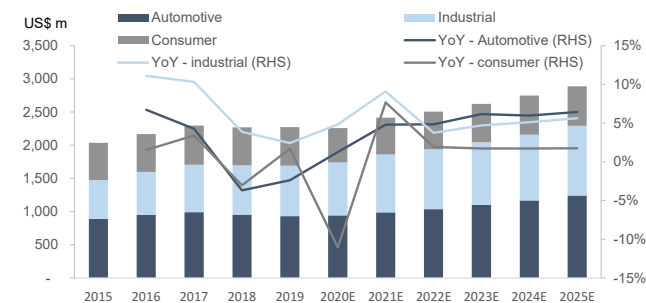
Exhibit 432: MOSFET, power, and sensors are key drivers for 2021-25E

Net income waterfall chart for 2020-25E



Source: Goldman Sachs Global Investment Research, Gao Hua Securities Research

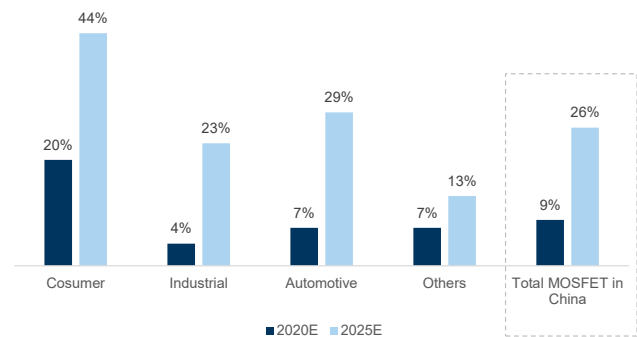
Exhibit 433: China auto, industrial, consumer MOSFET TAM



Source: Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 434: We expect CR Micro to reach 26% market share in China's MOSFET market by 2025E

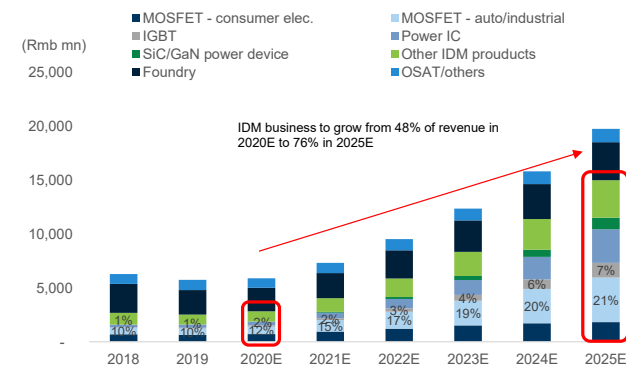
CR Micro mosfet market share trend by applications



Source: Goldman Sachs Global Investment Research, Gao Hua Securities Research

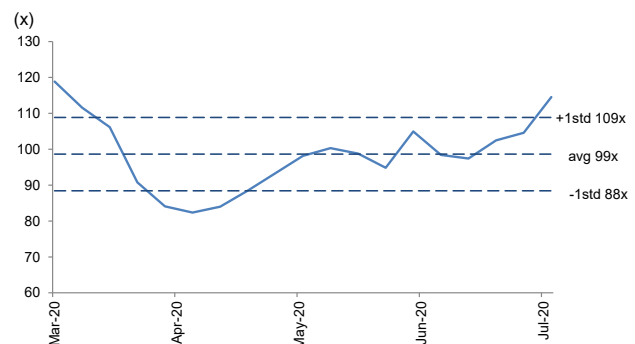
Exhibit 435: CR Micro revenue growth at 27% CAGR in 2020-25E

CR Micro revenue breakdown 2018-25E



Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 436: CR Micro 12M forward PE ratio



Source: Bloomberg, Goldman Sachs Global Investment Research, Gao Hua Securities Research

MOSFETs (Metal–Oxide–Semiconductor Field-Effect Transistors)

IGBTs (Insulated-Gate Bipolar Transistors)

SBDs (Schottky Barrier Diodes)

FRDs (Fast Recovery Diodes)

BMS ICs (Battery Management System (BMS) Integrated Circuits)

Leading IDM in China for MOSFET, expanding applications into automotive and industrial control

CR Micro is a leading power semiconductor IDM in China with 8% share in China's MOSFET market in 2019 and a diversified product portfolio covering power discretes (including MOSFETs, IGBTs, SBDs, FRDs) and power ICs (wireless charging IC, BMS IC, etc). We expect MOSFETs to be the key growth driver for the company given: 1) a growing TAM in automotive, industrial control, and consumer electronics markets; and 2) CR Micro is expanding its applications from consumer electronics to automotive and industrial markets, which should drive CR Micro's MOSFET revenue growth at a 31% CAGR in 2020-25E.

CR Micro business model snapshot

CR Micro is not only an IDM (design and manufactures its own products), but also provides foundry and OSAT services to customers through different subsidiaries. The key advantage of this business model is that it can better utilize its capacity regardless of the product cycles of its own solutions, reducing the burden of fixed costs.

MOSFET market to grow at 5% CAGR in 2020-25E

Based on our proprietary TAM model, we forecast the global and China MOSFET markets to grow at a 4%/5% CAGR in 2020-25E, respectively. By applications, automotive and EV charging will likely be the major growth driver in China and globally, thanks to the rising penetration of electric vehicles. We expect the automotive MOSFET market to grow at a 9%/6% CAGR in 2020-25E in the global/China markets. Industrial control and consumer applications will likely enjoy steady growth of 2-5% CAGR in 2020-25E in the global and China markets. In terms of revenue mix, automotive is the largest application, and we expect it to account for 30% of the global IGBT market in 2020E, followed by industrial 21%, consumer 20%, computing 14%, EV charging 4%, telecom network 4%, and others 5%.

Exhibit 437: China MOSFET TAM



Source: Goldman Sachs Global Investment Research, Gao Hua Securities Research

CR Micro's leading position in China's MOSFET market

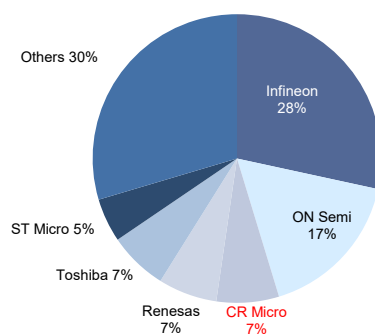
CR Micro had 8% market share in China's MOSFET market in China in 2019, ranked no.3 after Infineon and ON Semi, and other key competitors include Renesas, Toshiba,

STMicro, Silan, Sino-Micro, Yangjie, etc. CR Micro's MOSFET products cover voltages ranging from -100V to 1500V, wider than domestic peers: Silan at 30-900V, Sino Micro at 40-900V, and Yangjie at -60-150V. In terms of MOSFET device structure, CR Micro also has more comprehensive coverage with six structure types: Super Junction, Planar, Trench, Shielded-gate, Depletion, and P-channel. In comparison, domestic peers Silan/ Sino Micro /Yangjie have 5/2/4 of these same structure types. Compared to foreign peers, CR Micro's key advantage is that it can provide customized products per customers' requirements, even for small volume products.

New design-wins support MOSFET expansion into automotive/industrial applications

CR Micro achieved new design-wins in electric tailgates and automotive air conditioner compressors, UPS, servo drives, and welding machines in 2019, and appears on track to expand its MOSFET products from consumer electronics to automotive and industrial applications. The company has also completed the R&D of multi-epi Super Junction 650-700V process platform and launched several products for fast-charging, adapters, lighting, and high-power power supplies. CR Micro is also developing new generation Trench MOS for low-voltage applications such as power tools, smartphone fast charging, new energy batteries, energy storage batteries, etc.

Exhibit 438: China MOSFET market share 2018



Source: Company data

R&D on SiC/GaN and IGBT/IPM, supported by IPO funding

CR Micro plans to spend Rmb150m on R&D in each of the following categories: 1) SiC (silicon carbide)/GaN (gallium nitride) power devices; and 2) IGBTs/IPMs, with targets to complete technology development by end-2022. For SiC and GaN power devices, CR Micro plans to develop the design and manufacturing processes for a 650V silicon-based GaN device, SiC JBS devices, and SiC MOSFET, by leveraging its accumulated technologies in power semiconductors. These wide-band-gap power devices have the advantages of high-breakdown voltage, high-power density, high-temperature resistance, and high-frequency operation, which are suitable for high-power, high-frequency, and extreme environments. In IGBTs/IPMs, CR Micro plans to develop next generation Trench-FS IGBT chip structure design, SOI substrate chips, and IPM packaging technologies. These R&D projects will take three years (from January 2020), including six months of preparation, 24 months of construction, and six months of acceptance.

Expanding 14% of capacity on 8" wafer fab by 2021, supported by IPO funding

With IPO funding, the company plans invest Rmb2.3bn to expand 8" wafer fab capacity by 16k wafers/month for BCD and MEMS processes, targeting to complete by June 2021. This implies a 14% increase to its total 8" wafer fab capacity of 111k wafers/months (including the capacity for foundry and IDM business). According to the company, this capacity expansion plan began in September 2018 and will take 2.75 years, including 15 months of preparation, 12 months of construction, and six months of acceptance.

Potential expansion into 12" fab as the next step

CR Micro targets to expand into 12" wafer fabs for power devices, but the details of the plan are still under discussion/negotiation. Compared to 8" wafer fabs, the advantages of 12" wafer fabs include: 1) larger wafer size: 12" wafers are 2.25x the size of 8" wafers, making production more efficient; 2) equipment availability: as some equipment makers no longer sell new 8" wafer fab equipment, the price of second-hand tools is rising and it is more difficult to secure a full set of equipment for an 8" wafer fab in the second-hand market; and 3) production efficiency: 12" wafer fabs are more automated than 8" wafer fabs and can improve efficiency by 40% on 90nm compared with an 8" wafer fab (with second-hand tools). However, we also note challenges such as limited supply of 12" wafer substrates for certain power devices.

New drivers: Power ICs and smart sensors

Other than its growing MOSFET business, CR Micro is also expanding its product portfolio into power ICs and smart sensors by leveraging its BCD and MEMS manufacturing process, as well as the established customer base in its MOSFET business. The company is also developing higher-end products such as fast-charging power control ICs, 2W-100W smart audio amplifiers, and MEMS sensors for medical devices, driving long-term growth in power ICs and smart sensors. We model revenue from these two product lines to grow at a 54% CAGR in 2020-25E, contributing 22% of total revenue by 2025E (vs. 7% in 2019).

Power ICs - BMS ICs and wireless charging ICs are key growth drivers

We expect CR Micro's power IC revenue to grow at a 54% CAGR in 2020-25E, mainly driven by growing BMS (Battery Management System) ICs and wireless charging ICs. For BMS IC, CR Micro's products cover most applications for lithium battery systems with stable performance, and feature reliability as well as competitive pricing. Its BMS ICs are widely used in power tools, vacuum cleaners, electric bicycles, energy, storage, etc. For wireless charging ICs, CR Micro's products support over-temperature/ over-voltage/ over-current protection and dynamic current adjustment, with the advantages of high charging efficiency, low standby power consumption, low EMI, and competitive pricing. Its wireless charging ICs are widely used in smartphones and wearable devices. Other than these, CR Micro also provides AC-DC, LED driver ICs, liner regulator ICs, motor driver ICs, and audio amplifier ICs, which are mainly used in consumer electronics, industrial controls, smart lighting, and IoT applications.

Sensors - MEMS sensors offer exposure to the growing IoT trend

We model CR Micro's sensor revenue to grow at a 54% CAGR in 2020-25E, driven by growing demand for MEMS sensors for IoT applications. CR Micro's smart sensor products include MEMS sensors, smoke sensors, and optoelectronic sensors, which are used in auto electronics, consumer electronics, industrial, medical applications. Sensors are key components for all IoT devices to detect changes/input from the environment and send the data to MCU or other components for processing and storage. The growing IoT trend will drive the demand of sensors with low-power consumption, miniaturization, intelligence, and multi-function. In particular, MEMS sensors, which pack micro-level sensors, signal processors, and data processing units into one chip with a silicon-based fabrication process, are widely adopted in automotive, consumer electronics, industrial and applications. With overseas peers still dominating >60% of the MEMS sensor supply in China, we believe CR Micro has room to gain share in the China market.

R&D on higher-end power IC and MEMS sensors, supported by IPO funding

CR Micro plans to spend Rmb150m on R&D in each of the following categories: 1) power ICs; and 2) MEMS sensors, targeting to complete the technology development by end-2022. On power ICs, the company plans to develop higher-end products such as fast-charging power control ICs, 2W-100W smart audio amplifiers, and GaN based PD power control ICs. For MEMS sensors, CR Micro plans to develop MEMS sensors for

medical applications such as acoustic MEMS sensors and advanced sensors for human odor. Through the expansion into these new products, we believe CR Micro can better utilize its capacity to upgrade product mix and improve profitability in the longer-term. These R&D projects will take three years (from January 2020), including six months of preparation, 24 months of construction, and six months of acceptance.

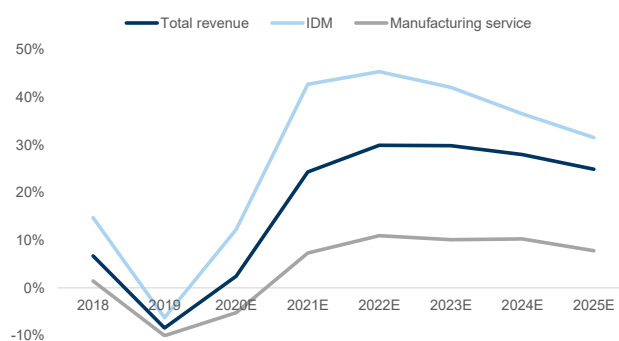
Manufacturing service business: Dedicated power semi foundry; one-stop shop with OSAT capacity

Other than the IDM segment that designs and manufactures its own products, CR Micro also has foundry/OSAT segments that provide manufacturing services to external customers. CR Micro's foundry business is smaller than SMIC and Hua Hong in terms of revenue scale and capacity. However, CR Micro mainly focuses on power semis and can provide OSAT services as well, which could be attractive to customers who seek a one-stop shop with a proven track record in power-semi devices. CR Micro's foundry business has capacity for 65k wafers/month on 8" wafer fab and 210k on 6" wafer fab in Wuxi, with technologies in 1.0-0.11um process nodes and platforms in silicon-based/SOI-based BCD (bipolar-CMOS-DMOS, a key technology for power ICs), mixed-signal, high-V CMOS, RF CMOS, bipolar, BiCMOS, eNVM, IGBT, MEMS, silicon-based GaN, SiC, etc.

Focusing resources on the high-margin IDM segment (vs. low-margin foundry/OSAT segments)

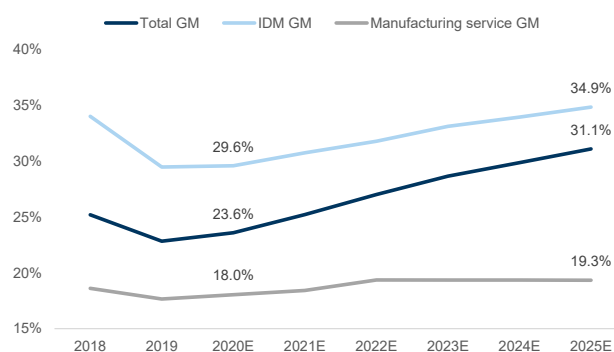
As an IDM company focusing on product solutions and expanding from power discretes to power ICs and smart sensors, we believe CR Micro will continue to prioritize capacity for its own product solutions (IDM segment) rather than the low-margin manufacturing service businesses (foundry/OSAT segments). However, we believe the company will still maintain certain levels of manufacturing services to external customers to keep its capacity utilization at a high level, and to reduce cost burdens and margin pressure. The GM of the IDM segment was 29% in 2019, higher than the GM for the foundry/OSAT segments at 18%, and we expect the GM of the IDM segment to further expand to 30%/31% in 2020/21E thanks to product mix improvements and better utilization. As such, we model slower revenue growth for the foundry/OSAT segments at a 9%/9% CAGR in 2020-25E, vs. the IDM segment's 40% revenue CAGR.

Exhibit 439: IDM segment to enjoy stronger revenue growth



Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research, Gao Hua Securities Research

Exhibit 440: IDM segment carries higher GM, driving margin expansion



Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research, Gao Hua Securities Research

Peer comparison in scale, product offerings, and technology

CR Micro is the MOSFET leader among Chinese peers in terms of: 1) revenue scale; 2) product offerings; 3) technology; and 4) customer base. Although CR Micro still lags behind global leaders in these aspects, we see the company catching up in technology and product offerings (expanding into industrial and automotive applications).

Revenue scale - CR Micro is leader in China, but only 7% of global leader

CR Micro's revenue from MOSFET was Rmb1.5bn in 2019, representing 2%/8% market share in the global/China MOSFET market. The company is the largest supplier among Chinese names with the closest Chinese peer being Silan, who reported Rmb676m revenue from MOSFET in 2019. Other key MOSFET suppliers in China include Sino Micro, Yangjie, etc. While its scale is dominant relative to domestic peers in the China market, CR Micro's MOSFET revenue in 2019 was only 7% of global market leader, Infineon's.

Product offerings - CR Micro has more diversified applications versus Chinese peers

CR Micro has diversified MOSFET product offerings and end-market exposure in consumer electronics, power supply, industrial, and automotive, PC, and LED lighting. Among domestic peers, Sino Micro also has more diversified end-market exposure including automotive, while Silan and Yangjie do not have automotive exposure yet. In comparison, global leaders in IGBT usually have comprehensive product offerings across all end markets. For CR Micro to catch up with global peers, it would likely need to further expand into telecom network, medical, and EV charging pile applications.

Exhibit 441: Product offerings comparison among major MOSFET suppliers

Applications	Consumer	Computing	Electric bike	Telecom network	Motor drive & power supply	Medical	Automotive	EV charging pile	LED lightings
Market mix	21%	15%	5%	4%	21%	1%	25%	3%	5%
Infineon	√	√	√	√	√	√	√	√	√
ST Micro	√	√	√	√	√	√	√	√	√
On Semi	√	√	√	√	√	√	√	√	√
Toshiba	√	√	√	√	√	√	√	√	√
CR Micro	√	√	√		√		√		√
Sino Micro	√	√		√	√		√		√
Silan	√				√				√
Yangjie	√			√	√			√	√
Wingtech	√	√		√	√	√	√		√
SiEn	√	√		√					√
Panjit	√	√	√		√		√	√	√
TSC	√				√		√		

Source: Company data as of 2019

Technology - CR Micro has similar technology coverage with global peers, but still lags in the Super Junction manufacturing process

CR Micro has similar technology coverage with global peers in terms of different types of MOSFET structure and voltage ranges. In MOSFET device structure, CR Micro covers six types: Super Junction, Planar, Trench, Shielded-gate, Depletion, and P-channel. In comparison, domestic peers Silan/ Sino Micro /Yanjie have 5/2/4 types of these same

MOSFET device structures. For MOSFET voltage, CR Micro's MOSFET products cover voltages ranging from -100V to 1500V, similar to the ranges covered by global leaders and more comprehensive than domestic peers (Silan at 30-900V, Sino Micro at 40-900V, and Yanjie at -60-150V).

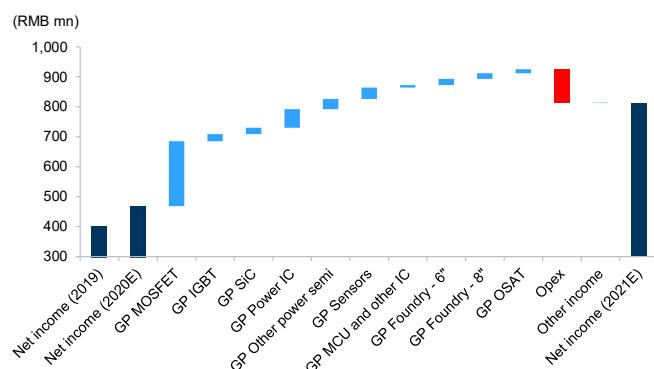
The key technology in which CR Micro still lags behind global peers is the manufacturing approach for Super Junction MOSFET. Specifically, there are two types of approaches for Super Junction: multi-epi process and trench filling. CR Micro uses the conventional multi-epi process, while global leaders use the more advance trench filling process, which can make P/N Junctions deeper and further reduces ON-resistance compared to the multi-epi process.

Earnings estimates: +55% NI CAGR in 2020-25E, mainly driven by MOSFET and power IC

Income statement

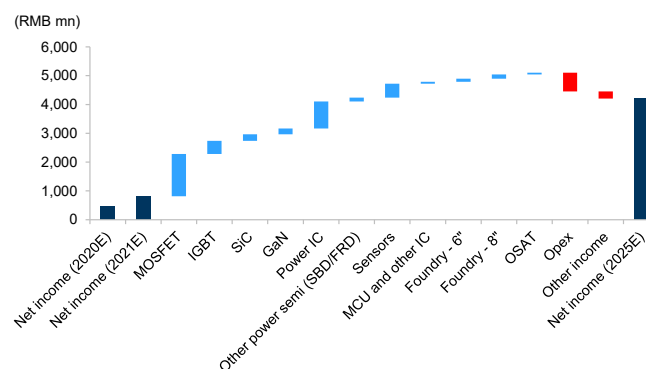
We model CR Micro's net income growth at a +55% CAGR in 2020-25E, with revenue growth at a +27% CAGR and operating income at a +66% CAGR. We expect revenue growth to be mainly driven by MOSFET for automotive/industrial control and power ICs, and forecast these segments to grow at a 43%/54% CAGR in 2020-25E, respectively. MOSFET for automotive/industrial controls is mainly driven by the growing demand for MOSFET in automobiles, which when coupled with CR Micro's market share gains from a low base should lead to +52%/+48%/+46% YoY revenue growth in 2021-23E for CR Micro's MOSFET for automotive/industrial controls business. Power IC is driven by growing BMS ICs and wireless charging ICs, and we expect power IC YoY revenue growth at +50%/+67%/+57% in 2021-23E.

Exhibit 442: MOSFET is the key driver for 2021E
Net income waterfall chart for 2020-21E



Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

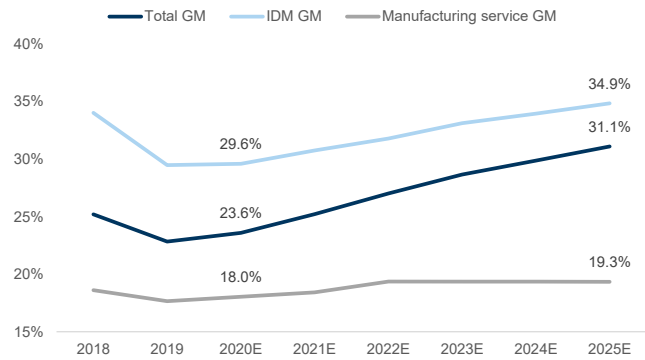
Exhibit 443: MOSFET, power, and sensors are key drivers for 2021-25E
Net income waterfall chart for 2021-25E



Source: Goldman Sachs Global Investment Research, Gao Hua Securities Research

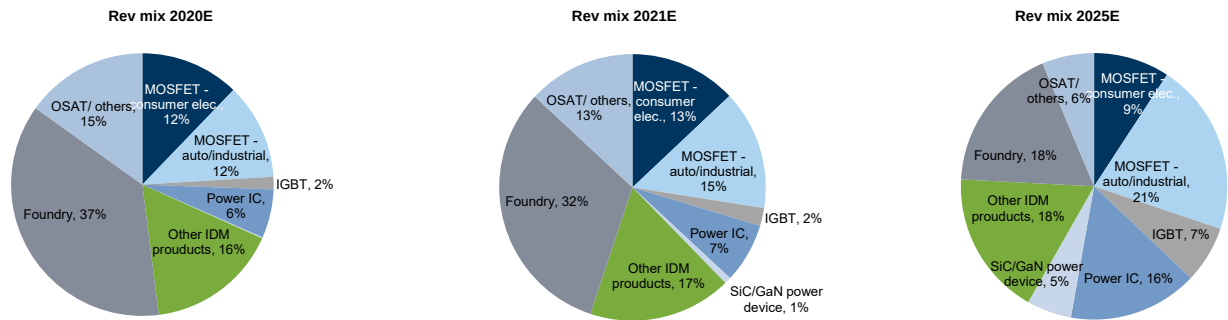
We model the company's GM to expand from 23.6% in 2020E to 25.2%/27.0%/28.7% in 2021-23E on the back of CR Micro's stronger growth in its IDM business (higher margin than manufacturing service business) and product mix improvement within the IDM business. By segment, the GM of the IDM business was at 29.5% in 2019, higher than the GM of the manufacturing service business at 17.7%, and we expect revenue contribution from IDM to increase from 48% in 2020E to 67% in 2023E. For the IDM business, we expect GM improvement from 29.6% in 2020E to 30.8%/31.8%/33.1% in 2021-23E, on the back of increasing revenue contribution from high-margin products such as power IC (32% GM in 2020E), IGBT (32.9% GM in 2020E), and sensors (43.3% GM in 2020E). For the manufacturing business, we expect a stable GM at 18-19% in 2020-23E.

Exhibit 444: CR Micro’s IDM segment to drive overall margin expansion
CR Micro margins trend



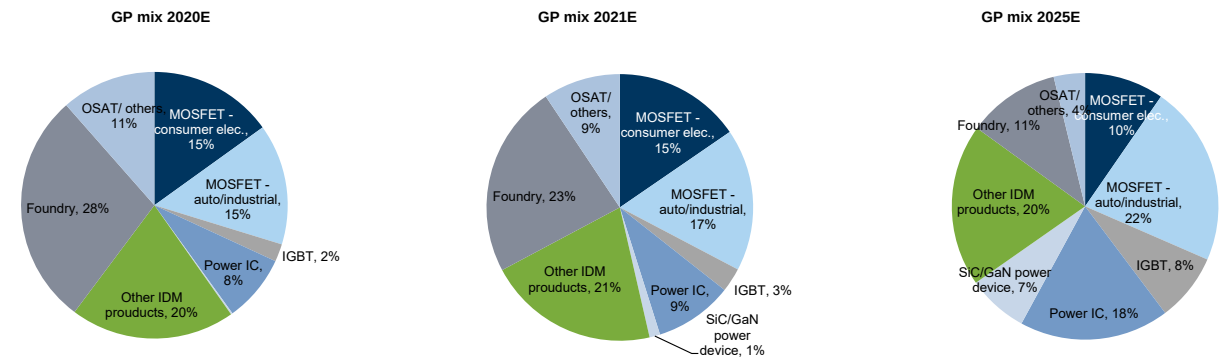
Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 445: MOSFET for auto/industrial and power IC are key revenue drivers
CR Micro estimated revenue mix



Source: Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 446: MOSFET for auto/industrial and power IC are key profit drivers
CR Micro estimated gross profit mix



Source: Goldman Sachs Global Investment Research, Gao Hua Securities Research

We model the company’s contribution margin at 49%/49% in 2020E/21E, similar to its historical range of 46-48% in 2017-19. The company’s major variable costs include materials (31% of COGS in 2019), direct labor cost (20%), and utility cost (12%), while its major fixed costs include depreciation (14%) and maintenance expenses (10%). In terms of opex, it is mainly from R&D expenses (8.4% of revenue in 2019), followed by

G&A at 6.6% and selling expenses at 2%. Based on historical data, we note that operating income changes to revenues changes did not follow the company's contribution margins, mainly due to its declining depreciation cost over the last two years (from 20% of revenue in 2017 to 13%/11% in 2018/19) as CR Micro has had limited capacity expansion over the recent past.

Where we are different from the Street

Our net income forecasts are 26%/75% higher than Wind consensus for 2021/22E mainly on higher margins as we expect a more favorable product mix to drive margin expansion. Our revenue forecasts are lower than consensus for 2020/21E as we are more cautious on a near-term end-demand slowdown due to COVID-19. However, this does not impact our positive view on CR Micro's long-term growth outlook which is supported by its solid market growth and market share gains.

Exhibit 447: GS vs. Wind consensus

(Rmb bn)	2020E			2021E			2022E		
	GS	Con	Diff	GS	Con	Diff	GS	Con	Diff
Revenue	5,884	6,513	-10%	7,315	7,598	-4%	9,505	8,681	9%
Net income	468	483	-3%	814	645	26%	1,343	769	75%
EPS	0.39	0.40	-4%	0.67	0.53	26%	1.10	0.63	75%
Margins									
Net margin	8.0%	7.4%		11.1%	8.5%		14.1%	8.9%	

Source: Wind, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 448: CR Micro P&L summary

(Rmb m)	1Q19	2Q19	3Q19	4Q19	1Q20	2Q20E	3Q20E	4Q20E	2016	2017	2018	2019	2020E	2021E	2022E
Revenue	1,186	1,454	1,492	1,611	1,382	1,469	1,472	1,559	4,397	5,876	6,271	5,743	5,884	7,315	9,505
Gross profit	192	354	379	387	344	331	337	375	637	1,035	1,581	1,311	1,388	1,845	2,569
Operating expense	(230)	(230)	(279)	(299)	(233)	(231)	(277)	(300)	(756)	(1,029)	(1,034)	(1,038)	(1,041)	(1,154)	(1,308)
Operating income	(38)	123	100	88	112	100	60	75	(119)	7	546	274	347	691	1,261
Pre tax profit	32	175	140	160	129	163	126	140	(284)	(59)	591	506	558	931	1,503
Net income	21	149	105	131	114	137	102	116	(303)	70	429	401	468	814	1,343
EPS (Rmb)	0.02	0.17	0.12	0.15	0.09	0.11	0.08	0.10	(0.34)	0.08	0.49	0.46	0.39	0.67	1.10
Margins / ratio															
Gross margin	16.2%	24.3%	25.4%	24.0%	24.9%	22.6%	22.9%	24.0%	14.5%	17.6%	25.2%	22.8%	23.6%	25.2%	27.0%
Opex ratio	-19.4%	-15.8%	-18.7%	-18.5%	-16.8%	-15.7%	-18.8%	-19.2%	-17.2%	-17.5%	-16.5%	-18.1%	-17.7%	-15.8%	-13.8%
Operating margin	-3.2%	8.5%	6.7%	5.5%	8.1%	6.8%	4.1%	4.8%	-2.7%	0.1%	8.7%	4.8%	5.9%	9.4%	13.3%
Net margin	2.7%	12.0%	9.4%	9.9%	9.3%	11.1%	8.5%	9.0%	-6.4%	-1.0%	9.4%	8.8%	9.5%	12.7%	15.8%
QoQ															
Revenue		23%	3%	8%	-14%	6%	0%	6%							
Gross profit		84%	7%	2%	-11%	-4%	2%	11%							
Operating income		nm	-19%	-12%	27%	-10%	-41%	25%							
Pre tax profit		454%	-20%	14%	-20%	27%	-23%	12%							
Net income		621%	-29%	24%	-13%	20%	-25%	13%							
EPS		621%	-29%	24%	-37%	20%	-25%	13%							
YoY															
Revenue					17%	1%	-1%	-3%		34%	7%	-8%	2%	24%	30%
Gross profit					79%	-6%	-11%	-3%		63%	53%	-17%	6%	33%	39%
Operating income					nm	-19%	-40%	-15%		nm	8150%	-50%	27%	99%	83%
Pre tax profit					308%	-7%	-10%	-12%		nm	nm	-14%	10%	67%	61%
Net income					450%	-8%	-3%	-12%		nm	511%	-7%	17%	74%	65%
EPS					298%	-34%	-30%	-36%		nm	511%	-7%	-15%	74%	65%

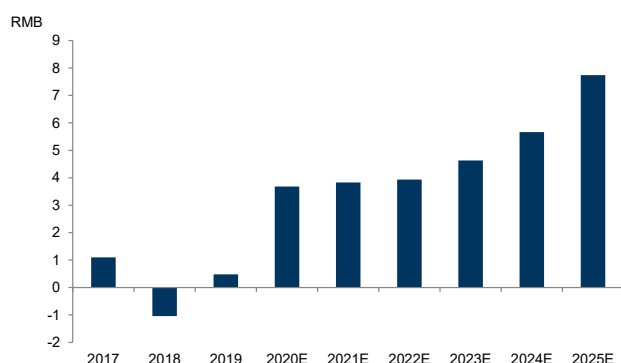
Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research, Gao Hua Securities Research

Balance sheet

Net cash per share: CR Micro was in a net debt position in 2018 and turned net cash in 2019 as the company paid back part of its debt that year. We model the company to remain in a net cash position in 2020-2025E, with net cash per share increasing from Rmb3.68 in 2020E to Rmb7.74 in 2025E, driven by increasing operating cash flow.

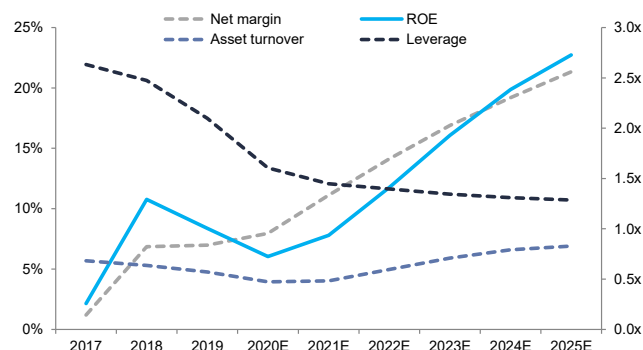
ROE: CR Micro's ROE improved from 2% in 2017 to 8% in 2019, mainly driven by improving net margin (from 1% in 2017 to 7% in 2019) despite a declining asset to equity ratio (from 2.6x in 2017 to 2.1x in 2019) and a stable asset turnover. For the coming years, we expect CR Micro's ROE to improve from 6% in 2020E to 8%/12%/16% in 2021E/22E/23E, mainly driven by improving net margin (8%/11%/14%/17% in 2020E/21E/22E/23E) and better efficiency in asset turnover (0.5x/0.5x/0.6x/0.7x in 2020E/21E/22E/23E).

Exhibit 449: CR Micro net cash per share



Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

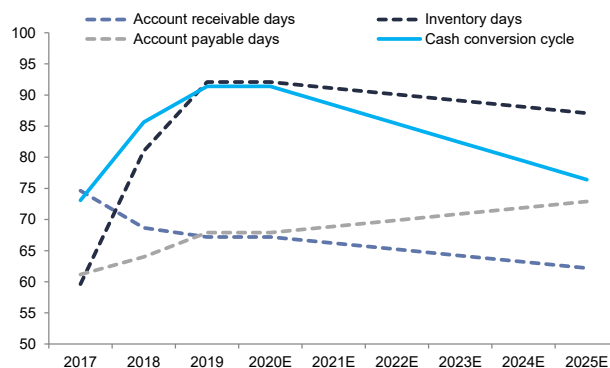
Exhibit 450: Dupont analysis



Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Cash conversion cycle: CR Micro's cash conversion cycle increased from 73 days in 2017 to 91 days in 2019, mainly due to longer inventory days (from 60 days in 2017 to 92 days in 2019), despite improvement in AR days (from 75 days to 67 days) and AP days (from 61 days to 68 days). In 2019, around 97% of the company's accounts receivables were not yet expired, while 1.6% were expired for more than one year. For the coming years, we expect CR Micro's cash conversion cycle to improve from 91 days in 2020E to 76 days in 2025E, in-line with its historical ranges and is mainly driven by improving AR days and inventory days thanks to its larger scale (better bargaining power) and improving AR/inventory management.

Exhibit 451: CR Micro cash conversion cycle



Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

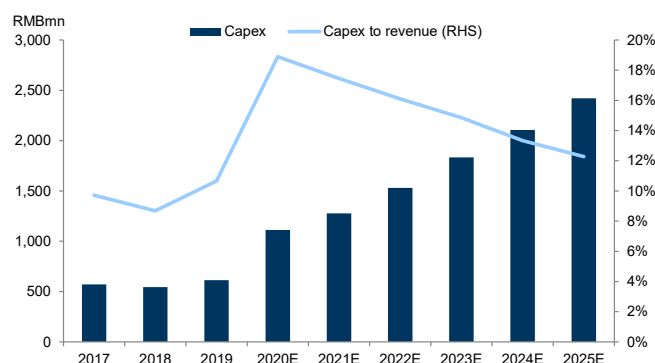
Cash flow

Capex: CR Micro's capex to revenue ratio was stable at 9-11% in 2016-19 as it has had limited capacity expansion over the past few years. We expect the ratio to increase to 19% in 2020E as the company will expand capacity with its IPO funding to fulfill growing demand for MOSFET, IGBTs, power ICs, etc. We model CR Micro's capex to grow at a 17% CAGR in 2020-25E for capacity expansion, and the capex to revenue ratio to gradually decline from 19% in 2020E to 12% in 2025E given its stronger revenue growth.

Free cash flow: CR Micro's free cash flow was positive during 2016-18 with an annual amount of Rmb903mn on average, or a 3% free cash flow yield on average. We expect the yield to increase from 0.4% in 2021E to 4.3% in 2025E, driven by rising operating cash flow and lower capex to revenue ratio.

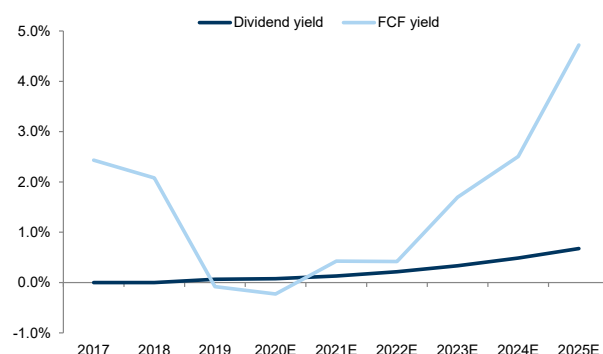
Dividend yield: CR Micro's dividend payout ratio was at 0%/10% in 2018/19, and we expect its dividend payout to be stable at 10% in 2020E-25E, implying a dividend yield of 0.1%/0.1% in 2020E/21E.

Exhibit 452: CR Micro capex intensity



Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 453: CR Micro dividend and FCF yield



Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Valuation: TP at Rmb88, implying 57% upside

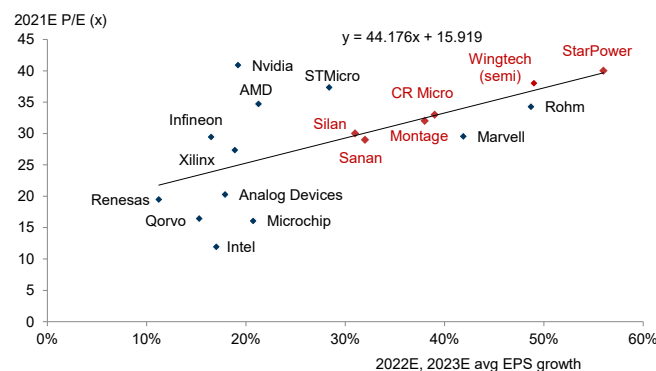
Our 12M target price of Rmb88 is based on discounted P/E methodology, which we believe is appropriate as we expect CR Micro to see stronger EPS growth versus peers through 2025E on the back of market share gains, product mix upgrades, and margin expansion. We apply a 33x target P/E multiple to CR Micro's 2025E EPS and discount back to 2022E at a COE of 9% (1.0 Beta, 3% risk-free rate, and 6% market risk premium). The 33x target P/E multiple is derived from our sector P/E-EPS YoY correlation, and we note that the market has generally rewarded higher EPS growth companies in the semiconductor industry based on our regression analysis. Our target price implies 80x 2022E P/E, or PEG at 1.6x based on average 2023-24E EPS YoY growth (50%). Our DCF valuation crosscheck also shows a similar theoretical share value of Rmb89.7, or 81x 2022E P/E. The stock currently trades at 51x our 2022E EPS and at 1.0x PEG based on average 2023-24E EPS YoY growth, which we believe is attractive considering its strong earnings growth at a +64% CAGR in 2020-23E (vs. peer avg. 33%).

Exhibit 454: Discounted PE valuation: 12m TP at Rmb88, implied 80x 2022P/E

(Rmb mn)	2017	2018	2019	2020E	2021E	2022E	2023E	2024E	2025E
Milestones				MOSFET for consumer elec.	MOSFET for auto, industrial			IGBT and power IC	
Revenue	5,876	6,271	5,743	5,884	7,315	9,505	12,340	15,794	19,728
YoY	34%	7%	-8%	2%	24%	30%	30%	28%	25%
Gross margin	17.6%	25.2%	22.8%	23.6%	25.2%	27.0%	28.7%	29.9%	31.1%
Operating profit	7	546	274	347	691	1,261	2,061	3,070	4,331
YoY	nm	8150%	-50%	27%	99%	83%	63%	49%	41%
Pre-tax profit	-59	591	506	558	931	1,503	2,305	3,328	4,602
Net profit	70	429	401	468	814	1,343	2,084	3,031	4,209
YoY	nm	511%	-7%	17%	74%	65%	55%	45%	39%
EPS (Rmb)	0.08	0.49	0.46	0.39	0.67	1.10	1.71	2.49	3.46
YoY	nm	511%	-7%	-15%	74%	65%	55%	45%	39%
2025E target P/E									33
Target multiple x EPS									114
Discounted back to 2022; TP (Rmb)						88.0			
Implied 2022E P/E						80			
COE assumption									
Beta		1.0							
Risk free		3.0%							
Market risk premium		6.0%							
COE		9.0%							

Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 455: Global semiconductor peers' PE vs. EPS growth



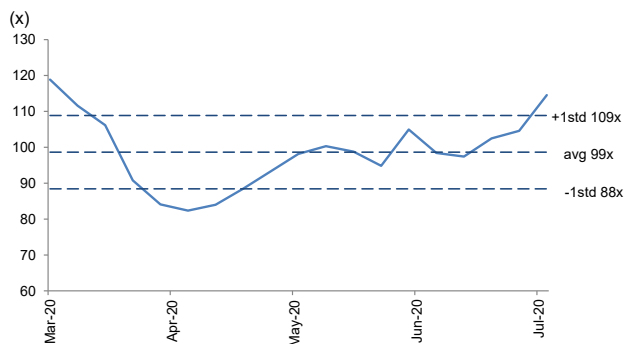
Names with 2025E PE and EPS forecast marked in red; Bloomberg estimates for Renesas, others are GSe.

Source: Bloomberg, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Our target price implies 80x 2022E P/E and 1.6x 2022E PEG, which we view as justified given: 1) strong earnings growth at a 64% CAGR in 2020-23E; 2) scarcity value as the domestic leader in MOSFET and leading IDM in China. Other than CR Micro, several A-share semiconductor names with scarcity value are trading at high multiples of 50-131x 2022E P/E, such as Anji (leading CMP slurry supplier in China), AMEC (leading SPE supplier in China), SG Micro (leading analog IC supplier in China), NAURA (leading SPE supplier in China), Montage (one of three memory interface IC supplier globally). These companies are trading at average 2022E PEG of 1.1x, higher than CR Micro's 1.0x.

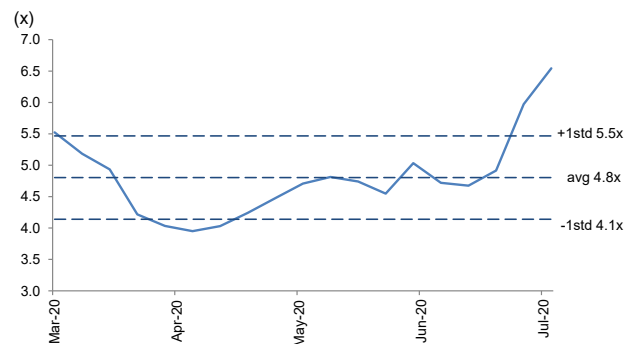
Our 12M target price implies 8.9x 2022E P/B, higher its historical trading range of 4.0-6.5x as we expect its ROE to expand from 6% in 2020E to 8%/12%/16% in 2021/22/23E. The stock is currently trading at 5.7x 2022E P/B, higher than global power semiconductor peers' trading range of 1.0x-3.3x despite its ROE being lower than peers, which we attribute to CR Micro's stronger earnings growth of 69% CAGR in 2020-22E (vs. peers at 39% CAGR). The A-share semiconductor names with scarcity value noted above are trading at 12-25x 2022E P/B, higher than the implied P/B multiple (5.7x) of our target price on CR Micro.

Exhibit 456: CR Micro 12M forward PE ratio



Source: Bloomberg, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 457: CR Micro 12M forward PB ratio



Source: Bloomberg, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 458: Power semi valuation comparison table

	Ticker	Rating	Analyst	Pricing currency	PX (LCY)	TP (LCY)	Upside (%)	Market cap (US\$m)	EV (US\$m)	LTM PX move (%)	LTM ADTV (US\$mm)	NI growth 2020E	2021E	2022E	Trading P/E 2020E	2021E	2022E	Trading P/B 2020E	2021E	2022E	ROE 2020	2021	2022	Div Yield 2020E	2021E	2022E	
Power Semi																											
Local																											
CR Micro	688396.SS	Buy	Allen Chang, Jin Guo	CNY	56.2	88	57%	9,415	9,512	340	163	17%	74%	65%	145.9	84.0	50.9	6.8	6.3	5.7	6%	8%	12%	0.1%	0.1%	0.2%	
StarPower	603290.SS	Buy	Allen Chang, Jin Guo	CNY	264.6	402	52%	6,049	6,048	1,981	108	27%	59%	82%	247.3	155.2	85.5	37.1	31.8	25.2	20%	22%	33%	0.1%	0.2%	0.4%	
Wingtech	600745.SS	Buy	Vereana Jeng, Jin Guo	CNY	180.0	189	18%	25,699	27,669	347	281	143%	54%	18%	59.1	36.5	32.6	7.6	6.5	5.5	14%	18%	18%	0.2%	0.3%	0.4%	
SG Micro	600460.SS	Buy	Lynn Luo, Jin Guo	CNY	17.0	21.5	26%	3,194	3,615	12	115	269%	292%	88%	416.9	106.2	56.5	6.5	6.3	5.8	2%	6%	11%	0.1%	0.3%	0.5%	
SG Micro	300661.SZ	Buy	Lynn Luo, Jin Guo	CNY	337.0	353	5%	7,484	7,425	453	69	38%	87%	70%	215.2	115.1	67.7	39.8	31.0	22.5	20%	30%	38%	0.1%	0.2%	0.3%	
Yangjie	300373.SZ	NC	NA	CNY	36.4	NA	NA	2,452	2,447	154	57	27%	28%	35%	59.6	46.5	34.4	6.0	5.4	4.7	10%	12%	14%	0.8%	0.7%	NA	
Jejie	300623.SZ	NC	NA	CNY	33.2	NA	NA	2,313	2,131	182	52	12%	27%	26%	67.5	53.2	42.1	6.5	5.8	5.2	10%	11%	13%	0.3%	0.4%	0.7%	
Sino-Micro	600360.SS	NC	NA	CNY	10.4	NA	NA	1,428	1,386	76	67	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA		
Good-Ark	002079.SZ	NC	NA	CNY	14.0	NA	NA	1,459	1,389	101	75	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA		
Jingdel	Private	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA		
WeEn	Private	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA		
CNR Yongdian	Private	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA		
Macmic	Private	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA		
NCE Power	Private	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA		
Global																											
ON Semi	ON	Buy	Toshiya Hari	USD	20.5	22	7%	8,401	11,290	4	137	-94%	2333%	87%	42.9	18.0	11.6	2.7	2.5	2.2	6%	14%	20%	0.0%	0.0%	0.0%	
Infineon	IFXQn.DE	Neutral	Alexander Duval	EUR	22.5	22.5	0%	33,210	31,393	43	159	-27%	21%	18%	47.4	37.9	32.4	3.0	2.8	2.7	6%	8%	9%	1.3%	1.3%	1.3%	
Mitsubishi	6503.T	Buy	Yushiro Iwayama	JPY	1,376.5	1,650	20%	27,646	26,136	52	61	-59%	133%	16%	32.6	14.0	12.1	1.2	1.1	1.1	4%	8%	8%	2.9%	2.9%	NA	
Rohm	6963.T	Neutral	Daiki Takayama	JPY	7,030.0	7,200	2%	6,773	4,229	(1)	52	-81%	772%	26%	144.6	16.2	12.5	1.0	0.9	0.9	1%	6%	7%	2.1%	2.1%	2.1%	
Cree	CREE	Neutral	Brian Lee	USD	63.0	56	-11%	6,815	6,469	5	73	151%	-37%	-85%	nm	nm	nm	73.5	3.6	3.8	3.7	-11%	-7%	-1%	0.0%	0.0%	0.0%
ST Micro	STM.PA	Sell	Alexander Duval	EUR	25.4	20.5	-19%	26,112	25,509	63	79	-52%	40%	36%	55.8	39.9	29.4	3.9	3.7	3.4	7%	9%	12%	0.5%	0.6%	0.7%	
Renesas	6723.T	Neutral	Daiki Takayama	JPY	592.0	490	-17%	9,495	15,244	(3)	65	NM	69%	NA	24.2	14.3	NA	1.6	1.4	NA	7%	10%	NA	0.0%	0.0%	NA	
Littelfuse	LFUS	NC	NA	USD	166.6	NA	NA	4,045	4,222	(3)	25	-38%	72%	20%	47.8	27.8	23.1	NA	NA	NA	6%	10%	NA	1.2%	1.3%	NA	
Diodes	DIO.D	NC	NA	USD	50.6	NA	NA	2,604	2,519	40	17	-28%	27%	NA	23.4	18.4	NA	NA	NA	NA	NA	NA	NA	NA	NA		
Vishay	VSH	NC	NA	USD	15.1	NA	NA	2,187	2,025	(4)	20	-42%	61%	33%	22.9	14.3	10.7	1.7	1.8	NA	6%	13%	NA	2.5%	2.5%	NA	
Panjit	2481.TW	NC	NA	TWD	29.0	NA	NA	3,26	478	(4)	4	40%	27%	5%	13.8	10.9	10.4	1.3	1.3	1.2	10%	11%	12%	4.2%	5.9%	6.7%	
Taiwan Semi	5425.TWO	NC	NA	TWD	41.0	NA	NA	346	467	(16)	3	-24%	36%	NA	23.5	17.4	NA	1.9	1.8	NA	8%	11%	NA	3.4%	4.6%	NA	
Toshiba	6502.T	CS	NA	JPY	3,510.0	NA	NA	14,938	16,159	3	71	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA		
Fuji	6504.T	NC	NA	JPY	2,781.0	NA	NA	3,884	5,685	(23)	21	-16%	-8%	24%	11.8	12.8	10.3	1.0	1.0	NA	7%	9%	NA	2.9%	3.2%	1.0%	
Microchip	MCHP	Buy	Toshiya Hari	USD	106.6	121	13%	26,155	35,373	21	267	61%	114%	36%	21.5	20.8	15.8	4.9	4.1	3.4	23%	21%	24%	1.6%	1.4%	1.4%	
Average excl. outliers											171	79	13%	48%	24%	60.8	39.8	34.3	8.1	6.9	7.1	9%	12%	16%	1.4%	1.6%	1.3%
Average											149	52	16%	210%	32%	33.1	40.9	33.0	7.3	6.3	6.2	8%	12%	16%	1.3%	1.5%	1.2%
Median											12	67	-16%	56%	26%	47.4	20.8	29.4	3.3	3.3	3.6	7%	11%	12%	0.6%	0.7%	0.7%

Prices as of July 10, 2020. NC = Not Covered, CS = Coverage Suspended. Target prices are based on a 12-month timeframe; *denotes on Conviction List

Source: Bloomberg, Goldman Sachs Investment Research

DCF cross-check

We use DCF as our valuation crosscheck, which suggests a theoretical share value of Rmb89.7, implying 81x 2022E P/E — slightly higher than our target price implied 2022E P/E of 80x. We model CR Micro's free cash flow to grow at an 83% CAGR in 2021E-25E, which then declines to 25% in 2026E-30E, with a terminal growth rate of 3%. We believe the company's free cash flow in 2021E-25E would be driven by: 1) increasing operating cash flow driven by revenue growth in MOSFET, power ICs, and IGBTs, as well as improving margins; 2) improving cash conversion days given its larger scale and improving AR/inventory management; and 3) disciplined capex. We model WACC at 8.8%, with COE at 9.0%, derived from a beta of 1.0, a risk-free rate of 3.0%, and a market risk premium of 6.0%.

Exhibit 459: DCF valuation at RMB 89.7, implied 81x 2022E P/E

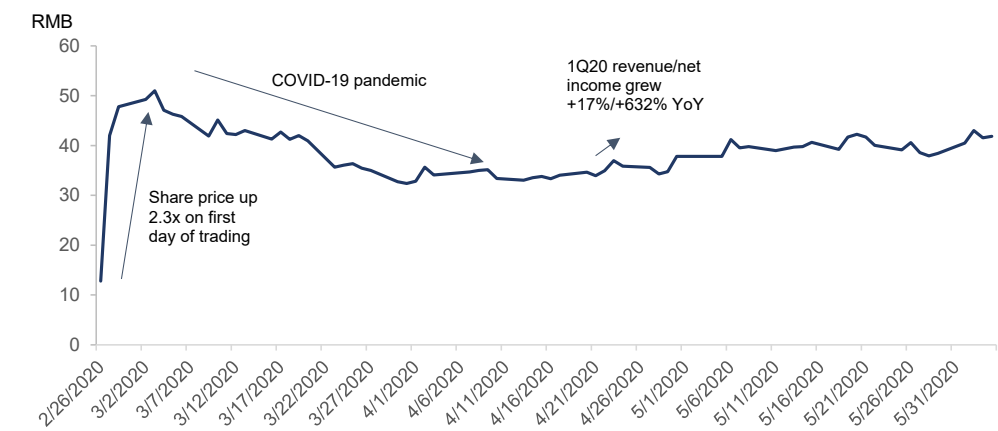
Rmb mn	2017	2018	2019	2020E	2021E	2022E	2023E	2024E	2025E	2026E	2027E	2028E	2029E	2030E
P&L														
Revenue	5,876	6,271	5,743	5,884	7,315	9,505	12,340	15,794	19,728					
YoY		7%	-8%	2%	24%	30%	30%	28%	25%					
GM	17.6%	25.2%	22.8%	23.6%	25.2%	27.0%	28.7%	29.9%	31.1%					
Opex ratio	17.5%	16.5%	18.1%	17.7%	15.8%	13.8%	12.0%	10.4%	9.2%					
Opex YoY	36%	1%	0%	0%	11%	13%	13%	12%	10%					
OP income	7	546	274	347	691	1,261	2,061	3,070	4,331					
YoY	nm	8150%	-50%	27%	99%	83%	63%	49%	41%					
Pretax income	(59)	591	506	558	931	1,503	2,305	3,328	4,602					
Net income	70	429	401	468	814	1,343	2,084	3,031	4,209					
YoY	nm	511%	-7%	17%	74%	65%	55%	45%	39%					
Cash flow														
CCC	73	86	91	91	88	85	82	79	76					
Capex	571	544	612	1,112	1,277	1,530	1,833	2,106	2,421					
Capex to revenues	10%	9%	11%	19%	17%	16%	15%	13%	12%					
Free cash flow	1,096	938	(36)	(142)	265	260	1,057	1,564	2,944	3,974	5,365	6,706	7,712	8,869
YoY		-14%				-2%	306%	48%	88%	35%	35%	25%	15%	15%
Terminal growth														3%
Terminal value														157,804
Discount factor							0.92	0.84	0.78	0.71	0.66	0.60	0.55	0.51
Present value of FCF							972	1,321	2,286	2,837	3,521	4,045	4,276	4,521
Enterprise value 2022E (Rmb m)						104,215								
Cash and equivalents						5,287								
Debt						506								
Equity value in 2022E (Rmb m)						108,996								
Value per share (RMB)						89.7								
Implied 2022E P/E						81x								
WACC assumption (2022E)														
Risk free rate	3.0%													
Beta	1.0													
Market risk premium	6.0%													
Cost of equity	9.0%													
Cost of debt	3.6%													
Tax rate	8%													
Debt / (debt+equity)	3.7%													
Equity / (debt+equity)	96.3%													
WACC	8.8%													

Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Share price movement

Despite a short listing history, we believe earnings growth will be a key growth driver for CR Micro's share price, similar to other A-share semiconductor names. CR Micro was listed on 26 Feb 2020 and the share price went up by 298% to Rmb50.99 by 3 March 2020 (CSI 300 Index +0.5%), which we attribute largely to its leading power semi IDM position in China with leading market share in MOSFET. The stock then declined from Rmb50.99 on 3 March to Rmb32.38 on 31 March as the market corrected on the COVID-19 pandemic. Following strong 1Q20 revenue/earnings growth of +17%/+632% YoY (announced on 22 April), the stock rebounded from Rmb130.37 on 29 April to >Rmb160 in mid-May.

Exhibit 460: CR Micro share price movement



Source: Bloomberg, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Downside risks

Key downside risks to our investment thesis are:

1) Weaker-than-expected MOSFET market growth: We forecast a 5% revenue CAGR for China's MOSFET market in 2020-25E, mainly driven by automotive, industrial, and home appliance applications. If the penetration of EV and inverter-based home appliances are slower than our forecast, or if the usage of MOSFET in EV/inverter-based home appliances are lower than our expectation, MOSFET market growth could be weaker than our current forecast.

2) Slower-than-expected new design-wins and market share gains: We model CR Micro to gain market share in China's MOSFET market from 9% in 2020E to 21% in 2025E, mainly in automotive, industrial, and consumer applications. If CR Micro's new design-wins or market share gains are slower than our expectation, there could be downside to our earnings estimates.

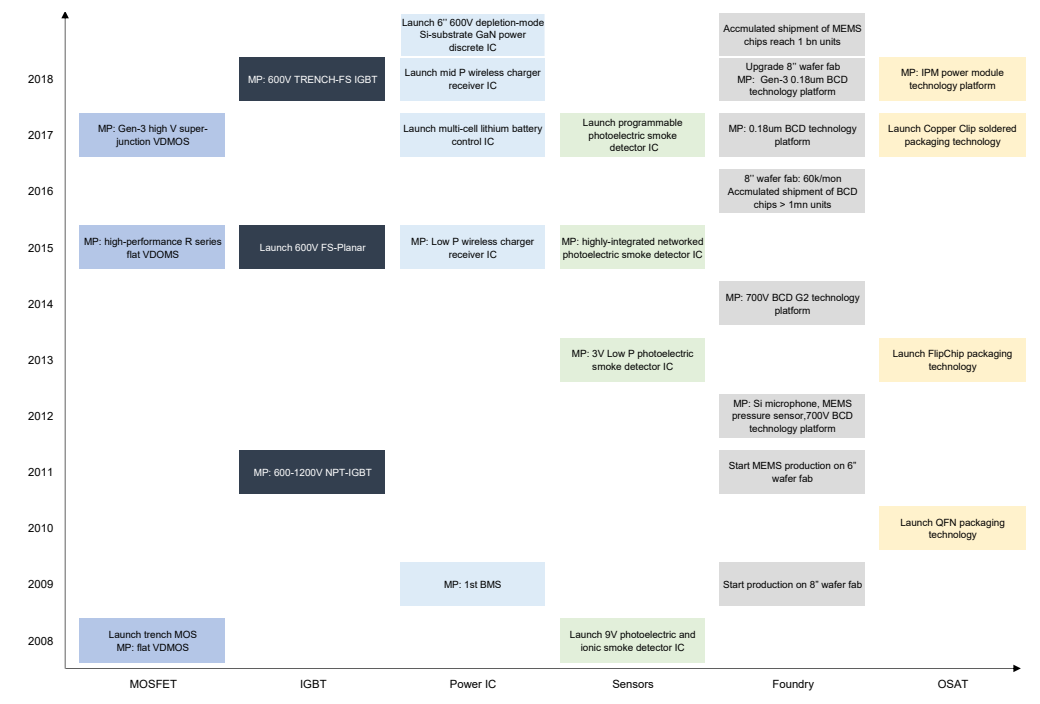
3) New product (IGBT and power IC) development progress: We expect CR Micro's IGBT revenue to increase from 1% of total revenue in 2019 to 2-7% in 2020-25E, and power IC revenue to increase from 5% of total revenue in 2019 to 6-16% in 2020-25E. If the R&D progress or customer qualification of IGBT and power IC is slower than our expectations, it could result in slower earnings growth in 2020-25E.

4) Intensifying competition: There are new entrants in MOSFET in China such as Wingtech, Jiejie Micro, etc. We expect CR Micro to have 26% market share in China's MOSFET market by 2025E. If other domestic competitors have faster R&D/new design-wins/market share gains from CR Micro, there could be downside to our earnings estimates.

5) Potential impact from COVID-19: CR Micro's revenue is mainly from the domestic market (~80% of revenue) but its customers' end products are sold globally, we thus believe CR Micro could be impacted by the macro economic slowdown globally in 2020. We are more cautious on CR Micro's revenue growth in near-term and model -2% revenue YoY in 2H20E (vs +17% YoY in 1Q20).

Company history and management background

Exhibit 461: CR Micro technology and production milestone



Source: Company data

Exhibit 462: CR Micro management background

Name	Position	Industry experience	Education background
Li Fuli	Chairman	2010 - 2018: China Minmetals Group, Vice President and Deputy General Manager; China Minmetals Corporation, Director and Deputy General Manager	MBA, CKGSB
Chen Nanxiang	Executive Vice Chairman,CIO	2013 - 2014: CR Micro, General Manager of R&D Center Current: CSIA, Vice President; ICTIA, Vice President	Ph.D. of Ion Beam Physics and Integrated Circuit Applications, Beijing Normal University
Wang Guoping	Head of Pioneer Technology R&D Center	2014 - 2019: CR Micro, General Manager of R&D Center	Master of Engineering, Chengdu Institute of Telecommunication Engineering
Li Hong	CEO of CR Mciro (Chongqing), Head of Power Semiconductor Technology Innovation Center	2014 - 2017: China Resources Huajing, Executive Deputy General Manager	Ph.D. of Physics, University of Wisconsin
Su Wei	Deputy General Manager of Wuxi CR Shanghua Semiconductor, Deputy Head of Pioneer Technology R&D Center	1998 - 2012: Wuxi China Resources Semiconductor, R&D Director and Deputy General Manager	Master of Software Engineering, Southeast University

Source: Company data

CR Micro

688396.SS	12m Price Target: Rmb88	Price: Rmb56.23	Upside: 56.5%		
Buy	GS Forecast				
Market cap: Rmb68.4bn / \$9.8bn	Revenue (Rmb mn)	12/19 5,742.8	12/20E 5,883.6	12/21E 7,315.1	12/22E 9,504.7
Enterprise value: Rmb64.9bn / \$9.3bn	EBITDA (Rmb mn)	966.5	1,138.2	1,589.4	2,285.9
3m ADTV :Rmb955.0mn/ \$135.0mn	EPS (Rmb)	0.46	0.39	0.67	1.10
China	P/E (X)	NM	145.9	84.0	50.9
Greater China Technology	P/B (X)	NM	6.8	6.3	5.7
M&A Rank: 3	Dividend yield (%)		0.1	0.1	0.2
	Net debt/EBITDA (X)	(0.4)	(3.9)	(2.9)	(2.1)
	CROCI (%)	1.9	6.6	7.4	9.4
	FCF yield (%)		(0.2)	0.4	0.4
		3/20 0.08	6/20E 0.06	9/20E 0.03	12/20E 0.04

Source: Company data, Goldman Sachs Research estimates, FactSet. Price as of 10 Jul 2020 close.

Montage (688008.SS): Leading memory interface IC designer, positively exposed to growing server DRAM

Primary analysts:

Lynn Luo, Jin Guo

Initiate at Buy with a 12-month TP of Rmb161: Montage is an IC design house focusing on memory interface ICs used in server DRAM modules to enhance the performance and stability of memory data access. As one of the three suppliers globally of memory interface ICs, Montage has 38% market share and serves all major DRAM makers (Samsung, SK Hynix, Micron, etc.) in the server market. Key growth drivers are the growing DRAM content in servers driven by cloud and AI computing, as well as the next generation of memory interface IC (DDR5) which supports faster data transmission speeds, and carries higher ASPs. In addition, we see optionality in its unique Jintide server platform for the information security field, a business area which we expect to grow from 1% of revenue in 2020E to 10% by 2023E.

Standard upgrade to DDR5 brings higher ASPs: We forecast Montage's core memory interface IC market to grow from US\$840m in 2020E to US\$3.0bn in 2025E, a 29% CAGR, driven by DRAM content growth in servers, despite largely flat server market growth. We expect demand for Montage's DDR5 product to be driven by global standard upgrades from the current mainstream DDR4 interface, with DDR5 shipments starting in 2021E, contributing 20%/53%/65% of total revenue in 2021-23E and carrying higher gross margins (78% in 2021E) than DDR4 (75% in 2021E). Compared with DDR4, DDR5 can support faster speeds (4800MT/s vs. DDR4 at 3200MT/s) at lower voltage (1.1V vs. DDR4 at 1.2V), enabling faster data transmission speeds and better power efficiency. With high barriers to entry in DDR5, we expect Montage's global market share to rise gradually to 42% in 2025E.

Jintide server platform a long-term growth driver: The platform realizes a real-time security monitoring function at the silicon level, enhancing information security for servers. We expect the increasing security requirements of customers, such as domestic server makers like Lenovo, H3C, Greatwall, Powerleader, etc. to drive demand growth for the Jintide server platform, which we forecast to contribute 3%/6% of the company's revenue in 2021/22E.

Valuation and Risks: To capture the company's long-term opportunities from the high-growth memory-interface IC market and its new product cycle (i.e., DDR5, Jintide), we value Montage using a discounted PE approach. Our target price of Rmb161 is derived by applying a 32x target P/E multiple (based on our sector P/E-EPS YoY correlation analysis) to Montage's 2025E EPS, discounted back to 2022 at a COE of 9%. Our target price implies 68x 2022E P/E (vs. global peer avg. at 34x), which we believe is justified by the company's strong earnings growth CAGR of +45% in 2020-23E (vs. peer average earnings CAGR of +29% in 2020-22E). Our DCF cross-check valuation also shows a similar theoretical share value of Rmb166, or 70x 2022E P/E. Risks are: 1) weaker-than-expected memory interface IC market growth; 2) slower-than-expected DDR5 adoption; 3) intensifying competition; and 4) potential impact from COVID-19.

PM summary: Top five questions

1. Why are we positive on the memory interface IC market? 29% CAGR driven by server DRAM content growth on the back of cloud and AI computing

We model the memory interface IC market to grow from US\$840m in 2020E to US\$3.0bn in 2025E, a 29% CAGR, driven by DRAM content growth in servers, despite largely flat server market growth. Our GS forecast for the global server market is for volumes to remain stable at 11.6m/11.3m/12.0m units in 2019-21E, and DRAM content per server to grow from 281GB in 2019 to 393/500GB in 2020E/21E, driving server DRAM unit growth from 3.3bn GB in 2019 to 4.5/6.0bn GB in 2020E/21E, or +37%/+34% YoY in 2020E/21E. We expect the growing DRAM content in servers to be driven by increasing cloud and AI computing, which drives demand for better performance and higher density DRAM. Memory interface IC market growth is mainly driven by DRAM shipments, while prices are relatively stable compared with DRAM prices.

2. Where we are different from the market? Our 2021/22E earnings are 19%/39% above consensus on higher revenue and margins

Our 2021/22E net income forecasts are 19%/39% higher than Bloomberg consensus mainly on higher revenue and gross margins. Our revenue forecasts are 10%/28% higher than consensus for 2021/22E as we expect stronger growth on the back of server DRAM content growth and DDR5 adoption. Our GM is 1.8ppt/1.3ppt higher than consensus for 2021-22E as we are more positive on interface ICs, which carry higher GM than the Jintide server platform.

3. What are Montage's near-term and long-term drivers? Server DRAM content growth, DDR5 migration, Jintide server platform

In the near term, we expect Montage to grow along with the server DRAM content growth, which drives demand for memory interface IC. We also expect Montage to start shipments of DDR5 interface ICs in 2021E, contributing 20%/53%/65% of total revenue in 2021-23E with higher GM (78% in 2021E) than DDR4 interface ICs (75% in 2021E). For the longer term, we see the Jintide server platform as a key growing business on the back of increasing security requirements from customers, and we model an 18% revenue contribution from Jintide server platform by 2025E.

4. How do we value the stock? P/E at 68x at our 2022E

Our 12M target price of Rmb161 (implying a 68x 2022E P/E) is derived from a discounted P/E methodology, which we view as appropriate for Montage as this method reflects the early stage of its new product cycle (i.e., DDR5, Jintide) and effectively captures the company's long-term business opportunities, as well as our expectations for Montage to enjoy stronger growth than its global peers. We apply a 32x target P/E multiple to Montage's 2025E EPS and discount back to 2022E at a COE of 9% (1.0 Beta, 3% risk-free rate, and 6% market risk premium). The 32x target P/E multiple is derived from the sector P/E-EPS YoY correlation, and we note that the market has generally rewarded higher EPS growth companies in the semiconductor industry based on our regression analysis. Our target price implies 68x 2022E P/E, or PEG at 1.6x based on

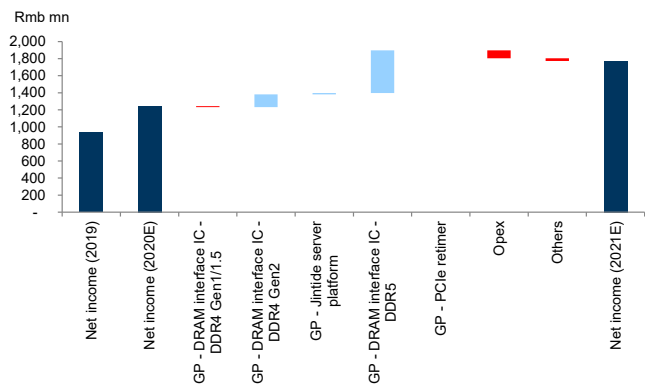
average 2023-24E EPS YoY growth (41%). Our valuation crosscheck using the DCF method also shows a similar theoretical share value of Rmb166, or 70x 2022E P/E. The stock currently trades at 75x/50x our 2021/22E EPS and at 1.6x/1.2x our PEG based on an average 2022-23E/2023-24E EPS YoY growth, which we believe is attractive considering its strong earnings growth at a +43% CAGR in 2020-25E.

5. Potential downside risks from COVID-19? *~90% revenue from Asia market*

Montage's revenues come mainly from the Asia market (~90% of revenue) but its customers' end products are sold globally. We therefore believe Montage could be impacted by the macro economic slowdown globally in 2020.

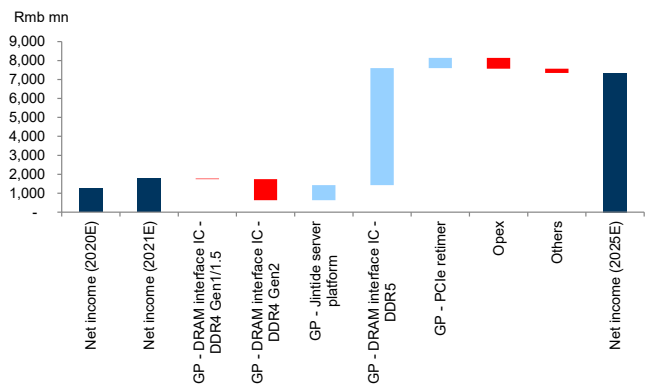
PM Summary: Top six charts

Exhibit 463: We expect DDR5 to be the major profit driver for Montage in 2021E
Net profit waterfall chart 2020-21E



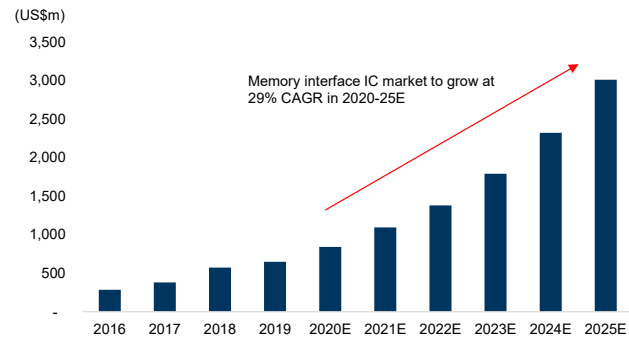
Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 464: DDR5 to have rising profit contribution during 2021-25E
Net profit waterfall chart 2021-25E



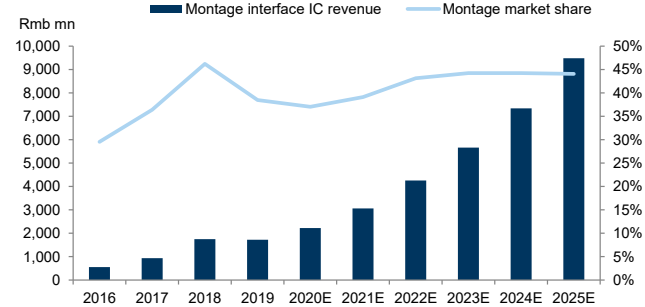
Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 465: Memory interface IC market to grow at 29% CAGR in 2020-25E



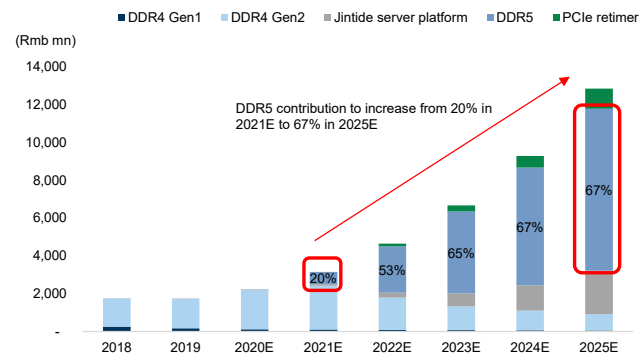
Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 466: We expect Montage market share to rise from 38% in 2019 to 44% in 2025E



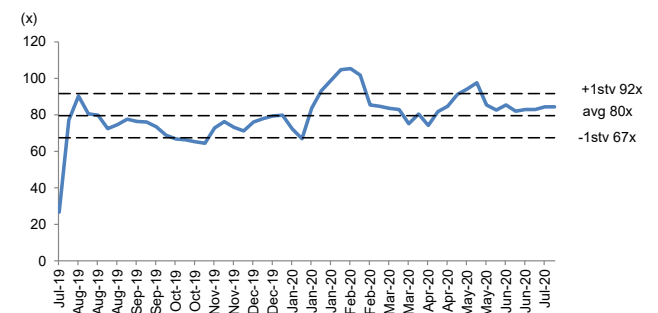
Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 467: DDR5 interface IC the key growth drivers in coming years
Montage revenue mix



Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 468: Montage average P/E at 80x since listed
Montage 12M forward PE ratio



Source: Bloomberg

Memory interface IC driven by server DRAM content growth and upgrades to DDR5 from DDR4

Montage is a leading supplier of memory interface ICs with 38% market share in a US\$647m market in 2019, serving all major DRAM makers (Samsung, SK Hynix, Micron, etc.) in the server market. Key growth drivers for memory interface ICs in the coming years are: 1) DRAM content growth in servers; and 2) mainstream standard upgrade from DDR4 to DDR5, which we expect will drive Montage's memory interface IC revenue growth at a 37% CAGR in 2020-23E.

What are memory interface ICs?

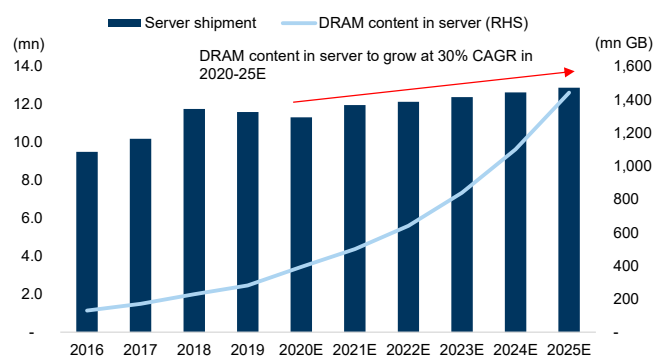
Memory interface ICs are key logic ICs in the DRAM (Dynamic random-access memory) module, which act as bridges between a CPU and memory ICs to enhance the performance, speed, and stability of memory data access. In PC/mobile DRAM, memory controllers (inside a CPU or separated chip) send all commands directly to DRAM dies in module. In a server DRAM module, RCD (register clock driver) and DB (data buffer) chips are added into DRAM modules, to buffer the control signals, so that the module can handle higher speeds and higher DRAM capacity with better stability.

DRAM content growth in servers to drive memory interface IC market growth

We model the memory interface IC market to grow from US\$840m in 2020E to US\$3.0bn in 2025E, a 29% CAGR, driven by DRAM content growth in servers, despite largely flat server market growth. Our GS forecast for the global server market estimates volumes to remain stable at 11.6m/11.3m/12.0m units in 2019-21E, and DRAM content per server to grow from 227GB in 2019 to 393/500GB in 2020E/21E, driving server DRAM unit growth from 3.3bn GB in 2019 to 4.5/6.0bn GB in 2020E/21E, or +37%/+34% YoY in 2020E/21E. The growing DRAM content in servers is driven by increasing cloud and AI computing, which drives demand for better performance and higher density DRAM. Memory interface IC market growth is mainly driven by DRAM shipments, while prices are relatively stable compared with DRAM prices.

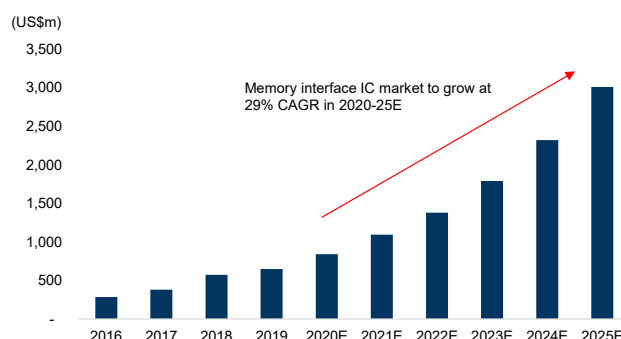
Exhibit 469: DRAM content in server to grow at 30% CAGR in 2020-22E

Global server unit shipments and DRAM content in server



Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 470: Memory interface IC market to grow at 29% CAGR in 2020-22E



Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Product mix upgrade to DDR5 from DDR4

DDR4 is currently the mainstream standard and Montage has been developing DDR5 interface ICs since 2017, targeting volume shipments in 2021. Compared with DDR4, DDR5 interface IC can support faster speed (4800MT/s vs. DDR4 at 3200MT/s) at lower voltage (1.1V vs. DDR4 at 1.2V), enabling faster data transmission speeds with better power efficiency. Montage's DDR5 interface ICs are currently under R&D, its first engineering version achieved tape-out (final result of the design process) in 2019, and its first mass production version is targeted to be complete by end-2020, with mass production slated for 2021. We expect Montage to start shipments of DDR5 interface ICs in 2021E, contributing 20%/53%/65% of total revenue in 2021-23E with higher GM (78% in 2021E) than DDR4 interface ICs (75% in 2021E). Customer adoption of DDR5 will also depend on DRAM maker progress in DDR5 DRAM mass production (likely in 2020-21) as well as new server CPU platforms to support DDR5 (likely in 2021-22).

Montage's market position

Montage is one of the three suppliers globally of memory interface ICs, competing with IDT (acquired in 2019 by Renesas, covered by Daiki Takayama) and Rambus (Not Covered). Montage's global market share increased from 30% in 2016 to 36%/46% in 2017/18, thanks to its strong DDR4 solutions which were adopted as an industry standard. Montage's invention of the fully buffered DDR4 "1+9" distributed architecture has been adopted by JEDEC (Joint Electronic Device Engineering Council, a semiconductor engineering standardization body) as an international standard, and its related products have successfully entered the industry mainstream memory, server, and cloud computing fields and serves the majority of the global market. For the coming years, we expect Montage to maintain market share at levels on par with 2019 given the unlikelihood of new competitors in DDR5 solutions.

Montage's "1+9" structure

In the DDR4 generation, Montage has invented the "1+9" structure, which has been adopted as global standard by JEDEC. The "1+9" structure is one Registering Clock Driver (RCD) with nine Data Buffers (DB), shortening the signal transmission distance, lowering data latency, better signal integrity, faster speed up to 3200MT/s (vs. traditional structure 1866MT/s), larger capacity up to 128GB (vs. 64GB), lower power consumption.

Jintide server platform, a new driver for the long term

What is the Jintide server platform?

Since 2016, Montage has been cooperating with Tsinghua University and Intel to develop the Jintide server platform, which combines the Jintide CPU with Montage's hybrid security memory module (HSDIMM). The platform has a realized real-time security monitoring function at the silicon level and can play an important role in the information security field. This architecture also incorporates advanced heterogeneous processing and interconnected technologies for future AI and big data applications, which provides strong support for comprehensive data processing and computing power for various applications in the AI era. The first generation of the Jintide server

platform was launched in 2018 and Montage reported 1% of revenue from this product line in 2019 (we model 10% by 20203E).

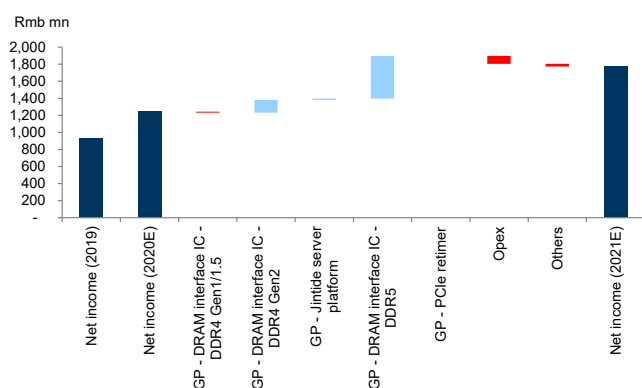
The business model of the Jintide server CPU: The Jintide server CPU was jointly developed by Montage, Intel, and Tsinghua University, and Montage owns the product and brand name. In this product, the general CPU core chip is provided by Intel, the algorithm for the RCP (Reconfigurable Computing Processor) is provided by Tsinghua University, while Montage designs other chips and the whole module, as well as outsources the manufacturing, packaging, and testing to suppliers. The Intel general CPU core chip accounts for ~90% of the cost of a Jintide server CPU.

Earnings estimates: 43% NI CAGR in 2020-25E, mainly driven by server DRAM content growth and DDR5 adoption

Income statement

We model Montage's net income growth at a +43% CAGR in 2020-25E, with revenue growth at +42% CAGR and operating income at a +46% CAGR. Revenue growth is mainly driven by server DRAM content growth and DDR5 penetration. We expect Montage's DDR5 interface ICs to contribute 21%/58%/76% of its interface IC revenue in 2021/22/23E, driving Montage's interface IC revenue growth at +38%/+39%/+33% YoY in 2021-23E. We also expect the Jintide server platform to grow from 1% of revenue in 2020E to 3%/6%/10% of revenue in 2021/22/23.

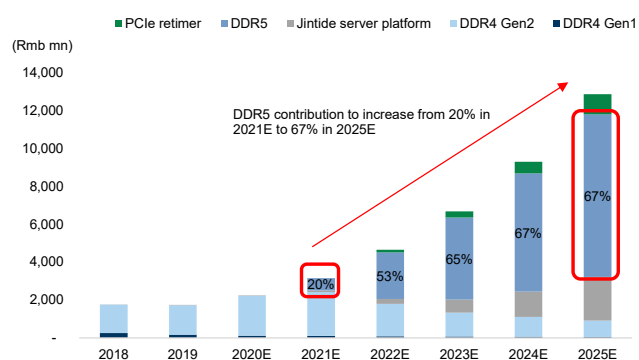
Exhibit 471: DDR5 interface IC the key growth driver for 2021E



Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

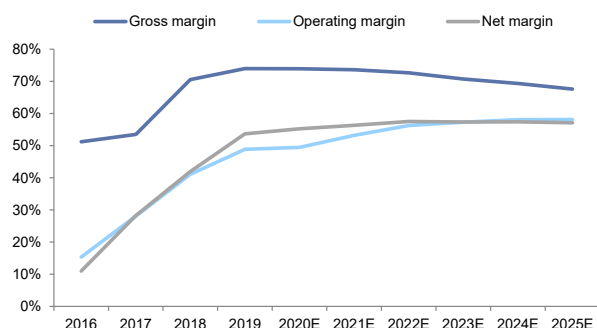
Exhibit 472: DDR5 interface IC the key growth drivers in coming years

Montage revenue mix

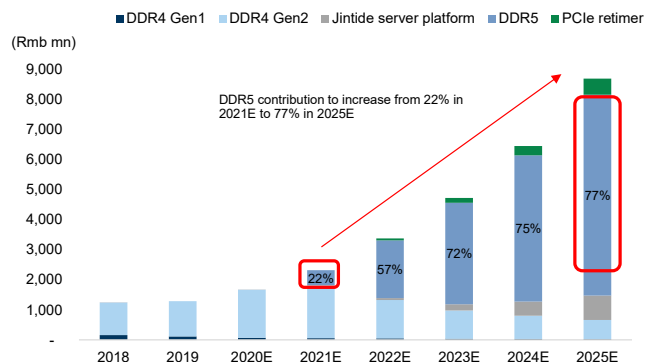


Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

We model the company's GM to decline from 73.9% in 2020E to 73.6%/72.7%/70.7% in 2021-23E due to product mix and margin contraction in the old generation DDR interface ICs. By products, Jintide server platforms carry lower GM (7% in 2020E vs. corporate average at 74%) and the increasing revenue contribution will weigh on overall margin. For interface ICs, we also model mild margin contraction per year as the technology matures over time.

Exhibit 473: GM mild decline on product mix

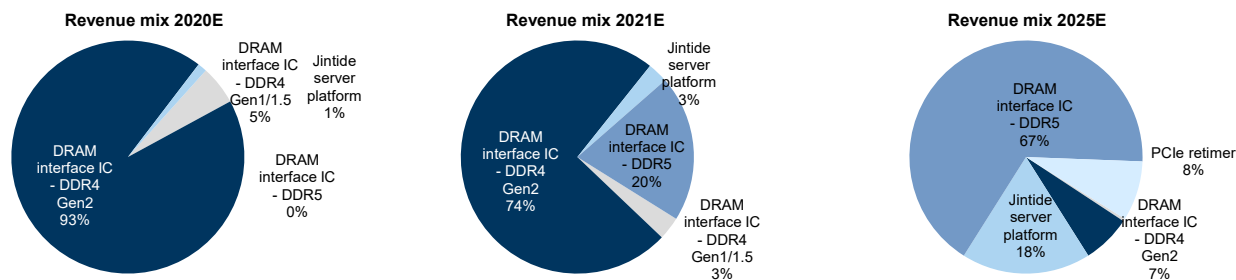
Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 474: DDR5 interface IC, the key profit contributor in coming years
Montage gross profit mix

Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 475: We expect DRAM interface IC - DDR5 to have rising revenue contribution during 2020-25E

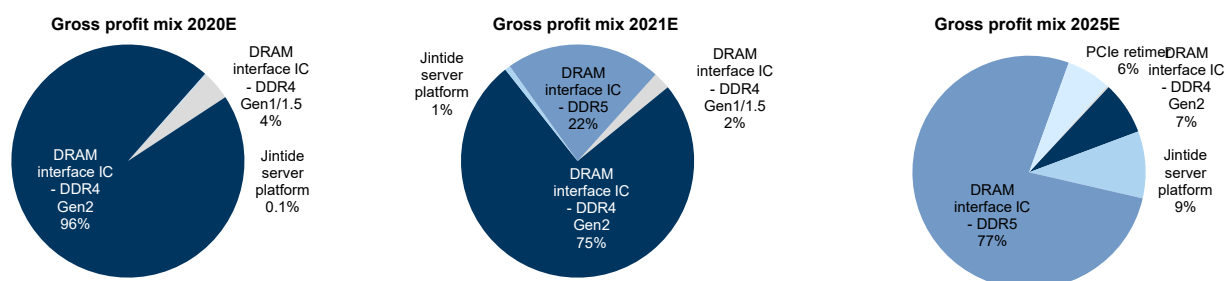
Montage revenue mix



Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 476: DDR5 to have 77% gross profit contribution by 2025E

Montage gross profit mix



Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Where we are different from the Street

Our 2021/22E net income forecasts are 19%/39% higher than Bloomberg consensus mainly on higher revenue and gross margins. Our revenue forecasts are 10%/28% higher than consensus for 2021/22E as we expect stronger growth on the back of server DRAM content growth and DDR5 adoption. Our GM is 1.8ppt/1.3ppt higher than consensus for 2021-22E as we are more positive on interface ICs, which carry higher GM than the Jintide server platform.

Exhibit 477: Our EPS is 19%/39% higher than consensus for 2021-22E

(Rmb bn)	2020E			2021E			2022E		
	GS	Con	Diff	GS	Con	Diff	GS	Con	Diff
Revenue	2,252	2,128	6%	3,148	2,850	10%	4,644	3,632	28%
Gross profit	1,665	1,512	10%	2,318	2,047	13%	3,374	2,592	30%
Operating income	1,114	1,172	-5%	1,675	1,638	2%	2,612	2,068	26%
Pre-tax profit	1,309	1,215	8%	1,867	1,618	15%	2,811	2,028	39%
Net income	1,243	1,143	9%	1,773	1,493	19%	2,671	1,924	39%
Margins									
Gross margin	73.9%	71.0%		73.6%	71.8%		72.7%	71.4%	
Operating margin	49.5%	55.0%		53.2%	57.5%		56.3%	56.9%	
Net margin	55.2%	53.7%		56.3%	52.4%		57.5%	53.0%	

Source: Bloomberg, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 478: Montage P&L summary

(Rmb m)	1Q19	2Q19	3Q19	4Q19	1Q20	2Q20E	3Q20E	4Q20E	2016	2017	2018	2019	2020E	2021E	2022E
Revenue	405	474	505	353	496	584	696	477	845	1,228	1,758	1,738	2,252	3,148	4,644
Gross profit	308	339	381	258	360	425	522	358	433	657	1,240	1,285	1,665	2,318	3,374
Operating expense	(64)	(188)	(80)	(104)	(163)	(196)	(84)	(108)	(303)	(312)	(518)	(437)	(551)	(643)	(761)
Operating income	244	150	300	154	197	229	438	250	130	344	722	849	1,114	1,675	2,612
Pre tax profit	235	224	307	214	277	263	472	297	99	362	786	979	1,309	1,867	2,811
Net income	226	225	293	189	263	250	448	282	93	347	737	933	1,243	1,773	2,671
EPS (Rmb)	0.21	0.21	0.28	0.18	0.23	0.22	0.40	0.25	0.12	0.46	0.87	0.88	1.10	1.57	2.36
Margins / ratio															
Gross margin	76.2%	71.4%	75.3%	72.9%	72.5%	72.8%	75.0%	75.1%	51.2%	53.5%	70.5%	74.0%	73.9%	73.6%	72.7%
Opex ratio	-15.9%	-39.7%	-15.9%	-29.4%	-32.9%	-33.6%	-12.0%	-22.7%	-35.9%	-25.4%	-29.4%	-25.1%	-24.5%	-20.4%	-16.4%
Operating margin	60.3%	31.7%	59.4%	43.5%	39.7%	39.2%	63.0%	52.4%	15.3%	28.1%	41.1%	48.8%	49.5%	53.2%	56.3%
Net margin	55.8%	47.4%	57.9%	53.6%	53.0%	42.8%	64.5%	59.2%	11.0%	28.3%	41.9%	53.7%	55.2%	56.3%	57.5%
QoQ															
Revenue	-20%	17%	6%	-30%	40%	18%	19%	-31%							
Gross profit	-15%	10%	12%	-32%	40%	18%	23%	-31%							
Operating income	47%	-38%	100%	-49%	28%	16%	91%	-43%							
Pre tax profit	20%	-5%	37%	-30%	29%	-5%	80%	-37%							
Net income	30%	0%	30%	-35%	39%	-5%	80%	-37%							
EPS	4%	0%	30%	-35%	30%	-5%	80%	-37%							
YoY															
Revenue			-7%	-30%	22%	23%	38%	35%		45%	43%	-1%	30%	40%	47%
Gross profit			-3%	-29%	17%	26%	37%	39%		52%	89%	4%	30%	39%	46%
Operating income			22%	-7%	-19%	52%	46%	62%		166%	110%	17%	31%	50%	56%
Pre tax profit			16%	10%	18%	18%	54%	39%		266%	117%	24%	34%	43%	51%
Net income			19%	9%	17%	11%	53%	49%		274%	112%	27%	33%	43%	51%
EPS			-5%	-13%	9%	4%	44%	40%		283%	89%	1%	25%	43%	51%

Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

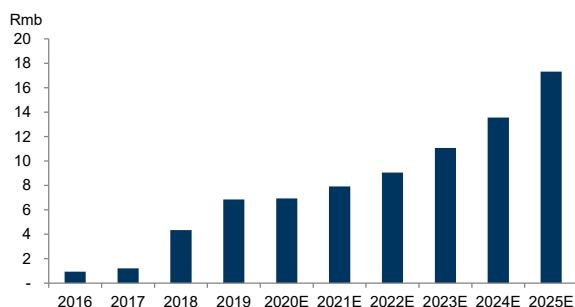
Balance sheet

Net cash per share: Montage was in a net cash position in 2016-19, and we expect this trend to continue for the next five years given its business model of asset-light fabless IC design, which outsources manufacturing to foundry and OSAT suppliers. We model the company to remain in a net cash position in 2020-2025E, with net cash per share increasing from Rmb6.9 in 2020E to Rmb17.3 in 2025E, driven by increasing operating cash flow.

ROE: Montage's ROE was at 31-34% in 2017-18, but decreased to 17% in 2019 due to lower asset turnover and a lower asset-to-equity ratio post the IPO in 2019, despite its net margin improving from 42% in 2018 to 54% in 2019. For the coming years, we expect Montage's ROE to improve from 16% in 2020E to 20%/26%/31% in 2021E/22E/23E, mainly driven by better efficiency in asset turnover (0.3x/0.3x/0.4x/0.5x in 2020E/21E/22E/23E) with a stable asset-to-equity ratio at 1.1x and less volatile net margin at 55-58% in 2020-23E.

Exhibit 479: We expect Montage net cash per share to increase during 2020-25E

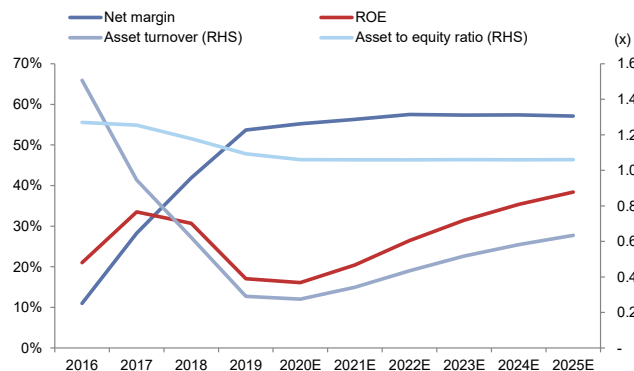
Montage net cash per share



Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

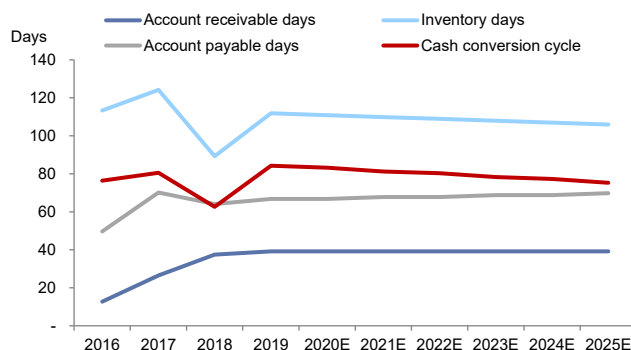
Exhibit 480: Improving ROE on increasing net margin

ROE and Dupont analysis



Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Cash conversion cycle: Montage's cash conversion cycle improved from 81 days in 2017 to 63 days in 2018, mainly due to lower inventory days (from 124 days in 2017 to 89 days in 2018). However, the cash conversion cycle increased from 63 days in 2018 to 84 days in 2019 due to longer inventory days (from 89 days in 2018 to 112 days in 2019). For the coming years, we expect Montage's cash conversion cycle to improve from 83 days in 2020E to 75 days in 2025E, mainly driven by improving inventory days thanks to its larger scale (better bargaining power) and improving inventory management.

Exhibit 481: We expect Montage's cash conversion cycle to improve from 83 days in 2020E to 75 days in 2025E


Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

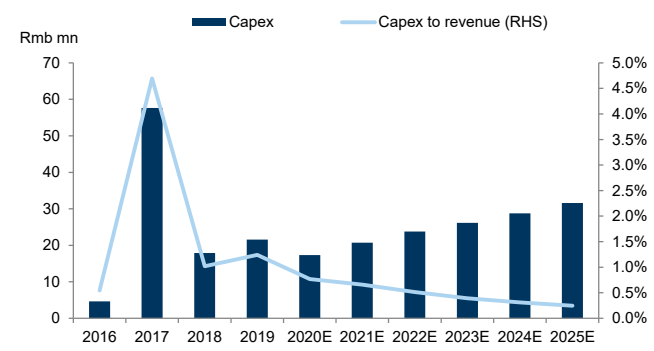
Cash flow

Capex: Montage's capex to revenue ratio was 1% in 2018-19 given its business model of fabless IC design, which outsources manufacturing to foundry and OSAT suppliers. We expect the ratio to remain at a low level of 0.2-0.8% in 2020-25E.

Free cash flow: Montage's free cash flow was positive during 2016-19 with an annual amount of Rmb588mn on average, or 0.8% free cash flow yield on average. We expect the yield to rise to 1.3%/1.7%/2.8% in 2021-23E, driven by rising operating cash flow and lower capex to revenue ratio.

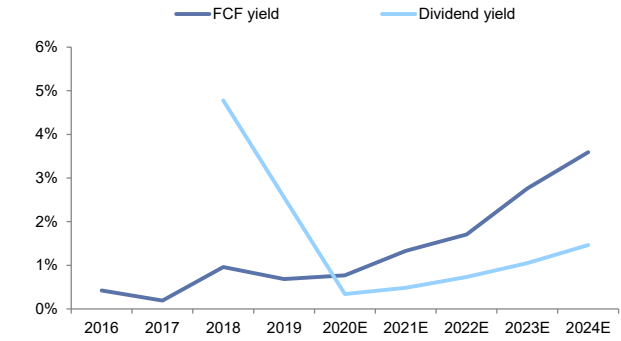
Dividend yield: Montage’s dividend payout ratio was at 36% in 20119, and we expect its dividend payout to be stable at 36% in 2020E-25E, implying a dividend yield of 0.5%/07% in 2020E/21E.

Exhibit 482: We expect capex to revenue ratio to be stable at below 1% in 2020-25E



Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 483: We forecast improving FCF and dividend yield for Montage



Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Valuation: TP at Rmb161, implying 37% upside

Our 12M target price of Rmb161 (implying a 68x 2022E P/E) is derived from a discounted P/E methodology. We believe a discounted P/E approach is appropriate for Montage as this method reflects the early stage of its new product cycle and effectively captures the company's long-term business opportunities, as well as our expectations for Montage to enjoy stronger growth than its global peers. We apply a 32x target P/E multiple to Montage's 2025E EPS and discount back to 2022E at a COE of 9% (1.0 Beta, 3% risk-free rate, and 6% market risk premium). The 32x target P/E multiple is derived from the sector P/E-EPS YoY correlation, and we note that the market has generally rewarded higher EPS growth companies in the semiconductor industry based on our regression analysis. Our target price implies 68x 2022E P/E, or PEG at 1.6x based on average 2023-24E EPS YoY growth (41%). Our valuation crosscheck using the DCF method also shows a similar theoretical share value of Rmb166, or 70x 2022E P/E. The stock currently trades at 75x/50x our 2021/22E EPS and at 1.6x/1.2x our PEG based on an average 2022-23E/2023-24E EPS YoY growth (vs. peer average 26x 2021E P/E and 23% average 2022-23E EPS YoY growth), which we believe is attractive considering its strong earnings growth at a +45% CAGR in 2020-23E (vs. peer average earnings CAGR of +29% in 2020-22E).

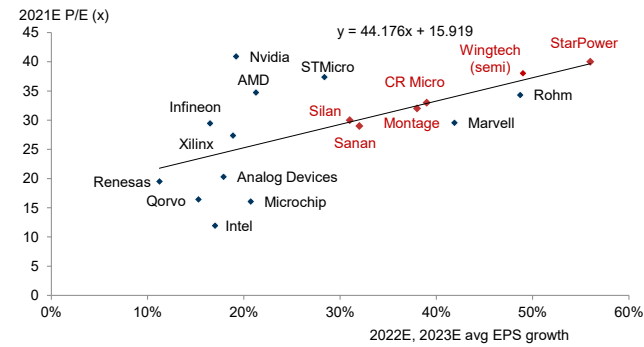
Exhibit 484: Montage discounted P/E valuation: TP at Rmb161, implied 68x 2022E P/E

(Rmb mn)	2017	2018	2019	2020E	2021E	2022E	2023E	2024E	2025E
Milestones				Server DRAM content growth		Growing DDR5 penetration		Jintide server platform, PCIe retimer	
Revenue	1,228	1,758	1,738	2,252	3,148	4,644	6,673	9,289	12,852
YoY	45%	43%	-1%	30%	40%	47%	44%	39%	38%
Gross margin	53.5%	70.5%	74.0%	73.9%	73.6%	72.7%	70.7%	69.3%	67.6%
Operating profit	344	722	849	1,114	1,675	2,612	3,824	5,397	7,471
YoY	166%	110%	17%	31%	50%	56%	46%	41%	38%
Pre-tax profit	362	786	979	1,309	1,867	2,811	4,028	5,614	7,729
Net profit	347	737	933	1,243	1,773	2,671	3,827	5,333	7,342
EPS (Rmb)	0.46	0.87	0.88	1.10	1.57	2.36	3.39	4.72	6.50
YoY	283%	89%	1%	25%	43%	51%	43%	39%	38%
2025E target P/E									32
Target multiple x EPS									208
Discounted back to 2022; TP (Rmb)						161			
Implied 2022E P/E						68			

COE assumption	
Beta	1.0
Risk free	3.0%
Market risk premium	6.0%
COE	9.0%

Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

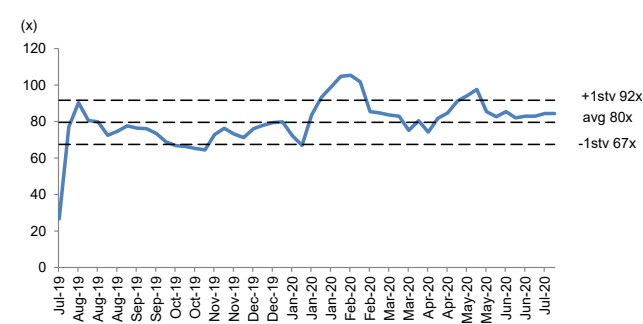
Exhibit 485: Global semi peers P/E vs. EPS YoY scatter chart



Red names are 2025E target P/E and 2025E EPS YoY

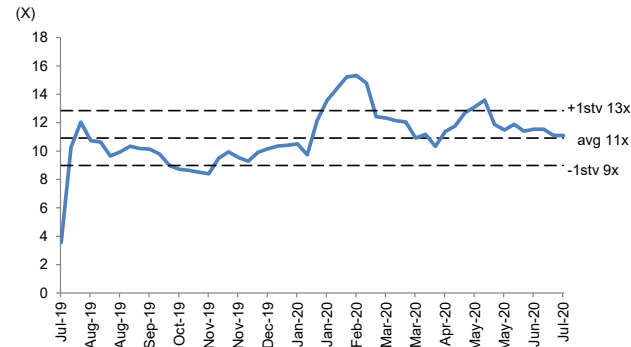
Source: Bloomberg, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 486: Montage P/E average at 80x since listing
Montage 12M forward PE ratio



Source: Bloomberg

Exhibit 487: Montage P/B average at 11x since listing
Montage 12M forward PB ratio



Source: Bloomberg

Exhibit 488: Montage peers valuation comp table

Ticker	Rating	Analyst	Pricing currency	PX (LCY)	TP (LCY)	Upside (%)	Market cap (US\$m)	EV (US\$m)	LTM PX move (%)	LTM ADTV (US\$m)	EPS growth	Trading P/E	Trading P/B	ROE	Div Yield											
IC design																										
Local																										
Montage	680008.SS	Buy	Lynn Luo, Jin Guo	CNY	117.2	161	37%	19,918	17,881	374	80	25%	43%	51%	74.7	49.6	16.3	14.3	12.1	16%	20%	26%	0.3%	0.5%	0.7%	
Goodix	603160.SS	Neutral	Allen Chang, Jin Guo	CNY	259.5	252	-3%	16,930	16,369	81	164	-56%	145%	20%	46.3	38.5	16.2	12.5	9.8	15%	30%	29%	0.1%	0.3%	0.4%	
Will Semi	603501.SS	Buy	Lynn Luo, Jin Guo	CNY	244.0	271	11%	30,104	30,401	342	125	330%	86%	35%	59.9	44.5	22.1	16.8	12.7	22%	32%	32%	0.1%	0.2%	0.3%	
Mascard	300782.SZ	Buy	Verena Jeng, Jin Guo	CNY	476.8	562	18%	12,257	12,116	355	129	12%	10%	55%	68.0	44.0	29.1	28.8	20.7	44%	49%	55%	0.5%	0.6%	0.9%	
GigaDevice	603988.SS	Buy	Jin Guo	CNY	273.8	326	19%	18,416	18,154	313	289	19%	48%	46%	77.2	53.0	21.4	17.5	13.8	20%	25%	29%	0.2%	0.3%	0.4%	
SG Micro	300661.SZ	Buy	Lynn Luo, Jin Guo	CNY	337.0	353	5%	7,484	7,425	453	69	38%	87%	70%	115.1	67.7	39.8	31.0	22.5	20%	30%	38%	0.1%	0.2%	0.3%	
Guoxin Micro	002049.SZ	NC	NA	CNY	129.0	NA	NA	11,184	11,152	205	237	72%	34%	37%	83.3	61.0	16.1	13.5	11.2	15%	17%	18%	0.1%	0.1%	0.2%	
Ingenic	300223.SZ	NC	NA	CNY	125.6	NA	NA	8,091	7,982	340	110	168%	0%	29%	161.1	124.4	19.1	17.0	15.0	7%	11%	12%	NA	NA	NA	
Jingjia Micro	300474.SZ	NC	NA	CNY	84.4	NA	NA	3,631	3,460	118	50	67%	39%	48%	62.8	42.5	9.8	8.7	7.2	11%	14%	16%	NA	NA	NA	
Alwinners	300458.SZ	NC	NA	CNY	45.8	NA	NA	2,165	1,953	96	55	68%	18%	19%	56.2	47.2	NA	NA	NA	NA	NA	NA	0.9%	1.0%	1.3%	
Belling	600171.SS	NC	NA	CNY	20.8	NA	NA	2,095	1,880	39	73	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
Fulian	300613.SZ	NC	NA	CNY	127.9	NA	NA	1,462	1,372	149	26	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
SinoWealth	300327.SZ	NC	NA	CNY	35.4	NA	NA	1,414	1,389	77	36	19%	31%	1%	33.5	33.1	9.0	7.8	6.2	20%	22%	19%	1.3%	1.7%	NA	
Natanz	300077.SZ	NC	NA	CNY	8.3	NA	NA	660	676	12	27	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
Global																										
Rambus	RMBS	NC	NA	USD	14.8	NA	NA	1,680	1,438	22	10	NM	5%	10%	14.1	12.8	1.9	2.1	2.1	-5%	-3%	-2%	0.0%	0.0%	0.0%	
Nvidia	NVDA	Buy	Toshiya Hari	USD	419.2	404	-4%	257,790	249,014	163	2,829	-23%	44%	37%	65.8	48.1	21.7	18.4	15.4	25%	30%	35%	0.3%	0.2%	0.2%	
MediaTek	2454.TW	Buy*	Bruce Lu	TWD	616.0	815	32%	33,121	28,458	97	139	26%	74%	13%	18.9	16.7	2.9	2.7	2.5	9%	15%	15%	2.1%	3.6%	4.0%	
Xilinx	XLNX	Buy*	Toshiya Hari	USD	96.1	113	14%	24,110	23,150	(14)	312	-3%	-12%	27%	33.5	26.4	11.8	12.2	11.9	33%	33%	42%	1.5%	1.5%	1.6%	
Realtek	2379.TW	Sell	Bruce Lu	TWD	359.5	256	-29%	6,213	5,373	70	35	14%	12%	11%	21.1	18.9	6.2	5.8	5.3	27%	28%	29%	3.5%	3.9%	4.4%	
Novatek	3034.TW	Buy	Bruce Lu	TWD	285.5	310	9%	5,879	5,250	71	48	13%	7%	8%	18.1	16.7	4.9	4.6	4.3	26%	26%	27%	4.2%	4.4%	4.8%	
Silergy	6415.TW	Neutral	Bruce Lu	TWD	1,870.0	1,865	0%	5,789	5,623	207	27	28%	23%	56%	45.8	29.3	9.9	8.5	6.6	19%	20%	25%	0.6%	0.7%	1.1%	
Parade	4966.TWO	Neutral	Bruce Lu	TWD	1,060.0	1,035	-2%	2,870	2,587	104	21	20%	20%	13%	23.4	20.8	6.4	5.6	4.9	24%	24%	24%	1.7%	2.1%	2.3%	
Average excl. outliers																										
Average											156	227	30%	35%	31%	56.6	41.7	14.3	12.4	10.1	19%	23%	26%	1.1%	1.3%	1.5%
Median											107	223	22%	31%	20%	50.2	42.5	14.0	12.3	10.5	20%	25%	26%	0.5%	0.6%	0.8%

Price as of July 10, 2020. NC = not covered, NC estimates from Bloomberg; *denotes on Conviction List

Source: Bloomberg, Goldman Sachs Global Investment Research, Gao Hua Securities Research

DCF cross-check: Implied valuation of Rmb166, similar to our discounted P/E TP

We use DCF as our valuation crosscheck, which suggests a theoretical share value of Rmb166, implying 70x 2022E P/E — slightly higher than our target price implied 2022E

P/E of 68x. We model Montage's free cash flow to grow at a 47% CAGR in 2020E-25E, which then declines to 17% in 2026E-31E, with a terminal growth rate of 3%. We believe the company's free cash flow in 2020E-25E would be driven by: 1) increasing operating cash flow driven by revenue growth in memory interface ICs given DRAM server content growth and DDR5 adoption; 2) improving cash conversion days given its larger scale and improving AR/inventory management. We model WACC at 9.0%, with COE at 9.0%, derived from a beta of 1.0, a risk-free rate of 3.0%, and a market risk premium of 6.0%.

Exhibit 489: Montage DCF valuation: Rmb166, implied 70x 2022E P/E

Rmb mn	2018	2019	2020E	2021E	2022E	2023E	2024E	2025E	2026E	2027E	2028E	2029E	2030E
P&L													
Revenue	1,758	1,738	2,252	3,148	4,644	6,673	9,289	12,852					
YoY	43%	-1%	30%	40%	47%	44%	39%	38%					
GM	70.5%	74.0%	73.9%	73.6%	72.7%	70.7%	69.3%	67.6%					
Opex ratio	29.4%	25.1%	24.5%	20.4%	16.4%	13.4%	11.3%	9.4%					
Opex YoY	66%	-16%	26%	17%	18%	18%	17%	16%					
OP income	722	849	1,114	1,675	2,612	3,824	5,397	7,471					
YoY	110%	17%	31%	50%	56%	46%	41%	38%					
Pretax income	786	979	1,309	1,867	2,811	4,028	5,614	7,729					
Net income	737	933	1,243	1,773	2,671	3,827	5,333	7,342					
YoY		27%	33%	43%	51%	43%	39%	38%					
Cash flow													
CCC	63	84	83	81	80	78	77	75					
Capex	18	22	17	21	24	26	29	32					
Capex to revenues	1%	1%	1%	1%	1%	0%	0%	0%					
Free cash flow	951	847	1,022	1,761	2,263	3,658	4,756	6,915	8,644	10,372	11,928	13,717	15,089
YoY		-11%	21%	72%	29%	62%	30%	45%	25%	20%	15%	15%	10%
Terminal growth													3%
Terminal value													259,031
Discount factor						0.9	0.8	0.8	0.7	0.6	0.6	0.5	0.5
Present value of FCF						3,356	4,003	5,340	6,123	6,741	7,112	7,504	7,573
Enterprise value 2022E (Rmb m)					177,751								
Cash and equivalents					10,236								
Debt					-								
Equity value in 2022E (Rmb m)					187,987								
Value per share (Rmb)					166								
Implied 2022E P/E					70x								
WACC assumption (2022E)													
Risk free rate	3.0%												
Beta	1.0												
Market risk premium	6.0%												
Cost of equity	9.0%												
Cost of debt	0.0%												
Tax rate	5%												
Debt / (debt+equity)	0%												
Equity / (debt+equity)	100%												
WACC	9.0%												

Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Downside risks

Key downside risks to our investment thesis are:

- 1) Weaker-than-expected memory interface IC market growth:** We forecast the memory interface IC market to grow at a 29% CAGR in 2020-25E, driven by DRAM content growth in servers. If the demand for servers or DRAM content growth in servers is weaker than our expectation, memory interface IC market growth could be weaker than our current forecasts.
- 2) Slower-than-expected DDR5 adoption:** We model Montage to start shipments of DDR5 interface ICs in 2021E with 20%/53% revenue contribution in 2021/22E. As the progress of DDR5 also depends on the schedule of DRAM makers' mass production of DDR 5 DRAM and new server CPU platforms to support DDR5, the timing of Montage's DDR5 interface IC shipments could be different from our expectation.
- 3) Intensifying competition:** The memory interface IC market is concentrated with only three suppliers in the DDR4 generation given the entry barriers of accumulated technologies (of previous DDR generations) and a strict qualification process. However, competition could be more intense than we expect if existing players target to gain more market share, or new entrants try to enter this market.
- 4) Potential impact from COVID-19:** Montage's revenue comes mainly from the Asia market (~90% of revenue) but its customers' end products are sold globally. We therefore believe Montage could be impacted by the macro economic slowdown globally in 2020.

Montage

688008.SS		12m Price Target: Rmb161		Price: Rmb117.2		Upside: 37.4%	
Buy		GS Forecast					
Market cap: Rmb132.4bn / \$18.9bn		Revenue (Rmb mn)	12/19	12/20E	12/21E	12/22E	
Enterprise value: Rmb124.6bn / \$17.8bn		EBITDA (Rmb mn)	878.7	1,139.6	1,694.6	2,632.0	
3m ADTV :Rmb393.5mn/ \$55.6mn		EPS (Rmb)	0.88	1.10	1.57	2.36	
China		P/E (X)	78.9	106.5	74.7	49.6	
Greater China Technology		P/B (X)	10.7	16.3	14.3	12.1	
		Dividend yield (%)	4.3	0.3	0.5	0.7	
M&A Rank: 3		Net debt/EBITDA (X)	(8.3)	(6.9)	(5.3)	(3.9)	
		CROCI (%)	12.5	14.7	18.9	24.8	
		FCF yield (%)	1.2	0.8	1.3	1.7	
			3/20	6/20E	9/20E	12/20E	
		EPS (Rmb)	0.23	0.22	0.40	0.25	

Source: Company data, Goldman Sachs Research estimates, FactSet. Price as of 10 Jul 2020 close.

NSIG (688126.SS): Pure play in growing local silicon wafer manufacturing, riding on 12" wafer ramp-up; initiate at Buy

Primary analysts:

Jin Guo, Allen Chang

Initiate at Buy with a 12-month TP of Rmb60: NSIG (National Silicon Industry Group) is the leading company among local peers in silicon wafer manufacturing and the first local supplier to start mass production of 12" wafers in 2018. China's silicon wafer supply is dominated by suppliers in Japan, South Korea, and Taiwan. With an increasing need from China's local semiconductor manufacturers to find local supply as a back-up against risks of losing access to imports, NSIG, as the largest pure-play silicon wafer producer locally, stands to be a key beneficiary of localization in silicon wafer manufacturing.

Our constructive view on NSIG is based on: 1) strong wafer fab capacity expansion, driving up demand from local customers; and 2) increasing order allocations from local customers to mitigate their supply chain risks amid trade tensions. We expect China's local wafer fab capacity to grow by c.8x during 2020-25E to 1.9mn wpm by 2025E driven by new memory and foundry projects and existing fabs' capacity expansion (e.g. SMIC, Hua Hong, etc.). NSIG's 12" wafers have received qualifications from 64 customers including YMTC, SMIC, Hua Hong, Huali, and Global Foundries, etc. With strong demand growth locally and an expanding customer base, we expect NSIG's wafer revenues to quintuple over 2020-25E. We expect 42% revenue CAGR in 2020-25E and 138% EPS CAGR in 2021-25E from a low base, driven by 12" wafer revenue expansion and margin improvements.

From a market share perspective, NSIG's 12" wafer shipments are only a fraction of China local fabs' demand. For context, SMIC's annual wafer purchase reached Rmb2bn in 2019, while NSIG's 12" wafer sales were Rmb215mn, or c.11% of SMIC's purchase. NSIG's sales to China customers (including all wafer sizes) were Rmb439mn in 2019, or 22% of SMIC's wafer demand. SMIC is only one of the several local customers and NSIG's shipments represent an even smaller portion when compared to the total wafer demand from all local customers. This suggests NSIG, as the leading local wafer producer, has a large potential to win order allocations from local customers as they seek local back-ups to reduce risks of losing critical raw materials.

Our 12m target price of Rmb60 is derived from a discounted PE valuation model to capture its long-term earnings growth, with an implied upside of 25% vs. 4% for our China Semi coverage. Risks include: 1) slower ramp-up in 12" wafers; 2) customer verification risks; and 3) delay in R&D of 12" silicon wafers for 20-14nm.

PM summary: Top five questions

1. What are the key products of NSIG? *12" polished/epitaxial wafers and 8" polished/epitaxial/SOI wafers*

NSIG is the leading silicon wafer producer in China and the first local supplier to start mass production of 12" wafers in 2018. The company's products include 12" polished/epitaxial wafers and 8" polished/epitaxial/SOI wafers. NSIG operates through three subsidiaries: Zing Semi (focus on 12" wafer), Okmetic (8" and below) and Shanghai Simgui (8" and below).

2. Who are the customers? *YMTC, SMIC, Hua Hong, and CR Micro, TSMC, Qorvo, GlobalFoundries, etc.*

Key customers of NSIG includes YMTC, SMIC, Hua Hong, and CR Micro in China and TSMC, Qorvo, and GlobalFoundries in the overseas market. NSIG's 8" wafer production has matured with utilization remaining close to the full level and a high quality customer base including leading semiconductor firms globally (e.g., ST Micro, Qorvo, Murata, etc.). NSIG's 12" wafer commercialization is still at an early stage with qualifications from 64 customers as of 2019 (vs. 655 customer qualifications in 8" or below products), according to the company. NSIG's current 12" products can cover 90nm-28nm process nodes with volume shipments to YMTC and SMIC, etc. The company is developing 12" products for 20-14nm chip manufacturing.

3. Why are we positive on NSIG? *Growing silicon wafer demand in China, local foundry diversifying supply chain*

We expect China's 12" wafer demand to grow by c.9x during 2020-25E, primarily driven by China's investments in building new fabs and expanding capacity across foundry, memory, and IDMs. With these new projects, China's 12" wafer fab capacity could reach 1.9mn wpm by 2025E, or 8.7x that in 2019. The strong demand growth, coupled with the trend to localize wafer production, brings significant growth opportunities for local suppliers. NSIG, as the leading local mass producer of 12" wafers, is well positioned to tap into the structural uptrend.

Currently, China's silicon wafer supply is dominated by suppliers in Japan, South Korea, and Taiwan. With an increasing need from China's local semiconductor manufacturers to find local supply as a back-up against risks of losing access to imports, NSIG, as the largest pure-play silicon wafer producer locally, stands to be a key beneficiary of localization in silicon wafer manufacturing.

4. How do we value NSIG? *80x 2025E EPS discounted to 2022E*

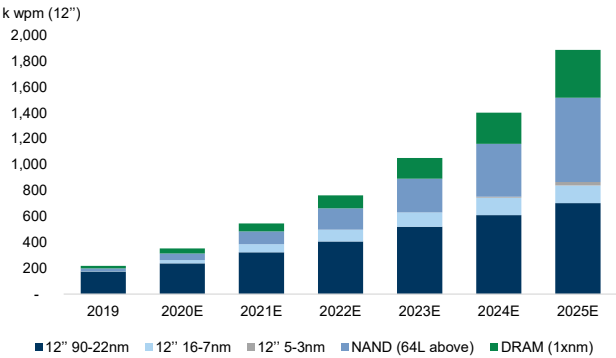
Our target price of Rmb60 is derived from a discounted PE valuation model to capture the company's long-term earnings growth. We apply 80x to our 2025E EPS estimates and discount back to 2022E at 9% p.a. (cost of equity, based on beta of 1, 3% risk-free rate and 6% market risk premium). Our target multiple of 80x is based on a global peer PE and their EPS growth correlation. The peer group represents major global wafer producers including Globalwafers, SUMCO, Soitec, Shin Estu, and Zhonghuan Semi and Wafer Works.

5. What are the risks? *Lower than expected 12" utilization, customer verification risks and delay in R&D*

Risks to our investment thesis include 1) Slower ramp-up in 12" utilization, which could be caused by lower-than-expected wafer demand or slower-than-expected yield rate ramp up; 2) Customer verification: Qualification of silicon wafers takes 12-18 months and NSIG has 64 12" wafer customers and 104 8" wafer customers under qualification as of 2019; 3) Delay in R&D of 12" silicon wafers for 20-14nm, which could drag the growth of 12" wafer revenues

Exhibit 490: China’s 12” wafer fab capacity to grow by c.8x during 2020-25E to 1.9mn wpm in 2025E

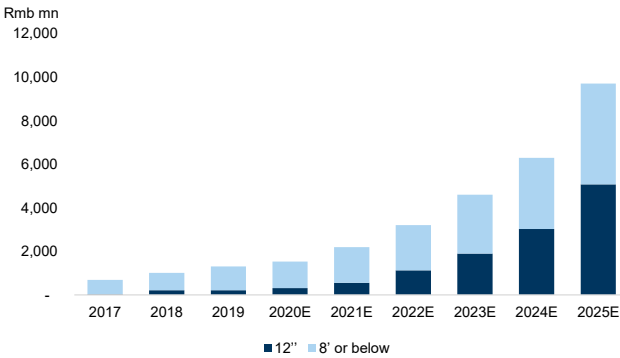
China’s local 12” fab capacity by technologies



Source: Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 491: We expect NSIG’s wafer revenue to quintuple during 2020-25E

12” wafer sales growth will be the key driver of revenue growth in 2020-25E



Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

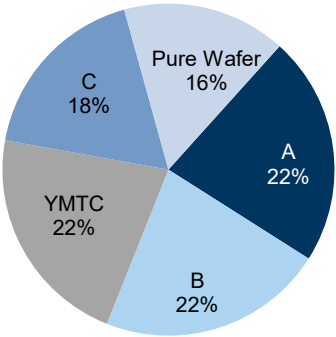
Product qualifications on-going: NSIG produces 8” (or below) and 12” wafer products. NSIG’s 8” wafer production has matured with utilization remains at close to the full level and a high quality customer base including leading semiconductor firms globally (e.g. ST Micro, Qorvo, Murata, etc.). NSIG is a new comer in 12” wafer production and has started mass production of 12” wafers in 2018. Its 12” wafer commercialization is still at an early stage with qualifications from 64 customers as of 2019 (vs. 655 customer qualifications in 8” or below products), according to the company. NSIG’s current 12” products can cover 90nm-28nm process node with volume shipments to YMTC and SMIC, etc. The company is developing 12” products for 20-14nm chip manufacturing.

Exhibit 492: Major products of NSIG

Size	Type of wafers	Applications	End products
8” or below	Polished, epitaxy, SOI	RF front-end, sensors, analog, discret, power semi	Smartphone, portable media device, automobile, IoT, industrial
12”	Polished, epitaxy	Memory, GPU, CPU, power semi	Smartphone, PC, cloud infrastructure

Source: Company data

Exhibit 493: NSIG revenue contribution by customer (2018)

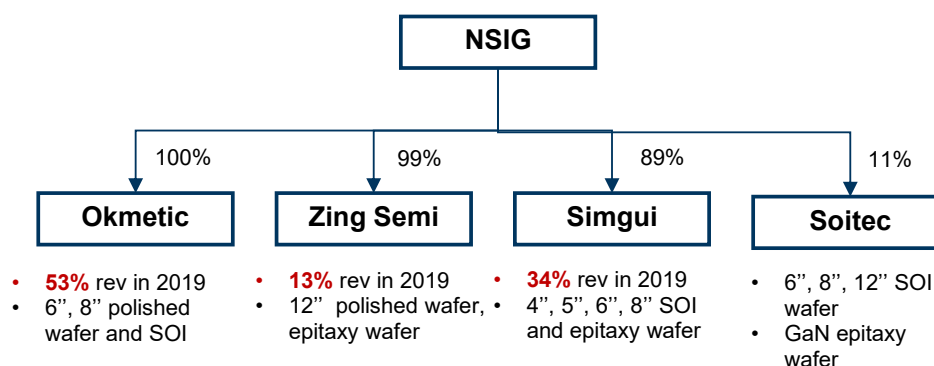


8”	12”
Soitec	Global Foundry
Qorvo	SMIC
Murata	Hua Hong
Vishay	YMTC
ST Micro	CR Micro

Source: Company data

Exhibit 494: NSIG operates its business via its subsidiaries

NSIG group's shareholding in its subsidiaries and their product offerings



Source: Company data

NSIG is a new comer in 12" wafer production and its products are required to pass qualifications at its direct customers (e.g. SMIC, YMTC, etc.) and eventual customers (e.g. SMIC's customers). The process could take 12-18 months and for some critical applications (e.g. medical, automotive), the process can take as long as 5 years.

Exhibit 495: Silicon wafer verification takes 12-18 months

Customer verification steps



Source: Company data

Exhibit 496: NSIG's 12" products are in the customer qualification process, which can take 1-5 years depending on the end application

End application	Typical qualification period
Typical applications (polished wafer and epitaxial wafer)	9-18 months
SOI wafers	1-2 years
Automobile electronics; Healthcare/medical; Aerospace/Aviation	3-5 years

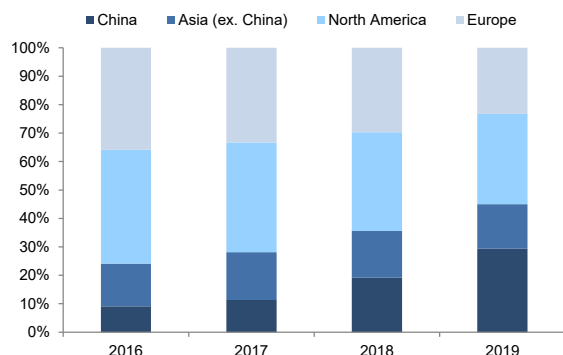
Source: Company data

Exhibit 497: Secured 64 customers for 12" wafers as of 2019

Customer type	Wafer size	2016	2017	2018	2019
Verification completed	8"	320	364	403	551
	12"	-	20	36	49
Existing customers, new products	8"	60	77	74	92
	12"	-	5	10	11
New customers	8"	13	15	14	12
	12"	-	1	4	4
Total	8"	393	456	491	655
	12"	-	26	50	64

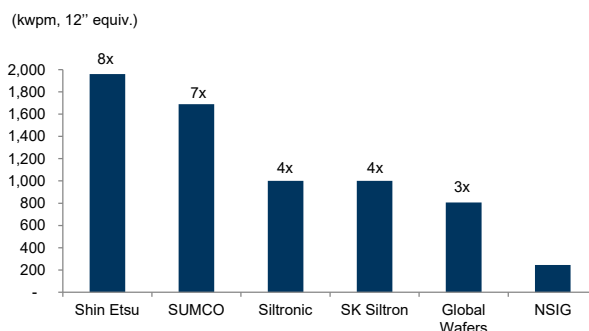
Source: Company data

Exhibit 498: Revenues from customers in China have been increasing driven by expansion of local customers and ramp-up of 12" wafer production
NSIG revenue by region



Source: Company data

Exhibit 499: NSIG's wafer production capacity is 1/8 of the global leader as of 2019; With China's rising wafer demand, we believe NSIG has ample room for expansion
Leading players' capacity vs. NSIG, 2019



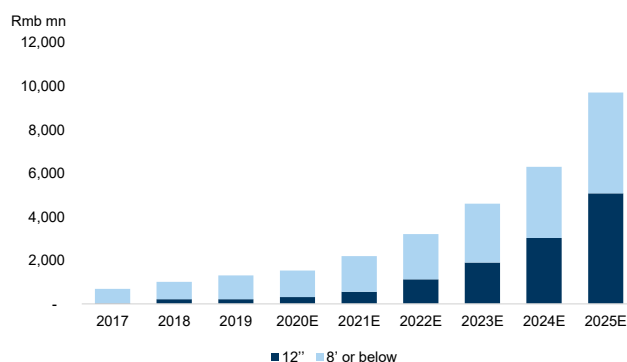
Source: Company data

Financial analysis

Income Statement

Revenues: we expect NSIG's revenues to grow by 15%/38%/43% in 2020/21/22E and 42% CAGR in 2020-25E driven by growth in 12" wafer shipments. 12" wafer revenues made up c.21%/14% of total sales in 2018/19, and we expect it to represent 19%/51% in 2020/25E supported by the increase in China local fabs' 12" wafer demand and NSIG's customer expansion locally. We expect 8" (or below) wafer revenues to grow by 30% CAGR during 2020-25E driven by SOI sales in RF applications and expansion in local 8" customers.

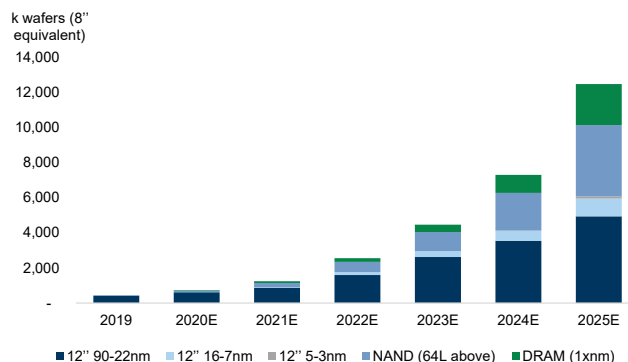
Exhibit 500: We expect revenues to grow by 42% CAGR during 2020-25E driven by 12" wafer ramp-up and robust growth in 8" products



Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 501: Shipments to local memory fabs to be the key driver of future growth

Forecasts on NSIG's 12" wafer shipment (in 8" equivalent) in local markets



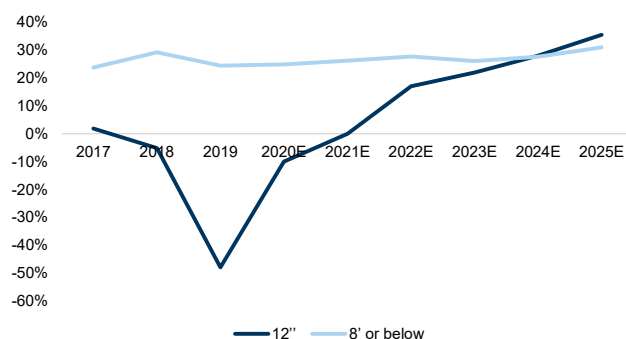
Source: Goldman Sachs Global Investment Research, Gao Hua Securities Research

Margin analysis: we expect an improving margin profile driven by ramp-up in 12" wafer utilization; NSIG's 12" wafer capacity utilization was c.40% in 2019 due to new capacity additions in 2019 but production and shipments remained flat vs. 2018. As a result, 12" wafer gross margin was negative in 2018-19. We expect utilization to increase

in 2020E and onward driven by better shipment trends, leading to an improvement in gross margin. For 8" (or below) products, given the products are matured, we expect margins to remain stable.

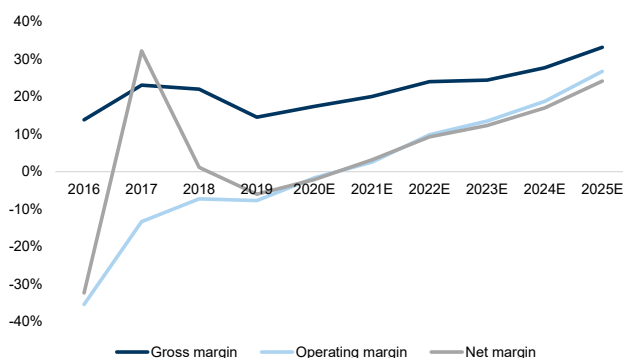
Exhibit 502: We expect 12" wafer gross margin to improve as utilization ramps up and 8" margin to remain stable

Gross margin trends by product



Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 503: We expect an improving margin profile mainly driven by ramp-up in 12" wafer

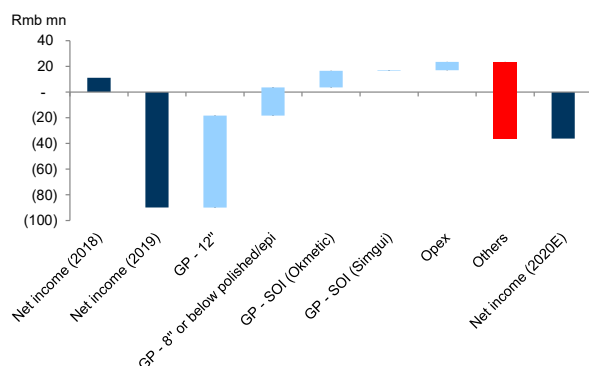


Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Earnings analysis: we expect NSIG to remain in net loss (Rmb36mn) for 2020E (vs. loss of Rmb90mn in 2019) and turn profitable in 2021E. We expect net profit to grow by 319%/88% in 2022/23E and 138% CAGR in 2021-25E on a low base. The earnings growth is mainly driven by 12" wafer revenue expansion and margin improvements.

Exhibit 504: We expect NSIG net loss to narrow in 2020E

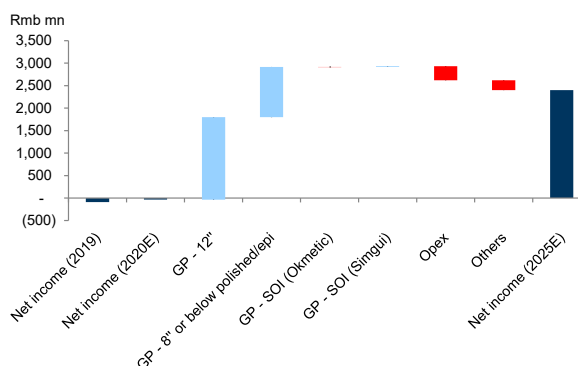
Net profit waterfall chart 2019-20E



Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 505: 12" to be the main contributor to profit during 2020-25E

Net profit waterfall chart 2020-25E



Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Balance sheet

NSIG turned into a net cash position after receiving cash proceeds from its IPO in April. We estimate the company has a debt-to-equity ratio of 0.24 in 2020E. NSIG's ROE was -2.1% in 2019 due to the reported net loss, but as the company's profitability improves, we expect ROE to turn positive in 2021E and improve to c.22% by 2025E.

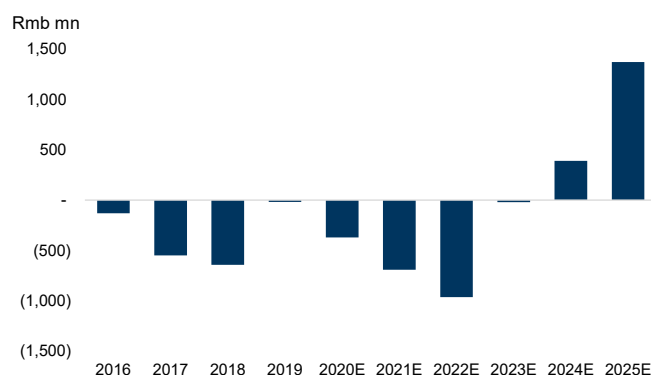
Exhibit 506: We expect ROE to gradually improve driven by better profitability and asset turnovers

Dupont analysis	2016	2017	2018	2019	2020E	2021E	2022E	2023E	2024E	2025E	2026E
Asset turnover	0.1	0.1	0.2	0.2	0.2	0.2	0.3	0.4	0.5	0.6	0.6
Leverage (assets/equity)	1.9	1.7	1.8	2.0	1.8	1.7	1.7	1.6	1.6	1.5	1.4
Net margin	-32.4%	32.2%	1.1%	-6.0%	-2.1%	3.2%	9.3%	12.3%	17.0%	24.2%	26.6%
ROE (common equity)	-7.4%	7.6%	0.3%	-2.1%	-0.6%	1.0%	4.1%	7.3%	12.3%	22.4%	23.3%
ROA	-4.0%	4.4%	0.2%	-1.1%	-0.3%	0.6%	2.5%	4.4%	7.7%	14.6%	16.3%

Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Cash flow

NSIG's cash flow from operations have consistently remained in the positive territory despite the net loss in 2019; we expect the company continues to deliver positive operating cash flows as profits improve. However, NSIG's free cash flow has been in a deficit given capex needed to build new capacity to support production demand. Going forward, we expect fixed assets capex will remain at a high level given its new capacity expansion plan (double current 12" wafer capacity to 300k wpm by end-2021, per NSIG) with an investment budget of Rmb2.1bn. We expect free cash flow to be negative during 2020-23E before turning positive in 2024E.

Exhibit 507: Free cash flow to remain negative given capex for new capacity construction

Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

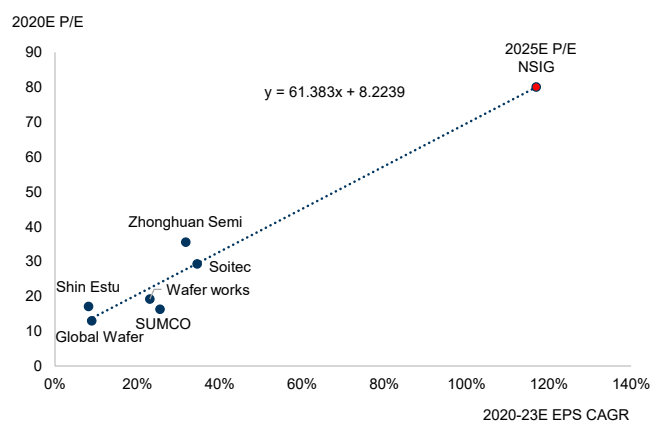
Valuation and risks

Our target price of Rmb60 is derived from a discounted PE valuation model to capture the long-term earnings growth. We apply 80x on 2025E EPS and discount back to 2022E at 9% p.a. (cost of equity, based on beta of 1, 3% risk-free rate and 6% market risk premium). Our target multiple of 80x is based on a global peer PE and their EPS growth correlation. The peer group represents major global wafer producers including Globalwafers, SUMCO, Soitec, Shin Estu, and Zhonghuan Semi and Wafer Works.

Exhibit 508: We use 80x on 2025E EPS and discount back to 2022E at 9% p.a. to get our 12-month TP of Rmb36.4

Rmb mn	2018	2019	2020E	2021E	2022E	2023E	2024E	2025E	2026E
Revenue	1,010	1,493	1,710	2,367	3,386	4,794	6,494	9,921	11,848
12"	215	215	317	551	1,130	1,895	3,026	5,075	6,425
8"	794	1,250	1,381	1,816	2,255	2,898	3,469	4,846	5,423
Others	2	27	13	-	-	-	-	-	-
Revenue YoY		48%	15%	38%	43%	42%	35%	53%	19%
GM	22.0%	14.5%	17.4%	20.0%	24.0%	24.4%	27.7%	33.2%	35.3%
OPEX	296	332	326	415	479	522	582	637	696
Opex ratio	29.2%	22.2%	19.0%	17.5%	14.1%	10.9%	9.0%	6.4%	5.9%
OP	(73)	(115)	(28)	59	334	648	1,218	2,655	3,483
Government subsidy	166	162	160	160	160	160	160	160	160
Other non-op	(57)	(120)	(165)	(146)	(151)	(158)	(158)	(156)	(146)
Pre-tax profit	35	(73)	(33)	73	342	650	1,220	2,659	3,497
Tax expense	(26)	(28)	(9)	(4)	(34)	(65)	(122)	(266)	(350)
Tax rate	73%	38%	26%	5%	10%	10%	10%	10%	10%
Minority	2	11	6	6	6	6	6	6	6
Net profit	11	(90)	(36)	75	314	590	1,104	2,399	3,153
EPS (Rmb)	0.01	-0.05	-0.02	0.03	0.13	0.24	0.44	0.97	1.27
YoY Growth					319%	88%	87%	117%	31%
Target multiple x EPS								77	
Discounted back to 2022								60	
2025E P/E	80x								
Discount rate (COE)	9.0%								
Discount factor (back to 2022E)	0.77								
Target price	60.0								
COE assumption									
Beta	1.0								
Risk free	3.0%								
Market risk premium	6.0%								
COE	9.0%								

Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 509: Our 2025E target P/E multiple is based on a peer group's P/E and EPS growth correlation; With 2025E earnings growth of 117%, we derive the target multiple of 80x

Source: Goldman Sachs Global Investment Research, Gao Hua Securities Research

Key risks:**1) Slower ramp-up in 12" wafers**

The key thesis for our positive view on NSIG lies in the strong growth potential in 12" wafer sales. However, 12" wafer production is an area with high technology and manufacturing requirements and if NSIG fails to achieve the desired yield level or the quality required by its customers, it could lead to significantly lower shipments than we currently expect. We estimate every 10% drop in our 12" wafer shipment assumption could lead to 8-10% earnings downside.

2) Customer verification risks

Given the importance of silicon wafers in IC fabrication, foundry customers have high requirements on the quality of wafers and suppliers. Qualification of silicon wafers takes 12-18 months and NSIG has 64 12" wafer customers and 104 8" wafer customers under qualification as of 2019. Any failure in customer verification could bring negative impact on revenue growth and utilization rates.

3) Delay in R&D of 12" silicon wafers for 20-14nm

NSIG is developing 12" silicon wafers suitable for advanced technology (20-14nm), which is currently the product of Zing Semi could only be used in the process node of 40-28nm. NSIG plans to invest Rmb1.5bn on 20-14nm 12" silicon wafer projects, with a target capacity of 50kwpm. If development is slower than expected, additional investment is required to support the project and mass production time will be delayed, leading to slower growth of 12" revenues.

Exhibit 510: NSIG quarterly P&L

(Rmb m)	1Q20	2Q20E	3Q20E	4Q20E	2016	2017	2018	2019	2020E	2021E	2022E
Revenue	419	425	432	434	270	694	1,010	1,493	1,710	2,367	3,386
Gross profit	60	79	80	79	37	160	222	217	298	474	812
Operating expense	(93)	(78)	(74)	(81)	(133)	(253)	(296)	(332)	(326)	(415)	(479)
Operating income	(33)	2	6	(2)	(96)	(93)	(73)	(115)	(28)	59	334
Pre tax profit	(47)	1	6	7	(91)	226	35	(73)	(33)	73	342
Net income	(54)	3	7	8	(87)	224	11	(90)	(36)	75	314
EPS (Rmb)	(0.02)	0.00	0.00	0.00	(0.05)	0.12	0.01	(0.05)	(0.02)	0.03	0.13
Margins / ratio											
Gross margin	14.2%	18.7%	18.5%	18.1%	13.8%	23.1%	22.0%	14.5%	17.4%	20.0%	24.0%
Opex ratio	-22.2%	-18.3%	-17.1%	-18.7%	-49.3%	-36.4%	-29.2%	-22.2%	-19.0%	-17.5%	-14.1%
Operating margin	-7.9%	0.4%	1.4%	-0.5%	-35.5%	-13.4%	-7.3%	-7.7%	-1.6%	2.5%	9.9%
Net margin	-12.8%	0.6%	1.6%	1.9%	-32.4%	32.2%	1.1%	-6.0%	-2.1%	3.2%	9.3%
QoQ											
Revenue	-1%	2%	2%	0%							
Gross profit	14%	33%	1%	-2%							
Operating income	nm	nm	278%	nm							
Pre tax profit	nm	nm	341%	27%							
Net income	nm	nm	159%	21%							
EPS	nm	nm	159%	21%							
YoY											
Revenue				3%		157%	46%	48%	15%	38%	43%
Gross profit				50%		329%	39%	-2%	37%	59%	71%
Operating income				nm		nm	nm	nm	nm	nm	463%
Pre tax profit				nm		nm	-84%	nm	nm	nm	370%
Net income				nm		nm	-95%	nm	nm	nm	319%
EPS				nm		nm	-95%	nm	nm	nm	319%

Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

NSIG

688126.SS	12m Price Target: Rmb60	Price: Rmb48.14	Upside: 24.6%		
Buy	GS Forecast				
Market cap: Rmb89.5bn / \$12.8bn	Revenue (Rmb mn)	12/19	12/20E	12/21E	12/22E
Enterprise value: Rmb88.7bn / \$12.7bn	EBITDA (Rmb mn)	1,492.5	1,710.4	2,366.6	3,385.6
3m ADTV: NA	EPS (Rmb)	200.1	323.9	467.0	811.7
China	P/E (X)	(0.05)	(0.02)	0.03	0.13
Greater China Technology	P/B (X)	NM	NM	NM	NM
	Dividend yield (%)	NM	16.0	15.9	15.2
M&A Rank: 3	Net debt/EBITDA (X)	NA	0.0	0.0	0.0
	CROCI (%)	5.3	(3.0)	(0.6)	0.8
	FCF yield (%)	33.8	9.3	10.1	13.3
		NA	(0.4)	(0.6)	(0.8)
		3/20	6/20E	9/20E	12/20E
	EPS (Rmb)	(0.02)	0.00	0.00	0.00

Source: Company data, Goldman Sachs Research estimates, FactSet. Price as of 10 Jul 2020 close.

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NAURA (002371.SZ): Recalibrating valuation and earnings estimates; TP up to Rmb307; maintain Buy

Primary analysts: Jin Guo,
Allen Chang

We update our earnings estimates for NAURA based on our updated China SPE demand forecasts. We revise up our net income estimates by 5.1%/1.8%/1.4%/0%/2.8%/1.3% for 2021-26E.

To align with the valuation framework of the companies being initiated on with this report, we have also recalibrated the target multiple (2025E P/E) for NAURA and raised it from 17x to 19x 2025E PE. Previously, the 17x was based on the simple average peer PE, and we change it to 19x based on peer PE and EPS growth correlation, the valuation method used across our China SPE coverage.

Our 12-month target price of Rmb307 is derived from a discounted PE model (unchanged) where we apply 19x to our 2025E EPS estimate and discount back to 2022E (vs previously to 2020E).

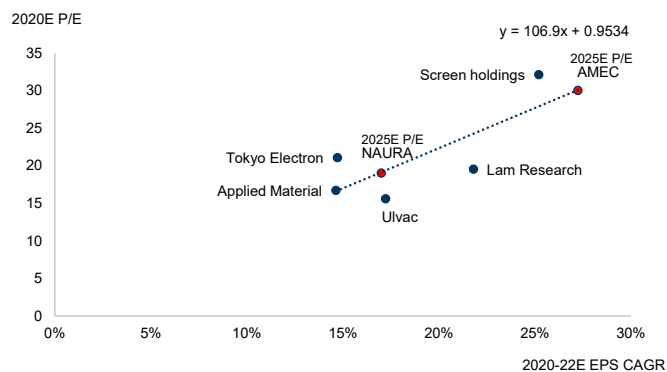
We maintain our Buy rating on NAURA as the company is the leading local supplier in multiple equipment segments including thermal process, deposition, and silicon etching. Similar to other category leaders, NAURA looks well-positioned for growing local demand and a rising share allocation in local customers' SPE purchases.

Key risks: China semiconductor firms potentially losing access to US semiconductor equipment on the back of trade tensions. While we do not take a view on potential trade disputes, any adverse moves here could significantly hinder China's wafer fab construction progress, and hence reduce the demand for NAURA's equipment as well. Other risks include: (1) Slower-than-expected progress at NAURA's customers (i.e., SMIC, Hua Hong, Huali Microelectronics, YMTC), which could lead to slower revenue growth than we expect and therefore lower earnings than our current estimates; (2) competition could become tougher than we anticipate, which could lead to market share losses and margin pressure; and (3) slower progress in technology development at NAURA than we currently expect.

Exhibit 511: Earnings revisions for NAURA based on updated SPE demand model

Rmb mn	2020E	2021E	2022E	2023E	2024E	2025E	2026E
Old							
Revenue	5,193	7,936	12,267	18,917	29,644	44,540	40,195
OP	613	1,241	2,537	4,547	7,919	12,707	10,374
Net income	506	1,001	2,028	3,656	6,387	10,266	8,376
GPM	41%	42%	43%	43%	44%	44%	44%
OPM	12%	16%	21%	24%	27%	29%	26%
NM	10%	13%	17%	19%	22%	23%	21%
New							
Revenue	5,193	8,092	12,379	18,986	29,639	45,124	40,872
OP	613	1,304	2,583	4,608	7,916	13,060	10,815
Net income	506	1,052	2,065	3,706	6,385	10,552	8,733
GPM	41%	42%	43%	43%	44%	44%	44%
OPM	12%	16%	21%	24%	27%	29%	26%
NM	10%	13%	17%	20%	22%	23%	21%
New vs. Old							
Revenue	0.0%	2.0%	0.9%	0.4%	0.0%	1.3%	1.7%
OP	0.0%	5.0%	1.8%	1.3%	0.0%	2.8%	4.2%
Net income	0.0%	5.1%	1.8%	1.4%	0.0%	2.8%	4.3%
GPM	0ppts	0ppts	0ppts	0ppts	-0.1ppts	0ppts	0ppts
OPM	0ppts	0.5ppts	0.2ppts	0.2ppts	0ppts	0.4ppts	0.6ppts
NM	0ppts	0.4ppts	0.2ppts	0.2ppts	0ppts	0.3ppts	0.5ppts

Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 512: NAURA's new target multiple of 19x 2025E P/E is based on peer PE and EPS growth correlation, in line with our valuation framework for the SPE initiations in this report

Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Sanan (600703.SS): Early mover gets the growth; initiate Buy

Primary analysts:

Allen Chang, Jin Guo

Initiate at Buy with a 12-month TP of Rmb40: Sanan is expanding beyond the LED business into the RF PA (radio frequency power amplifier) and compound semi foundry areas. PAs are key semiconductor devices in smartphones and base stations that convert a low-power RF signal into a higher power signal, and will see increasing demand with the migration to 5G smartphones and base stations. Sanan had 3%/9% market share in the global/China RF PA foundry market in 2019.

We are positive on Sanan's expansion into RF PA/compound semi foundry businesses (from LED), and model a 40% earnings CAGR in 2020-23E from:

- **RF PA driven by 5G content growth:** As an early mover in GaAs and GaN technologies for RF PAs in China, we expect RF PA to be a key growth driver for Sanan given: 1) 5G will drive PA content growth in smartphones/base stations, and 2) there is significant market share upside for Sanan (off a low base) as domestic customers are actively seeking to diversify their supply chains. We model a 50% revenue CAGR in 2020-23E for RF PA and expect it to account for 13% of overall revenues by 2023E (vs 8% in 2020E).
- **Mini-LEDs and Micro-LEDs:** Sanan's Mini-LED and Micro-LED products were both in small volume shipments in 2019, and we expect Mini-LED revenue to pick up first this year for high-end TV backlight applications, followed by Mini-LED display for NB/PC monitors in 2021, and Micro-LED display for automotive, wearables, display walls in 2022-25. We expect revenues from Mini-LED and Micro-LED to grow at a 92% CAGR in 2020-23E, contributing 24% of revenues by 2023E (vs. 7% in 2020E).

41% upside to our 12MTP Rmb40; initiate Buy: Our 12-month target price of Rmb40 is derived from applying a 29x target P/E multiple to Sanan's 2025E EPS and discounting back at a COE of 9%; we use discounted P/E to value Sanan as the company is still in the early stages of its technology roadmap and capacity build compared to global leaders. Our target price implies a 55x 2022E P/E, which we believe is justified by its strong earnings growth of +40% CAGR in 2020-23E. We cross-check this with DCF which derives a similar value of Rmb40.9, or 56x 2022E P/E.

Risks: 1) weaker-than-expected PA market growth; 2) slower-than-expected new order win and market share gains; 3) slower-than-expected development progress in new technology (compound semis, mini/micro-LEDs); 4) more severe competition in the LED market; and 5) potential impact from COVID-19.

PM summary: Top Five Questions

1. Why are positive on the PA market?

We forecast the overall RF PA market to grow at an 18% CAGR in 2019-22E, mainly driven by base stations (25% of the PA market in 2020E; 45% CAGR in 2019-22E) and smartphones (59% of the PA market in 2020E; 16% CAGR in 2020-23E). RF PA is a semiconductor device that can convert a low-power RF signal into a higher power signal, and is widely adopted in wireless communication networks such as base stations, smartphones and WiFi routers.

2. What are Sanan's near-term and long-term drivers?

We forecast a 2020-23E net income CAGR of +40% with a revenue CAGR of +29% and operating income CAGR of +49%. Revenue growth will mainly be driven by RF PAs and mini/micro-LEDs, where we forecast 2020-23E CAGRs of 50% and 92%, respectively. RF PA revenues will be driven by growth in 5G content and capturing orders from domestic customers actively seeking to diversify their supply chains. Mini/micro-LED revenue growth is driven by growing adoption of mini/micro-LEDs in displays for NBs/PCs, automotives, wearables, and display walls.

3. What is Sanan's technology gap vs. global leaders?

The PA market is dominated by IDMs with foundries only accounting for 39% of the market in 2019. In the GaAs foundry market, Win Semi is the largest global player with a 76% market share, followed by Advanced Wireless Semiconductor Company (AWSC) at 8%, and Global Communication Semiconductor (GCS) at 6%. Sanan only started PA foundry mass production in 2018 and we estimate it had a 3% market share in global PA foundry in 2019.

In terms of manufacturing technology, Sanan's RF portfolio includes GaAs HBT, InGaP HBT, GaAs-pHEMT, E/D pHEMT, GaAs Bi-HEMT, and GaAs-IPD. While not as comprehensive as Win Semi and Qorvo, it is more similar to AWSC. For pHEMT, Sanan covers 0.15um-0.5um processes, while Win Semi covers 0.1um-0.5um processes.

4. How do we value the stock?

Our 12-month target price of Rmb40 (which implies a 55x 2022E P/E) is based on a discounted P/E, as we believe Sanan's compound semi business is still at the early stages of its technology roadmap and capacity build compared to global leaders. In our view, discounted P/E captures Sana's long-term business opportunity which justifies its current higher-than-peer P/E multiple. We apply a 29x target P/E multiple to Sanan's 2025E EPS and discount it back at a COE of 9% (1.0 Beta, 3% risk-free rate, and 6% market risk premium). The 29x target P/E multiple is derived from the sector P/E-EPS YoY correlation; our regression analysis shows that the market has generally rewarded higher EPS growth companies in the semiconductor industry.

Our target price implies 55x 2022E P/E, or a PEG of 1.5x based on average 2023-24E EPS YoY growth (37%). Our valuation cross-check (DCF) derives a similar value of Rmb40.9, or 56x 2022E P/E. The stock currently trades at 39x our 2022E EPS and at

GaAs HBT: Gallium arsenide heterojunction bipolar transistor, InGaP HBT: Indium phosphide heterojunction bipolar transistor, GaAs-pHEMT: Gallium arsenide pseudomorphic high electron mobility transistor, E/D pHEMT: E/D mode high electron mobility transistor, GaAs-IPD: Gallium arsenide integrated passive device

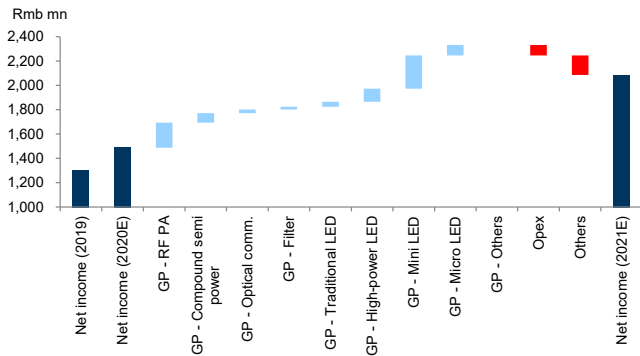
1.0x our PEG based on average 2023-24E EPS YoY growth, which we believe is attractive given its strong earnings growth (+40% CAGR in 2020-23E).

5. What are the potential downside risks from COVID-19?

The lion's share of Sanan's revenue comes from the domestic market (~85% of revenue) but its customers' end products are sold globally, thus Sanan could be impacted by the global macro slowdown in 2020. Sanan's revenue declined 3% YoY in 1Q20 (vs +8% YoY in 4Q19) due to COVID-19.

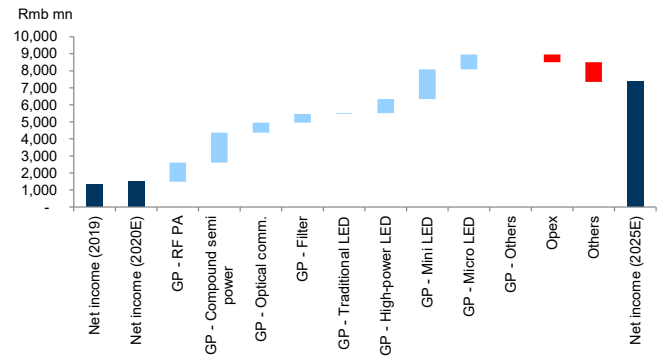
PM summary: Top Six Charts

Exhibit 513: RF PA and mini LED are key profit drivers in 2020-21
Net profit waterfall chart (2020-21E)



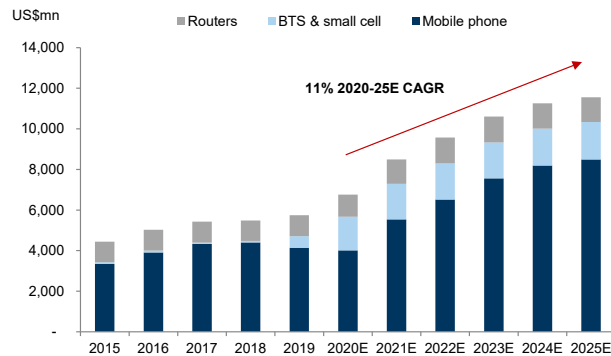
Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 514: RF PA, compound semi, and Mini/Micro LED will be major profit contributors
Net profit waterfall chart (2020-25E)



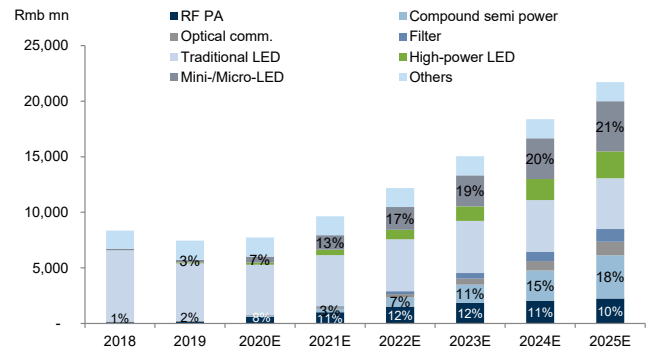
Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 515: Global PA market to grow at an 11% CAGR in 2020-25E driven by 5G smartphones and base stations



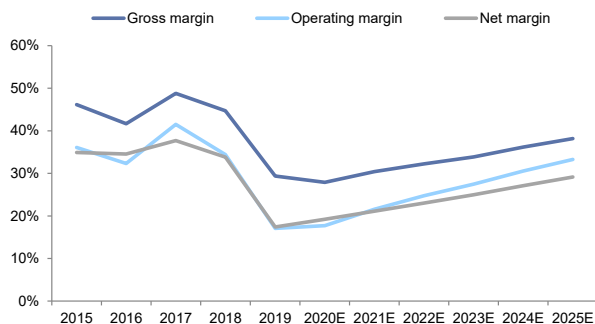
Source: IDC, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 516: Sanan is diversifying into RF PAs and compound semis
Sanan revenue mix



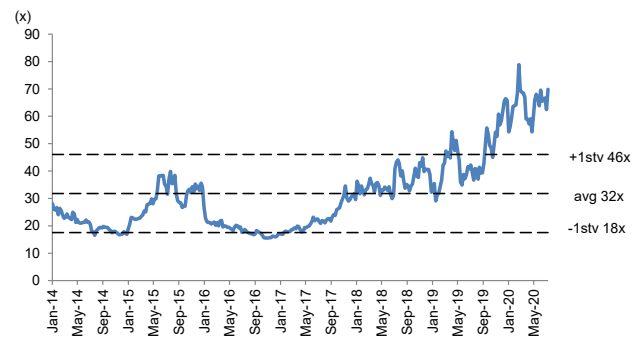
Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 517: Margin expansion on improving utilization and mix
Sanan margin trend



Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 518: Sanan's 12M forward P/E has averaged 32x since 2014



Source: Bloomberg

Driver 1: RF PA foundry business to benefit from content growth in 5G smartphones/base stations

As an early mover in GaAs and GaN technologies for RF PAs in China, we expect RF PA to be a key growth driver for Sanan given: 1) 5G will drive PA content growth in smartphones/base stations, and 2) there is significant market share upside for Sanan (off a low base) as domestic customers are actively seeking to diversify their supply chains. We model Sanan's RF PA revenues to grow at a 50% CAGR in 2020-23E, accounting for 13% of revenue by 2023E (vs 8% in 2020E).

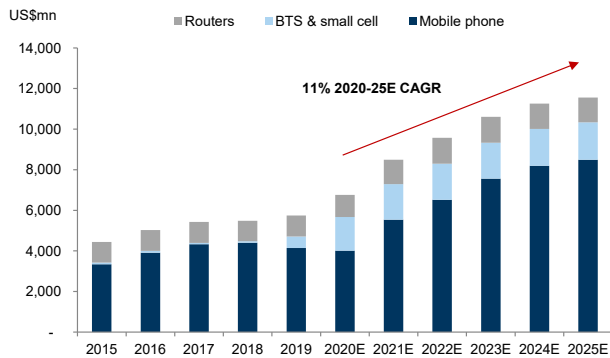
RF PA market to grow at 18% CAGR in 2019-22E, driven by 5G smartphones and base stations

We forecast the overall RF PA market will grow at an 18% CAGR in 2019-22E, mainly driven by base stations (25% of the PA market in 2020E, 45% CAGR in 2019-22E) and smartphones (59% of the PA market in 2020E, 16% CAGR in 2020-23E). RF PA is a semiconductor device that can convert a low-power RF signal into a higher power signal, and is widely adopted in wireless communication networks such as base stations, smartphones, WiFi routers and CPE.

5G base stations - up to 16x the PA content vs. 4G base stations: 5G base stations will drive PA usage due to the adoption of MIMO antennas (8TR/16TR/32T/64TR). Each TR requires one PA and each base station has three antennas, meaning one 5G base station of 64TR MIMO needs 192 units of PA. This is a significant increase compared to a 4G base station, which only requires 12 units of PA (4TR multiplied by three antennas). In addition, GaN will replace LDMOS as the mainstream technology for PAs in base stations given GaN's advantages of wider bandwidth, larger power density, and smaller form-factor.

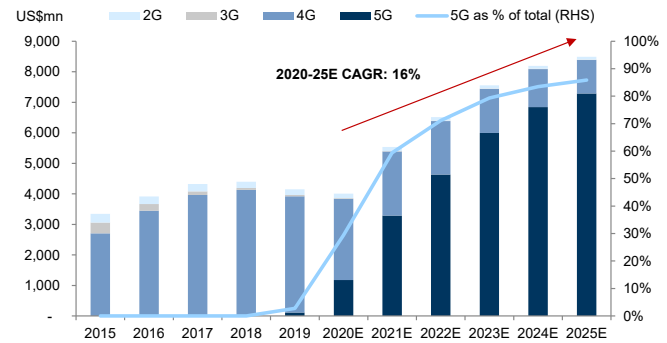
5G smartphones require >2x the PA content of 4G phones: 5G smartphones need US\$7-8 of PA content per phone (vs. US\$2-5 for a 4G smartphone and <US\$1 for a 3G smartphone), as 5G smartphones require higher power, higher frequency, and better efficiency. In 4G smartphones, PAs are mainly made by CMOS and GaAs processes, followed by SOI and SiGe processes. In 5G smartphones, GaAs will become the mainstream for PAs as the electron mobility of GaAs is higher than other materials (e.g. 5x-6x that of silicon), enabling a higher frequency of operation. We expect the 5G smartphone penetration rate to increase from 11% in 2020E to 45% in 2023E, driving smartphone PA market growth.

Exhibit 519: Global PA market to grow by an 11% CAGR in 2020-25E driven by 5G smartphones and base stations



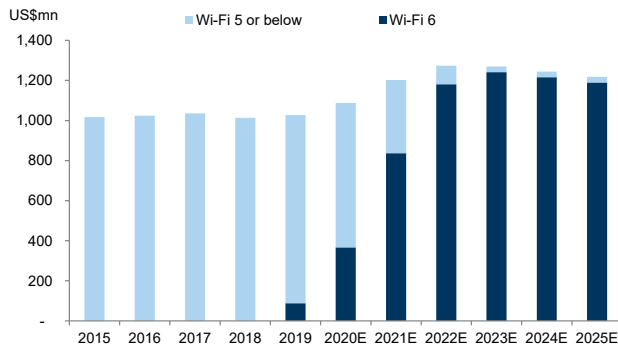
Source: IDC, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 520: Global mobile phone PAs to see a 16% 2020-25E CAGR driven by rising 5G penetration



Source: IDC, Gartner, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 521: Wi-Fi 6 will also drive PA content growth
Global router PA by technology



Source: IDC, Goldman Sachs Global Investment Research

Sanan's position in the PA market

The PA market is dominated by IDMs with foundries only accounting for 39% of the market in 2019. In the GaAs foundry market, Win Semi is the largest global player with a 76% market share, followed by Advanced Wireless Semiconductor Company (AWSC) at 8%, and Global Communication Semiconductor (GCS) at 6%. Sanan only started its PA foundry mass production in 2018 and we estimate it had a 3% market share in global PA foundry in 2019.

In terms of its manufacturing technology, Sanan's RF portfolio includes GaAs HBT, InGaP HBT, GaAs-pHEMT, E/D pHEMT, GaAs Bi-HEMT, and GaAs-IPD. While not as comprehensive as Win Semi and Qorvo, it is more similar to AWSC. For pHEMT, Sanan covers 0.15um-0.5um processes, while Win Semi covers 0.1um-0.5um processes.

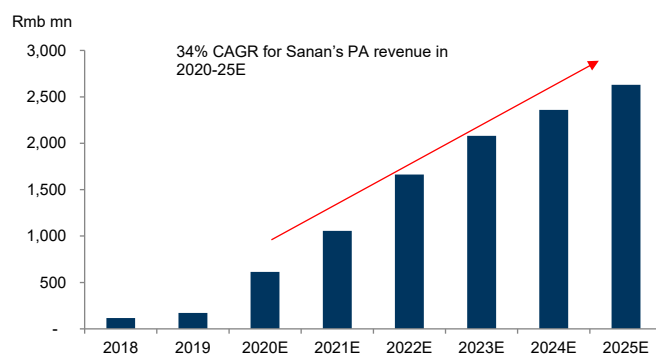
Exhibit 522: Among Chinese players, Sanan's technology is similar to AWSC and GCS

Category	Technology	Sanan	HiWafer	Win Semi	AWSC	GCS	Qorvo	Skyworks
HBT	GaAs HBT	✓	✓	✓	✓		✓	✓
	InGaP HBT	✓	✓	✓	✓	✓	✓	✓
HEMT	GaN HEMT	✓	✓	✓		✓	✓	✓
	Switch pHEMT	✓	✓	✓	✓	✓	✓	✓
	E/D pHEMT	✓		✓	✓	✓	✓	✓
	Bi-HEMT	✓	✓	✓	✓		✓	✓
	PINHEMT			✓			✓	✓
	HFET					✓	✓	✓
IPD	IPD	✓		✓	✓	✓	✓	✓

GaAs HBT = gallium arsenide heterojunction bipolar transistor; InGaP HBT = Indium phosphide heterojunction bipolar transistor; GaN HEMT = gallium nitride/gallium nitride high electron mobility transistor; pHEMT = pseudomorphic high electron mobility transistor; E/D pHEMT = E/D mode pseudomorphic high electron mobility transistor; HFET = heterojunction field effect transistor; IPD = integrated passive device

Source: Company data

We expect Sanan to expand its GaAs capacity from 4.5k wafers/month in end-2019 to 9k/13k/18k by end-2020E/21E/22E. Sanan's customers in PA are mainly Chinese IC design houses such as HiSilicon, UniSoC, Lansus, and Creotech. Its GaAs wafers for 2G-4G smartphone PAs are in volume shipments and GaAs wafers for 5G smartphone PAs will start volume shipments in 2020. We model Sanan's PA foundry business revenue to grow from Rmb613m in 2020E to Rmb2.1bn in 2025E, or a 50% CAGR.

Exhibit 523: We model Sanan PA revenue at a 34% CAGR in 2020-25E

Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Domestic customers actively diversifying their seeking supply chains: While Sanan's RF PA technology and production yield rate still lag behind global leaders, large domestic customers (such as Huawei, UniSoC, Lansus, and Creotech) have been willing to work with Sanan to improve their joint capability as these domestic customers have been building a comprehensive domestic supply chain to manage supply risk. As the first mover in RF PA foundry in China, Sanan is best positioned among Chinese foundries to partner with domestic customers and capture a growing order book.

GaN/SiC power devices expanding from diodes to bipolar transistors: Sanan's compound semi power devices are currently mainly low-voltage diodes for inverter applications, and it plans to start shipments of bipolar transistors in 2020. The company is also developing GaN/SiC power devices for EV applications. The company is working with customers such as Sungrow (inverter), Nari Group (grid), Xuji Electric (grid), Winline (charging pile), King Long (automotive), Kehua Hengsheng (datacenter power supply) and Midea Group (home appliances).

Driver 2: Mini/Micro-LEDs

Sanan's Mini-LED and Micro-LED products are both in small volume shipments in 2019, and we expect Mini-LED revenue to pick up first this year for high-end TV backlight applications, followed by Mini-LED display for NB/PC monitors in 2021, and Micro-LED display for automotive, wearables, and display walls in 2022-25. We expect revenue from Mini-LEDs and Micro-LEDs to grow at a 92% CAGR in 2020-23E, contributing 24% of revenue by 2023E (vs. 7% in 2020E).

Sanan is an early mover in China, collaborating with Samsung on Micro-LEDs

Sanan started R&D in Mini-LEDs and Micro-LEDs in 2017 with small volume production beginning in 2018. Sanan also collaborates with Samsung on Micro-LED, with the two companies signing a prepayment agreement in 2018 in which Samsung agreed to pay Sanan US\$16.8m as a prepayment for a certain amount of LED chips made by Sanan. Samsung also agreed to purchase a certain amount of LED chips from Sanan during this 3-year period.

Compared with traditional LED's size of 1000um, Mini-LED is only 200um, which enables more local dimming zones to improve contrast ratio. For example, a 65" TV with standard LED backlight has 300-400 LEDs, which can be divided into 300-400 dimming zones, but a 65" TV with mini-LED backlight can be divided into ~1,000 dimming zones with ~1,000 mini-LED chips in the backlight. A micro-LED is even smaller at 100um and is self-emitting, with advantages of high luminous efficiency, high brightness, high contrast ratio, high reliability, and short response time. However, the manufacturing process of Micro-LED is more complicated than Mini-LED with key bottlenecks such as "mass transfer" yet to be solved for mass production.

Aggressively expanding capacity in Mini/Micro-LEDs

In November 2019, Sanan announced a private placement to raise funding of up to Rmb7bn to expand its capacity in Mini-LEDs, Micro-LEDs, traditional LEDs, and LED packaging. This includes: 1) GaN LED wafer annual capacity of 7.7mn (including 1.6mn of Mini/Micro-LED), 2) GaAs LED wafer annual capacity of 1.2mn (including 176k of Mini/Micro-LED), and 3) LED packaging capacity of 8.7bn units per year. Sanan expects this project will take four years for construction and seven years to reach full production, with annual revenue/net profit of Rmb8.2bn/Rmb2.0bn once it reaches full production. We model Sanan's Mini/Micro-LEDs to contribute 7%/15%/20% of total revenue in 2020-22E.

Peer comparison in technology, customers, R&D

Sanan is an emerging player in the RF PA space and a leader in the LED market in China. In RF PAs, its major competitors are compound semiconductor foundries such as Win Semi, AWSC, and GCS, as well as RF PA IDMs such as Qorvo and Broadcom (Avago), etc. In LED market, its major competitors include Epistar, Cree, Nichia, OSRAM, Seoul Semiconductor, and Philips Lumileds.

RF PA technology/product portfolio comparison

Sanan's technology portfolio in RF includes GaAs HBT, InGaP HBT, GaAs-pHEMT, E/D pHEMT, GaAs Bi-HEMT, and GaAs-IPD, and while not as comprehensive as Win Semi and Qorvo, it is more comprehensive than domestic peer HiWafer. For pHEMT, Sanan covers 0.15um-0.5um processes, while Win Semi covers 0.1um-0.5um processes. In terms of end-market applications, Sanan's technologies are used in smartphones (2G-5G), WiFi routers, IoT, base stations, and satellite communications, but are yet to be used in military applications.

RF PA customer base comparison

Sanan's customers in RF PA are mainly Chinese fabless companies such as HiSilicon, UniSoC, Lansus, and Creotech. In comparison, RF PA foundry peers' major customers are global PA IC design houses and IDMs such as Skyworks, Qorvo, Broadcom, Qualcomm and Murata. HiSilicon is a key customer of peer Win Semi.

R&D expense comparison

Sanan's R&D expense ratio in 2019 was 3%, lower than RF PA peers at 6-14% and LED peers at 4-13%, mainly due to a higher % of Sanan's R&D investment that is capitalized (71% in 2019). If including the capitalized component, Sanan's R&D investment to sales ratio would be 8% in 2019, in-line with peers in 2019.

Exhibit 524: Recent developments in mini-LED industry in China

Company	Ticker	Progress	Announcement date
BMTC	002429.SZ	Cooperating with Korean and Taiwan companies on Mini LED used in high-end displays	January, 2020
NationStar	002449.SZ	Mass production of Mini LED IMD-M09T Launched IMD-M05 with a smaller pitch Launched light source display modules for Mini LED backlight, smart home appliances	April, 2020
BOE	000725.SZ	Mass production of glass-based Mini LED backlight and Mini LED displays in 2H20	March, 2020
Refond	300241.SZ	Ready for massive production of Mini LED and will expand the production line, based on customer orders	May, 2020
Jufei	300303.SZ	Mini LED is a newly-developed business of mass-production capability, and key investment direction in the future. Mini LED modules adopt COB (Chip on Board) or COG (Chip-On-Glass) solutions	May, 2020
Mason	002654.SZ	Small-batch production of Mini LED	December, 2019
Coreach	002983.SZ	Mini LED display technology was selected as a major scientific and technological project in Anhui Province, and some technologies have obtained patents and entered into the customer sample stage	May, 2020
Unilumin	300232.SZ	Launched Zhou Ming UMini (Mini LED) in 2020, which adopted full-flip LED chips, mass transfer and integrated packaging technology to achieve high-density and reliable LED display	May, 2020

Source: Company data

Exhibit 525: Production capacity expansion for Sanan and its Chinese peers

Company	Project	Process/product	Capacity k wpm (4")	Construction start
Sanan	Quanzhou 1	GaN	160	2019
	Quanzhou 1	PSS-substrate	192	2019
	Quanzhou 1	GaAs	26	2019
	Hubei	GaN	134	2019
	Hubei	GaAs	63	2019
HC SemiTek	Zhangjiagang 1	Blue and green LED epitaxial wafer	35	2012
	Zhangjiagang 2	Red and yellow LED epitaxial wafer	10	2013
	Zhangjiagang 3	Red and yellow LED epitaxial wafer	55	2014
	Zhangjiagang 4	LED epitaxial wafer	188	2018
	Yunnan 1	LED sapphire substrate	729	2017
	Zhejiang	LED epitaxial wafer	63	2016
		LED sapphire substrate	271	
Changelight	Yangzhou	AlGaInP red and yellow LED chip	11bn units	2017
	Nanchang 1	GaN epitaxial wafer	200	2018
Focus Lightings	Suqian 1	GaN	400	2018
	Suqian 2	GaN	300	Not yet

Source: Company data

Exhibit 526: Mini-LED projects for Sanan and its peers

Company	Location	Project	Details	Announcement date	Investment amount
Sanan	Xiamen	Mini LED chip supply to Samsung	Signed "Prepayment Agreement" with Samsung. Samsung will prepay in exchange for a certain proportion of Sanan's production line of LED chips	February, 2018	RMB117.8mn (US\$16.8mn)
	Quanzhou	Semiconductor R&D and industrialization (Phase 1)	3 major business segments focus: GaN, GaA and special packaging	November, 2019	RMB13.8bn
Liantronics + Konka	Chongqing	Mini LED and Micro LED large-screen display	Signed "Strategic Cooperation Framework Agreement" to establish JV	December, 2019	
Leyard + Epistar	Wuxi	Mini LED backlight display, Mini/Micro self-luminous display	5-year construction in two stages: 1) 2020-2022: Mini LED backlight display, Mini/Micro self-luminous display production ramped up 2) 2023-2025: Micro LED production expansion	March, 2020	RMB1bn
NationStar	Foshan	Packaging	Packaging line for Mini LED	April, 2020	RMB1-2bn
HGC	Wuhan	Mini LED	Small-size Mini LED production line planned to start construction in 2020	May 2020	Not disclosed
Refond	Yiwu	Mini LED	Full-color surface mount LED packaging expansion, Mini LED backlight packaging, Micro LED R&D center	May 2020	RMB1bn
BMTC	Nanchang	Red and yellow LED epitaxy wafer, chip and Mini LED, Micro LED Project (Phase 1)	Signed "Investment Agreement" with Nanchang High-tech Industrial Development Zone Management Committee to produce red and yellow LED epitaxy wafer and chips, Mini LED, Micro LED	December 2019	RMB1bn

Source: Company data

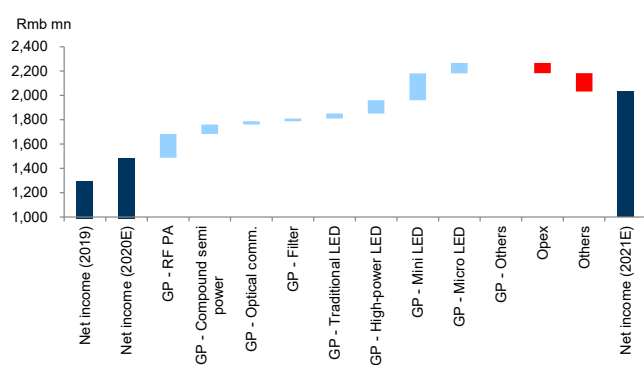
Earnings estimates: +40% NI CAGR in 2020-23E, mainly driven by RF PA and mini/micro-LED

Income statement: earnings growth driven by revenue growth and margin expansion

We forecast a 2020-23E net income CAGR of +40% with a revenue CAGR of +29% and operating income CAGR of +49%. Top line growth will mainly be driven by RF PAs and mini/micro-LEDs, where we forecast revenue 2020-23E CAGRs of 50% and 92%, respectively. RF PA revenues will be driven by growth in 5G content and capturing orders from domestic customers actively seeking to diversify their supply chains. Mini/micro-LED revenue growth is driven by growing adoption of mini/micro-LEDs in displays for NBs/PCs, automotives, wearables, and display walls.

Exhibit 527: We expect RF PA and mini LEDs to be major profit contributors in 2021E

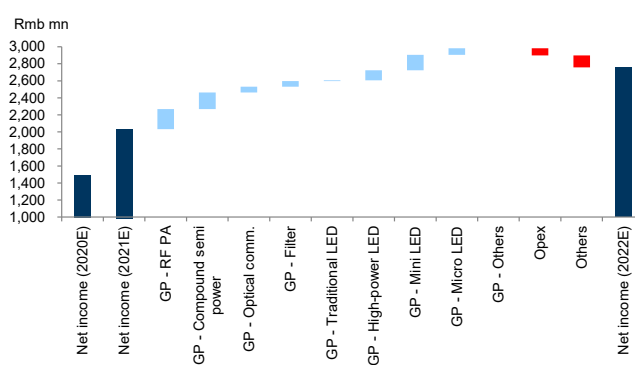
Net profit waterfall chart 2020-21E



Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 528: 2022E earnings will be driven by RF PAs, compound semis and mini LEDs

Net profit waterfall chart 2021-22E



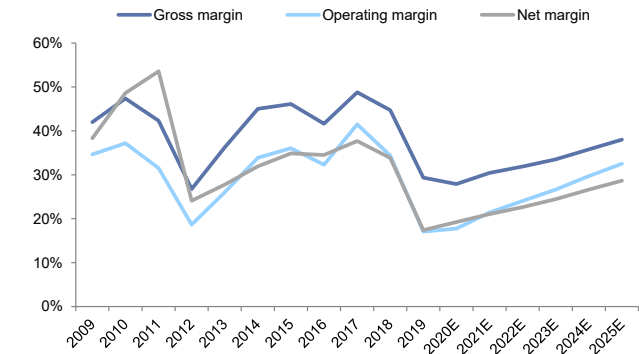
Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

We forecast GM to expand from 27.9% in 2020E to 30.4%/32.2%/33.9% in 2021-23E on the back of an improving product mix and higher utilization rates. RF PAs (14% GM in 2020E) and mini/micro-LEDs (14% GM in 2020E) have higher GMs than traditional LED (12% GM in 2020E), and we expect GMs for both to further expand in next few years as utilization improves.

- **RF PAs:** we model GM to improve from 14% in 2020E to 28%/36%/39% in 2021-23E with capacity utilization rising from 49% to 63%/76%/88% over the same period.
- **Mini/micro-LEDs:** we expect GM to improve from 14% in 2020E to 30%/32%/33% in 2021-23E with capacity utilization rising from 80% to 85%/89%/91% over the same period.

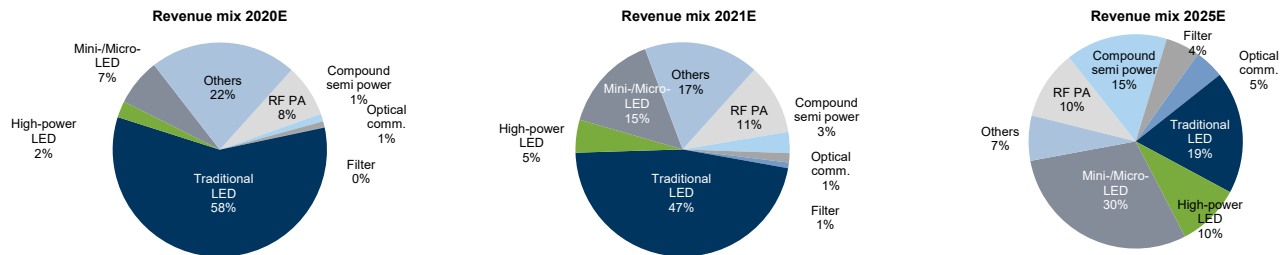
We model opex ratio to decline from 10.2% in 2020E to 6.4% in 2023E on the back of strong revenue growth.

Exhibit 529: We expect Sanan’s margins to improve as utilization ramps up
Sanan margin trend



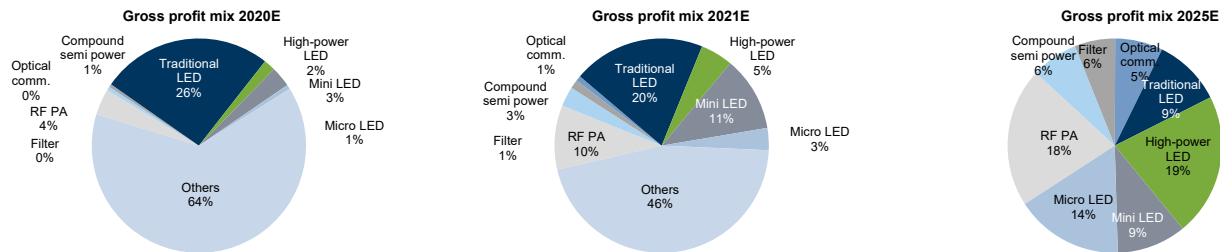
Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 530: Growing top line contribution from RF PAs and mini/micro LEDs
Sanan revenue mix in 2020E/21E/25E



Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 531: RF PAs and mini/micro LEDs will be key gross profit drivers in 2020-25E
Sanan gross profit mix in 2020E/21E/25E



Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 532: Sanan P&L Summary

(Rmb m)	1Q19	2Q19	3Q19	4Q19	1Q20	2Q20E	3Q20E	4Q20E	2016	2017	2018	2019	2020E	2021E	2022E
Revenue	1,729	1,659	1,945	2,128	1,682	1,713	2,093	2,248	6,273	8,394	8,364	7,460	7,735	9,874	12,860
Gross profit	639	553	535	465	475	482	569	631	2,612	4,095	3,740	2,191	2,157	3,002	4,142
Operating expense	(201)	(224)	(237)	(255)	(228)	(200)	(172)	(186)	(585)	(612)	(863)	(917)	(785)	(872)	(962)
Operating income	437	328	298	210	247	282	397	445	2,027	3,484	2,876	1,274	1,372	2,130	3,180
Pre tax profit	694	329	326	241	442	342	457	506	2,617	3,854	3,248	1,591	1,747	2,483	3,523
Net income	621	262	269	146	392	287	384	425	2,167	3,164	2,830	1,298	1,487	2,086	2,959
EPS (Rmb)	0.15	0.06	0.07	0.04	0.10	0.07	0.09	0.10	0.53	0.78	0.69	0.32	0.36	0.51	0.73
Margins / ratio															
Gross margin	36.9%	33.3%	27.5%	21.8%	28.2%	28.1%	27.2%	28.1%	41.6%	48.8%	44.7%	29.4%	27.9%	30.4%	32.2%
Opex ratio	-11.6%	-13.5%	-12.2%	-12.0%	-13.5%	-11.7%	-8.2%	-8.3%	-9.3%	-7.3%	-10.3%	-12.3%	-10.2%	-8.8%	-7.5%
Operating margin	25.3%	19.8%	15.3%	9.9%	14.7%	16.5%	19.0%	19.8%	32.3%	41.5%	34.4%	17.1%	17.7%	21.6%	24.7%
Net margin	35.9%	15.8%	13.9%	6.9%	23.3%	16.8%	18.3%	18.9%	34.5%	37.7%	33.8%	17.4%	19.2%	21.1%	23.0%
QoQ															
Revenue	-12%	-4%	17%	9%	-21%	2%	22%	7%							
Gross profit	-10%	-13%	-3%	-13%	2%	1%	18%	11%							
Operating income	2%	-25%	-9%	-30%	18%	14%	41%	12%							
Pre tax profit	116%	-53%	-1%	-26%	83%	-23%	34%	11%							
Net income	163%	-58%	3%	-46%	168%	-27%	34%	11%							
EPS	165%	-58%	3%	-46%	167%	-27%	34%	11%							
YoY															
Revenue	-11%	-26%	-12%	8%	-3%	3%	8%	6%	29%	34%	0%	-11%	4%	28%	30%
Gross profit	-36%	-47%	-46%	-35%	-26%	-13%	6%	36%	17%	57%	-9%	-41%	-2%	39%	38%
Operating income	-46%	-62%	-62%	-51%	-43%	-14%	33%	112%	16%	72%	-17%	-56%	8%	55%	49%
Pre tax profit	-38%	-65%	-63%	-25%	-36%	4%	40%	110%	25%	47%	-16%	-51%	10%	42%	42%
Net income	-36%	-70%	-64%	-38%	-37%	10%	42%	191%	28%	46%	-11%	-54%	15%	40%	42%
EPS	-35%	-70%	-63%	-38%	-37%	9%	42%	190%	-25%	47%	-12%	-54%	14%	40%	42%

Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

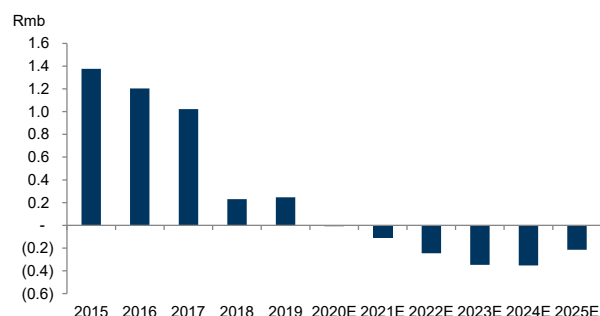
Balance sheet

Net cash becoming net debt with rising capex: Over the past five years Sanan has been in a net cash position by generating positive operating cash flow of between Rmb665-3,339mn in 2014-19. However, we expect Sanan's net cash position to become a net debt position in 2020E as Sanan continues to spend capex in to expand capacity in PAs, compound semis, and mini/micro-LEDs.

ROE to recover in 2020-25E as net margins expand: Sanan posted ROE of between 12-17% in 2015-19 with net margins at 34-38%. However, ROE fell to as low as 6% in 2019 on decreasing profitability in its LED business as net margins fell sharply (17%) due to LED price weakness. Asset turnover and asset to equity ratio have been relatively more stable over the past five years (0.2-0.3x and 1.3-1.4x, respectively). In the coming years, we expect ROE to improve from 7% in 2020E to 9%/12%/15% in 2021-23E mainly on the back of rising net margins (19%/21%/23%/25% in 2020-23E) and also better efficiency in asset turnover (0.3x/0.3x/0.4x/0.4x in 2020-23E).

Exhibit 533: Sanan's net cash position has turned to net from 2020E on rising capex

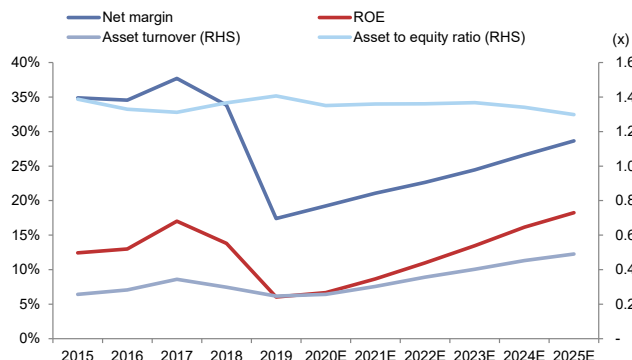
Net cash (debt) per share



Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 534: Sanan's ROE to improve as margins tick up and asset turnover improves

ROE and dupont analysis

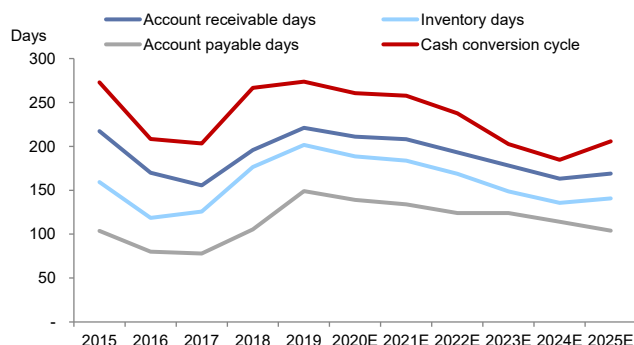


Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Cash conversion cycle to improve from 261 days in 2020E to 173 days in 2025E:

Sanan's cash conversion cycle improved from 273 days in 2015 to 203 days in 2017, mainly due to lower account receivables (from 217 days in 2015 to 156 days in 2017) and lower inventory days (from 159 days in 2015 to 126 days in 2017), while account payable days shorten from 104 days in 2015 to 78 days in 2017.

However, its cash conversion cycle increased from 203 days in 2017 to 274 days in 2019, mainly due to higher account receivable days and longer inventory days, which we attribute to weaker LED demand over past two years (revenue 0%/-11% YoY in 2018/19 vs. +29%/+34% YoY in 2016/17). In the coming years, we expect Sanan's cash conversion cycle to improve from 261 days in 2020E to 173 days in 2025E on the back of shorter AR and inventory days thanks to its larger scale (better bargaining power) and improving AR/inventory management.

Exhibit 535: Sanan's cash conversion cycle


Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Cash flow

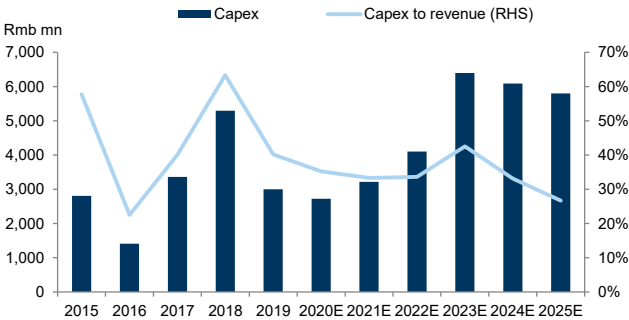
Capex-to-sales ratio to gradually fall on stronger revenue growth: Sanan's capex to revenue ratio was volatile at 23-53% in 2015-2019 as it expanded LED capacity. We expect Sanan's **capex-to-sales** ratio to decline slightly from 35% in 2020E to 23% in

2025E as we expect revenue growth (+27% CAGR in 2020-25E) to be stronger than capex growth (+18% CAGR).

Free Cash Flow to turn positive in 2021E with a 0.2% FCF yield: Sanan’s free cash flow was negative Rmb208-1,957m in 2017-19 due to high capex (Rmb3.0-5.3bn). We expect FCF to turn positive in 2022E with FCF yield of 0.6%/0.4% in 2022E/23E and 2.3-3.3% in 2024-25E from rising operating cash flow and a lower capex to revenue ratio.

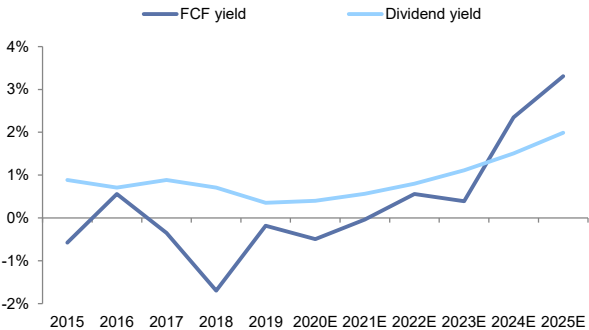
Dividend yield at 0.5%/0.6% in 2020E/21E: Sanan’s dividend payout ratio was at 29-32% in 2017-19. We expect its dividend payout ratio to be stable at 30% in 2020E-25E, implying a dividend yield of 0.4%/0.6% in 2020E/21E and 0.8-2.0% in 2022-25E.

Exhibit 536: Sanan capex to revenue ratio to gradually fall on stronger revenue growth



Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 537: Free cash flow yield and dividend yield to improve



Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Valuation: TP at Rmb40, implying 41% upside

Our 12-month target price of Rmb40 (which implies a 55x 2022E P/E) is based on a discounted P/E, as we believe Sanan's compound semi business is still at the early stages of its technology roadmap and capacity build compared to global leaders. In our view, discounted P/E captures Sanan's long-term business opportunity which justifies its higher-than-peer P/E multiple. We apply a 29x target P/E multiple to Sanan's 2025E EPS and discount it back at a COE of 9% (1.0 Beta, 3% risk-free rate, and 6% market risk premium). Our 29x target P/E multiple is derived from the sector P/E-EPS YoY correlation; our regression analysis shows that the market has generally rewarded local semi stocks with high growth EPS.

Our target price implies 55x 2022E P/E, or a PEG of 1.5x based on average 2023-24E EPS YoY growth (37%). Our valuation cross-check (DCF) derives a similar value of Rmb40.9, or 56x 2022E P/E. The stock currently trades at 39x our 2022E EPS and at 1.0x our PEG based on average 2023-24E EPS YoY growth, which we believe is attractive given its strong earnings growth (+40% CAGR in 2020-23E).

Exhibit 538: Sanan's discounted P/E valuation: Our Rmb40 TP implies 55x 2022E P/E

(Rmb mn)	2018	2019	2020E	2021E	2022E	2023E	2024E	2025E
Milestone			RF PA			Mini-/Micro-LED		SiC power device
Revenue	8,364	7,460	7,735	9,874	12,860	16,440	20,563	25,219
Compound Semi	171	241	775	1,594	3,055	4,829	6,859	8,941
Mini/micro/high power LED	147	316	741	1,953	3,411	5,191	7,303	9,895
Traditional LED/material scrap sale	8,047	6,904	6,220	6,327	6,394	6,420	6,401	6,383
YoY	0%	-11%	4%	28%	30%	28%	25%	23%
Compound Semi		41%	222%	106%	92%	58%	42%	30%
Mini/micro/high power LED		115%	134%	164%	75%	52%	41%	35%
Traditional LED/material scrap sale		-14%	-10%	2%	1%	0%	0%	0%
GM	44.7%	29.4%	27.9%	30.4%	32.2%	33.9%	36.2%	38.2%
Compound Semi	0.0%	0.0%	13.9%	27.9%	35.6%	38.8%	42.8%	45.7%
Mini/micro/high power LED	10.0%	13.0%	16.1%	30.0%	31.5%	33.0%	34.5%	36.0%
Traditional LED/material scrap sale	46.3%	31.1%	31.0%	31.2%	31.0%	30.9%	31.0%	31.0%
Operating profit	2,876	1,274	1,372	2,130	3,180	4,515	6,286	8,385
YoY		-56%	8%	55%	49%	42%	39%	33%
Pre-tax profit	3,248	1,591	1,747	2,483	3,523	4,891	6,640	8,754
Net profit	2,830	1,298	1,487	2,086	2,959	4,105	5,570	7,349
EPS (Rmb)	0.69	0.32	0.36	0.51	0.73	1.01	1.37	1.80
YoY	-12%	-54%	14%	40%	42%	39%	36%	32%
2025E target P/E								29
Target multiple x EPS								52
Discounted back to 2022; TP (Rmb)					40.0			
Implied 2022E P/E					55			

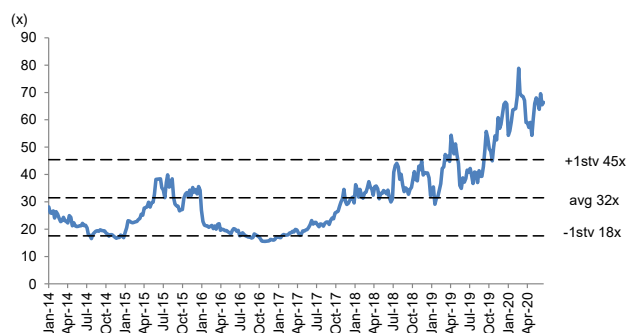
COE assumption	
Beta	1.0
Risk free	3.0%
Market risk premium	6.0%
COE	9.0%

Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Our 12-month target price implies a 6.2x 2022E P/B, higher than its historical trading range of 1.7-5.0x, as we forecast ROE will expand from 7% in 2020E to 9%/12% in 2021/22E. The stock is currently trading at 4.4x 2022E P/B, higher than global power semiconductor peers (1.0x-3.3x), in our view due to Sanan's stronger earnings growth. Putting this in context, A-share semiconductor names with scarcity (such as SG Micro, GigaDevice, NAURA and Will Semi) currently trade at 11-27x 2021E P/B, significantly

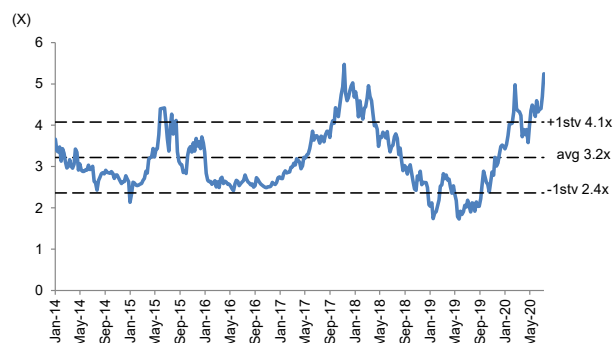
higher than the implied P/B multiple (6.2x) from our target price for Sanan. In our view this is because Sanan's PA foundry capacity is still ramping up as its revenue to date has predominantly come from LED.

Exhibit 539: Sanan's 12-month forward P/E has averaged 32x since 2014



Source: Bloomberg

Exhibit 540: Sanan's 12-month forward P/B averaged 3.2x since 2014



Source: Bloomberg

DCF cross-check: Value of Rmb40.9, similar to our discounted P/E TP

Our DCF cross-check derives a value of Rmb40.9, which implies 56x 2022E P/E, consistent with our target price implied 2022E P/E (also 55x). We model free cash flow to grow at an 81% CAGR in 2022E-25E, falling to 30% in 2025E-30E, with a terminal growth rate of 3%. We believe the company's free cash flow in 2020E-25E will be driven by: 1) increasing operating cash flow driven by revenue growth in RF PA, compound semis, mini/micro LEDs, as well as improving margins; 2) improving cash conversion days given its larger scale and improving AR/inventory management; and 3) disciplined capex. We model WACC at 8.6% and a COE of 9.0%, based on a beta of 1.0, a risk-free rate of 3.0%, and a market risk premium of 6.0%.

Exhibit 541: Sanan DCF valuation cross-check: RMB40.9 value implies 56x 2022E P/E

Rmb mn	2017	2018	2019	2020E	2021E	2022E	2023E	2024E	2025E	2026E	2027E	2028E	2029E	2030E
P&L														
Revenue	8,394	8,364	7,460	7,735	9,874	12,860	16,440	20,563	25,219					
YoY	34%	0%	-11%	4%	28%	30%	28%	25%	23%					
GM	48.8%	44.7%	29.4%	27.9%	30.4%	32.2%	33.9%	36.2%	38.2%					
Opex ratio	7.3%	10.3%	12.3%	10.2%	8.8%	7.5%	6.4%	5.6%	4.9%					
Opex YoY	5%	41%	6%	-14%	11%	10%	10%	9%	8%					
OP income	3,484	2,876	1,274	1,372	2,130	3,180	4,515	6,286	8,385					
YoY	72%	-17%	-56%	8%	55%	49%	42%	39%	33%					
Pretax income	3,854	3,248	1,591	1,747	2,483	3,523	4,891	6,640	8,754					
Net income	3,164	2,830	1,298	1,487	2,086	2,959	4,105	5,570	7,349					
YoY	46%	-11%	-54%	15%	40%	42%	39%	36%	32%					
Cash flow														
CCC	203	267	274	261	258	231	196	173	173					
Capex	3,363	5,296	2,997	2,725	3,216	4,099	6,395	6,089	5,798					
Capex to revenues	40%	63%	40%	35%	33%	32%	39%	30%	23%					
Free cash flow	(405)	(1,957)	(208)	(568)	(45)	645	452	2,707	3,816	5,343	7,213	9,377	11,721	14,065
YoY							-30%	500%	41%	40%	35%	30%	25%	20%
Terminal growth														3%
Terminal value														258,808
Discount factor							0.92	0.85	0.78	0.72	0.66	0.61	0.56	0.52
Present value of FCF							416	2,296	2,980	3,841	4,775	5,716	6,580	7,271
Enterprise value 2022E (Rmb m)						167,663								
Cash and equivalents						1,396								
Debt						2,401								
Equity value in 2022E (Rmb m)						166,658								
Value per share (Rmb)						40.9								
Implied 2022E P/E						56x								
WACC assumption (2022E)														
Risk free rate	3.0%													
Beta	1.0													
Market risk premium	6.0%													
Cost of equity	9.0%													
Cost of debt	5.0%													
Tax rate	16%													
Debt / (debt+equity)	8%													
Equity / (debt+equity)	92%													
WACC	8.6%													

Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Downside risks

Key downside risks to our investment thesis are:

1. **Weaker than expected PA market growth:** We forecast the global and China PA market to grow at 18% and 31% CAGRs in 2019-22E, respectively, as 5G will drive significant PA content growth in both base stations and smartphones. If the penetration of 5G or PA content growth is slower than our expectations, growth in the PA market could be weaker than our current forecast.
2. **Slower than expected new order win and market share gains:** We model a 50% revenue CAGR in 2020-23E for Sanan's RF PA business, driven by market growth, new orders wins, and market share gains. If Sanan's new order wins or market share gains are slower than our expectations, there could be downside risk to our earnings estimates.
3. **Slower than expected development progress in new technology (compound semis, mini/micro-LEDs):** We model compound semi (power devices, optical communication devices, filters) to contribute 2%/5%/11% of revenues in 2020-22E, and mini/micro-LED to contribute 7%/15%/20% of revenues in 2020-22E. If progress in R&D or customer adoption/qualification of these products is slower than our expectations, it could result in slower earnings growth than our current forecast.
4. **More severe competition in the LED market:** Given LED is a mature market, if more suppliers expand capacity or if demand is weaker than expected, there could be price pressure across the industry. We model Sanan's revenue from traditional LED to decline from 58% of revenues in 2020E to 47%/36% in 2021E/22E. In addition, if other domestic competitors have faster R&D/new design-wins in mini/micro-LED, there could be downside to our earnings estimates.
5. **Potential impact from COVID-19:** The lion's share of Sanan's revenue comes from the domestic market (~85% of revenue) but its customers' end products are sold globally, thus Sanan could be impacted by the global macro slowdown in 2020. Sanan's revenue declined 3% YoY in 1Q20 (vs +8% YoY in 4Q19) due to COVID-19.

Company background

Management background

- **Chairman:** Sanan's current chairman Lin Zhiqiang is the son of Sanan Group's founder Lin Xiucheng. He served as Chairman of Hunan Sanan Mining, Director and Deputy General Manager of Fujian Sanan Group, Chairman of Xiamen Guoguang Industry and Trade before taking charge of Sanan Optoelectronics. He was also the Deputy of 16th NPC in Xiamen Siming district.
- **Vice Chairman, General Manager:** Sanan's Vice Chairman and General Manager Lin Ke Chuang was also part of Sanan Group before taking the management role of Sanan, he served as Deputy General Manager of Fujian Sanan Group
- **Director, Deputy General Manager:** Wei Daman is Director and Deputy General Manager at Sanan, he served several roles including General Manager of Sangang Machinery Manufacturing, Assistant General Manager of Sangang Group, Deputy General Manager of Sangang (Minguan), Director & Deputy General Manager of Sangang Group before moving to Sanan Optoelectronics.
- **Director:** Ren Kai is one of Sanan's directors, who served on the Judging Board in China Development Bank before joining Sanan. He is also the current Vice President of Huaxin Investment Management, Director of JCET (Suzhou) and Suzhou Changdian Xinpeng Investment
- **Director:** Another director of Sanan Kan Hongzhu worked in the government of Shitang, Anhui, served as Deputy Director of Longcheng Towel Factory in Feidong, Anhui, Deputy General Manager of Xiamen Aidi Electronics, General Manager of Fujian Jianchenglong Industrial Development before joining Sanan.

Sanan

600703.SS	12m Price Target: Rmb40	Price: Rmb28.28	Upside: 41.4%		
Buy	GS Forecast				
Market cap: Rmb115.3bn / \$16.5bn	Revenue (Rmb mn)	12/19	12/20E	12/21E	12/22E
Enterprise value: Rmb115.4bn / \$16.5bn	EBITDA (Rmb mn)	7,460.0	7,735.3	9,874.5	12,860.0
3m ADTV :Rmb2.5bn/ \$346.4mn	EPS (Rmb)	2,884.3	3,415.6	4,504.7	5,951.2
China	P/E (X)	0.32	0.36	0.51	0.73
Greater China Technology	P/B (X)	41.5	77.5	55.3	39.0
	Dividend yield (%)	2.5	5.1	4.8	4.4
M&A Rank: 3	Net debt/EBITDA (X)	0.8	0.4	0.6	0.8
	CROCI (%)	(0.3)	0.0	0.2	0.2
	FCF yield (%)	5.4	12.7	14.1	15.8
		(0.4)	(0.5)	(0.0)	0.6
		3/20	6/20E	9/20E	12/20E
	EPS (Rmb)	0.10	0.07	0.09	0.10

Source: Company data, Goldman Sachs Research estimates, FactSet. Price as of 10 Jul 2020 close.

Silan (600460.SS): MOSFET and power IC bundled solutions the key growth driver and differentiator; initiate at Buy

Primary analysts:

Lynn Luo, Jin Guo

Initiate at Buy with a 12-month TP of Rmb21.5: Silan is a power semiconductor integrated device manufacturer (IDM) in China focusing on MOSFETs, IGBTs, and power ICs, with 3%/1% market share in China MOSFET/IGBT market in 2019. Both MOSFETs and IGBTs are used as switches in power electronics for applications such as industrial converters, home appliances, consumer electronics, power tools, etc. Silan's key point of differentiation from other local peers is that it can provide bundle solutions for both power ICs and MOSFETs.

We are positive on Silan, a leading power-semi IDM, and model net income growth at a 55% CAGR in 2021-25E, driven by:

- **MOSFET and power IC bundled solutions:** Silan's key differentiation from domestic power semi IDM peers is that it not only focuses on power discretes, but also has a comprehensive product portfolio in power ICs such as AC-DC, DC-DC, power management, and fast-charging ICs, which it can bundle into solutions with its MOSFET. We model Silan's MOSFET revenue to grow at a +24% CAGR in 2021-25E, driven by growing demand from automotive and industrial applications, as well as Silan's bundled sales of MOSFET and power ICs.
- **IGBT expansion into EV and industrial markets:** Silan's IGBTs are 600-1200V for consumer electronics products, and it is expanding into higher voltage (1700V and above) IGBTs for EV and industrial applications. For EV applications, Silan has developed IGBTs for car air conditioners, main motor drives, and onboard chargers. We model Silan's IGBT revenue to grow at a 41% CAGR in 2021-25E, contributing 22% of revenue by 2025E (vs 10% in 2020).
- **Margin recovery:** Silan's GM was 25-27% in 2015-18, but declined to 19.5% in 2019 due to a low utilization rate at its 8" fab. We model GM to recover from 20.4% in 2020E to 22.2%/23.9%/25.6% in 2021-23E on the back of improving utilization and product mix improvement. By product, both IGBTs (GM 29% in 2020E) and MOSFET (GM 25% in 2020E) carry higher GM than other product lines (other power discretes, power ICs, and LEDs). The increasing revenue contribution from IGBT/IPM (from 10% in 2020E to 22% in 2025E) and MOSFET (from 22% in 2020E to 26% in 2025E) will drive GM expansion in our view.

26% upside to 12M TP of Rmb21.5, initiate at Buy: Our 12-month target price of Rmb21.5 is derived from applying a 30x target P/E multiple to Silan's 2025E EPS and discounting back to 2022E at a COE of 9.2%. We use discounted P/E as we believe Silan is at an earlier stage of development than global leaders. Our target price implies 71x 2022E P/E, which we believe is justified by its strong earnings growth (+55% CAGR in 2021-25E). Our cross-check DCF also shows a similar per-share theoretical value of Rmb22.2, or 74x 2022E P/E. Risks are: 1) weaker-than-expected IGBT market growth; 2) weaker-than-expected MOSFET market growth; 3) slower-than-expected new design-win and market share gain; and 4) potential impact from COVID-19.

PM summary: Top five questions

1. Why are we positive on the MOSFET market in China? 5% CAGR driven by automotive, industrial, consumer applications

We expect China's MOSFET market to grow at a 5% CAGR in 2020-23E, mainly driven by automotive (5% CAGR, 33% of total market), industrial (6% CAGR, 27% of total market), and consumer electronics (4% CAGR, 18% of total market). Silan has 3% market share in China MOSFET market in 2019, and we see upside for Silan in the domestic market given: 1) customers are seeking to diversify supply chain risks; and 2) Silan can provide MOSFET and power IC bundled solutions.

2. What are Silan's key advantages compared with domestic peers in power semis such as StarPower and CR Micro? More comprehensive product portfolio in power ICs

While Silan's MOSFET and IGBT businesses are smaller in revenue scale compared with local leaders such as StarPower and CR Micro, its key advantage is a more comprehensive product portfolio in power ICs such as AC-DC, DC-DC, power management, and fast-charging ICs, which it can bundle into solutions with its MOSFET. Silan also has a more balanced exposure among IGBTs, MOSFETs, and power ICs, which should help it reduce the cycles and the risks of a single market.

3. What are Silan's near-term and long-term drivers? MOSFETs, power ICs, and IGBTs

We expect revenue growth to be mainly driven by IGBTs (including IPMs) / MOSFETs / power ICs, for which expect CAGRs of +41% / +24% / +21% in 2021-25E, respectively. We see IGBT/IPM revenue growth being driven by IPMs for home appliances and Silan's expansion into IGBTs for industrial and EV applications. MOSFET revenue growth will likely be driven by expansion into higher voltages and bundled solutions with power ICs.

4. How do we value the stock? 71x our 2022E P/E

Our 12M target price of Rmb21.5 (implies a 71x 2022E P/E) is derived from discounted P/E, as we believe Silan is still at an early stage of development relative to global leaders. We believe a discounted P/E approach captures the company's long-term business opportunities and justifies its current higher-than-peers P/E multiple. We apply a 30x target P/E multiple to Silan's 2025E EPS and discount back to 2022E at a COE of 9.2% (1.0 Beta, 3% risk-free rate, and 6% market risk premium). The 30x target P/E multiple is derived from sector P/E-EPS YoY correlation, with the market generally rewarding higher EPS growth companies in the semiconductor industry based on our regression analysis. Our target price implies 71x 2022E P/E, or PEG at 1.3x based on average 2023-24E EPS YoY growth (+54%). Our valuation cross-check using DCF also shows a similar per-share theoretical value of Rmb22.2, or 74x 2022E P/E. The stock currently trades at 57x our 2022E EPS and at 1.0x our PEG based on average 2023-24E EPS YoY growth. We see these levels as attractive considering its strong earnings growth at a +55% CAGR in 2021-25E.

5. Potential downside risks from COVID-19? *~98% revenue from domestic market*

Silan's revenue is mainly from the domestic market (~98% of 2019 revenue) but its customers' end products are sold globally, and therefore Silan could be indirectly impacted by the macro economic slowdown globally in 2020.

IGBT: +41% revenue CAGR in 2021-25E

Silan provides both discrete IGBTs and IPMs (Intelligent Power Module; a kind of IGBT module), which together contribute 10% of revenue in 2020E. Silan's IGBT products are mainly 600V for consumer electronics/EVs, and 1,200-1,300V for induction cookers. Key drivers for its IGBT business are home appliance, solar, EV, and industrial applications in coming years. Silan started mass production of Punch Through IGBTs in 2010 and Non Punch Through IGBTs in 2011, and completed R&D on Field Stop IGBTs in 2013 and Trench IGBTs in 2015. Its 8" wafer fab started production in late 2015 and Silan successfully developed the Trench IGBT at its 8" wafer fab in 2018. The company is currently developing Field Stop IGBTs for automotive and higher-end industrial markets.

MOSFET: +24% revenue CAGR in 2021-25E

Silan's MOSFETs are used mainly in PCs, UPS, car inverters, consumer electronics, and electric bikes. Silan used to manufacture MOSFETs at 6" wafer fabs and started to migrate to 8" wafer fabs in 2017. The company also plans to migrate MOSFETs to its 12" wafer fab and is developing low-voltage, high-voltage, and trench MOSFET at the 12" wafer fab, which would be more efficient than its 8" wafer fab and has more equipment available. Its key MOSFET product lines include Trench LVMOS (30-600V), Planar MOS (250-1500V), and Super Junction MOS (600-800V). Other than discrete MOSFETs, Silan also sells MOSFETs together with its power ICs. For example, Silan's SSR (secondary side regulated) flyback power management chip has a built-in high-power MOSFET, which can be used in adapters for fast charging, displays, and tablets.

Key customers

Silan has a diversified customer base with its top 5 customers contributing only 15% of its total revenue in 2019. Key customers in each product line are as below:

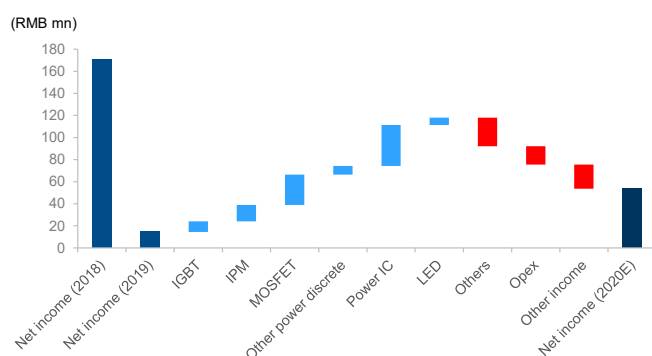
- **Power discretes** (MOSFET, IGBT, TVS, FRD, etc): Oppo, Vivo, Xiaomi, Lenovo, TCL, ZTE, LG, Amazon, Cisco, Delta, Flextronics
- **IPM**: Midea, Hisense, Haier
- **AC-DC**: Acbel Polytech, Exar, Flex
- **LED driver**: Osram, Navigate, Yankon

Earnings estimates: +55% NI CAGR in 2021-25E, driven by MOSFET, power IC, IGBT

Income statement

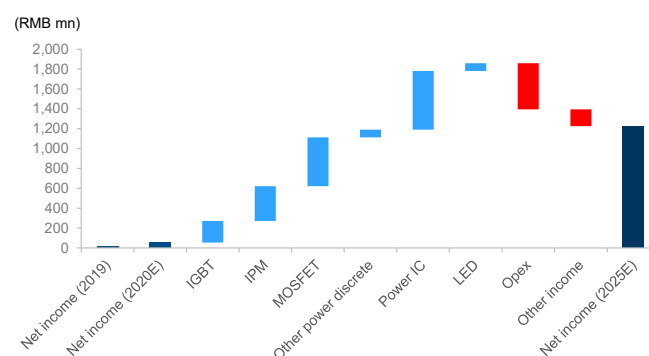
Silan reported an operating loss of Rmb90m/10m in 2019/1Q20 due to lower GM resulting from the low utilization rate of its 8" fab. We expect operating losses to narrow to Rmb29m in 2020E, followed by a rebound to profit of Rmb145m in 2021E. We model Silan's net income to rebound from a low base of Rmb15m in 2019 to Rmb54m/210m in 2020E/21E as utilization of the 8" fab improves and higher revenues offset the depreciation cost. For 2021-25E, we model net income growth at a +55% CAGR with a revenue CAGR of +21% and operating income CAGR of +73%. We expect revenue growth to be mainly driven by IGBTs (including IPMs) / MOSFETs / power ICs, for which expect CAGRs of +41%/ +24%/ +21% in 2021-25E, respectively. We see IGBT/IPM revenue growth being driven by IPMs for home appliances and Silan's expansion into IGBTs for industrial and EV applications. MOSFET revenue growth will likely be driven by expansion into higher voltages and bundled solutions with power ICs.

Exhibit 542: Net income waterfall chart 2019-20E



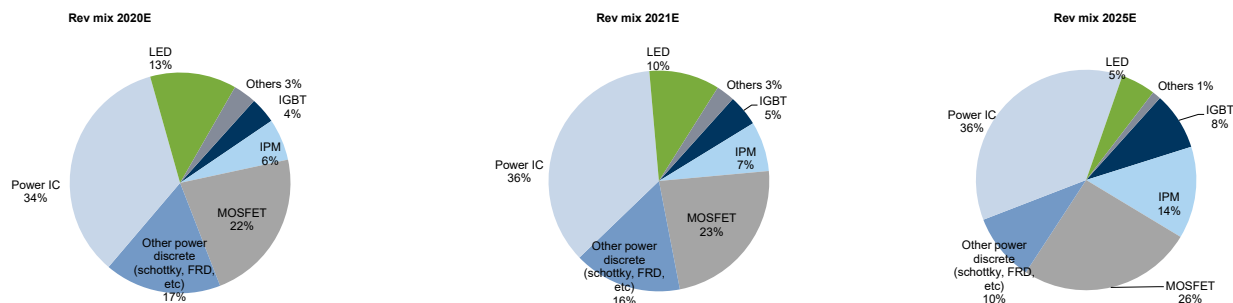
Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 543: Net income waterfall chart 2020-25E

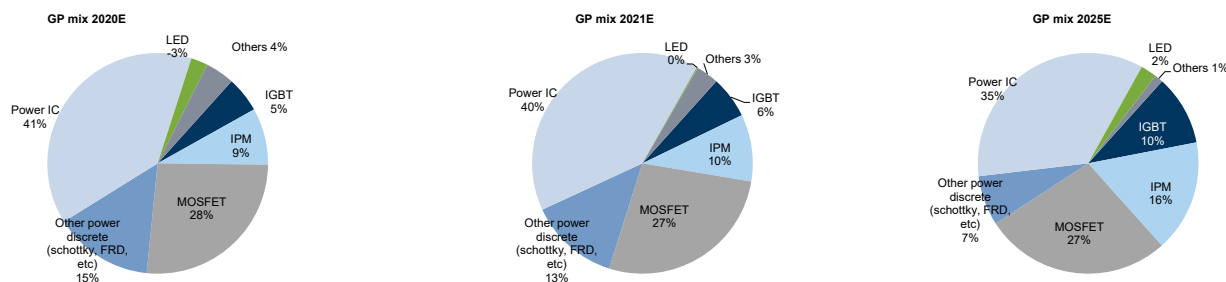


Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Silan's GM was 25-27% in 2015-18, but declined to 19.5% in 2019 due to low utilization rate of the 8" fab. We model GM to recover from 20.4% in 2020E to 22.2%/23.9%/25.6% in 2021-23E on the back of improving utilization and product mix improvement. By product, both IGBTs (GM 29% in 2020E) and MOSFETs (GM 25% in 2020E) carry higher GMs than other product lines (other power discretes, power ICs, and LEDs). The increasing revenue contribution from IGBT/IPM (from 10% in 2020E to 22% in 2025E) and MOSFET (from 22% in 2020E to 26% in 2025E) will drive GM expansion in our view. We also expect Silan to improve the capacity utilization of its 8" fab, which should help margin expansion as well.

Exhibit 544: Silan revenue mix

Source: Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 545: Silan GP mix

Source: Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 546: Silan P&L summary

(Rmb m)	1Q19	2Q19	3Q19	4Q19	1Q20	2Q20E	3Q20E	4Q20E	2016	2017	2018	2019E	2020E	2021E	2022E
Revenue	660	780	783	887	691	816	851	989	2,375	2,742	3,026	3,111	3,348	4,172	5,256
Gross profit	146	159	119	181	143	164	173	203	586	732	770	606	683	928	1,257
Operating expense	(151)	(160)	(172)	(213)	(154)	(165)	(180)	(214)	(499)	(584)	(651)	(696)	(713)	(783)	(884)
Operating income	(5)	(1)	(53)	(31)	(10)	(1)	(7)	(11)	87	148	119	(90)	(29)	145	372
Pre tax profit	(10)	3	(55)	(68)	(24)	(9)	(16)	(29)	89	119	80	(130)	(78)	99	312
Net income	23	35	(7)	(36)	2	25	19	8	96	169	170	15	54	210	396
EPS (Rmb)	0.02	0.03	(0.01)	(0.03)	0.00	0.02	0.01	0.01	0.08	0.14	0.13	0.01	0.04	0.16	0.30
Margins / ratio															
Gross margin	22.1%	20.4%	15.2%	20.4%	20.7%	20.1%	20.3%	20.5%	24.7%	26.7%	25.5%	19.5%	20.4%	22.2%	23.9%
Opex ratio	-22.9%	-20.5%	-22.0%	-24.0%	-22.3%	-20.2%	-21.2%	-21.6%	-21.0%	-21.3%	-21.5%	-22.4%	-21.3%	-18.8%	-16.8%
Operating margin	-0.8%	-0.1%	-6.8%	-3.5%	-1.5%	-0.1%	-0.9%	-1.1%	3.7%	5.4%	3.9%	-2.9%	-0.9%	3.5%	7.1%
Net margin	-1.5%	0.4%	-7.0%	-7.6%	-3.4%	-1.1%	-1.9%	-3.0%	3.7%	4.3%	2.6%	-4.2%	-2.3%	2.4%	5.9%
QoQ															
Revenue	-19%	18%	0%	13%	-22%	18%	4%	16%							
Gross profit	-17%	9%	-25%	52%	-21%	15%	5%	18%							
Operating income	nm	nm	nm	nm	nm	nm	nm	nm							
Pre tax profit	nm	nm	nm	nm	nm	nm	nm	nm							
Net income	22%	49%	nm	nm	nm	1024%	-24%	-60%							
EPS	19%	49%	nm	nm	nm	1024%	-24%	-60%							
YoY															
Revenue	1%	-1%	1%	9%	5%	5%	9%	12%	23%	15%	10%	3%	8%	25%	26%
Gross profit	-14%	-25%	-43%	3%	-2%	3%	45%	12%	14%	25%	5%	-21%	13%	36%	35%
Operating income	nm	nm	nm	nm	nm	nm	nm	nm	24%	70%	-20%	nm	nm	nm	157%
Pre tax profit	nm	-94%	nm	nm	nm	nm	nm	nm	216%	34%	-33%	nm	nm	nm	214%
Net income	-25%	-46%	nm	nm	-90%	-28%	nm	nm	140%	77%	1%	-91%	269%	292%	88%
EPS	-27%	-47%	nm	nm	-90%	-28%	nm	nm	167%	75%	-7%	-92%	309%	292%	88%

Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

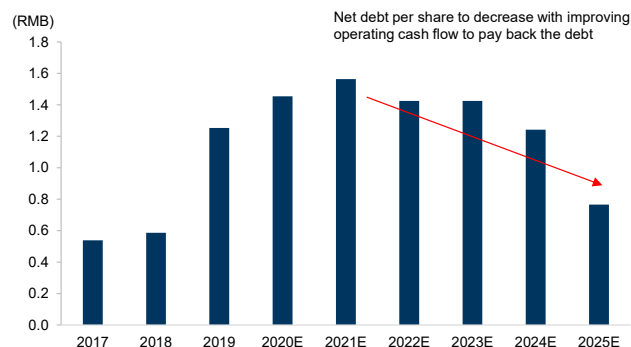
Balance sheet

Net debt per share: Silan has been in a net debt position since 2015, and we expect this trend to persist in coming years as it continues to invest capex for capacity expansion to drive long-term growth. However, we expect its net debt per share to decrease from Rmb1.45 in 2020E to Rmb0.77 by 2025E as we assume the company will gradually pay back debt with increasing operating cash flow.

ROE: Silan's ROE dropped from 5.6% in 2018 to 0.4% in 2019 due to a decline in net margin from 5.6% in 2018 to 0.5% in 2019 given low utilization and weak profitability of the 8" fab. Asset turnover was stable at 0.4x and the asset-to-equity ratio increased slightly from 2.4x in 2018 to 2.5x in 2019. We forecast that Silan's ROE will improve from 1.6% in 2020E to 6.6%/10.7%/15.4% in 2021E/22E/23E, mainly driven by improving net margin (1.6%/5.0%/7.5%/9.9% in 2020E/21E/22E/23E) and better efficiency in asset turnover (0.4x/0.5x/0.6x/0.6x in 2020E/21E/22E/23E).

Exhibit 547: We expect net debt per share to decrease in coming years

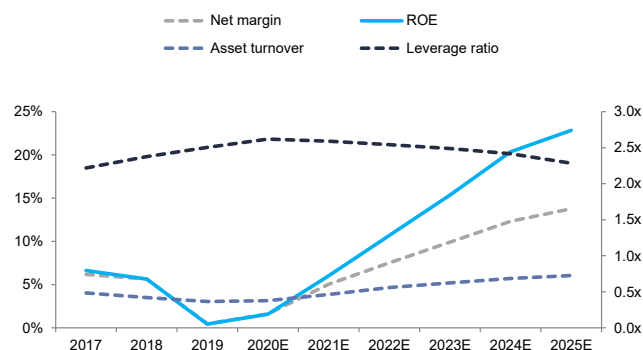
Silan's net debt per share



Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 548: We expect Silan's ROE to improve on net margin and asset turnover

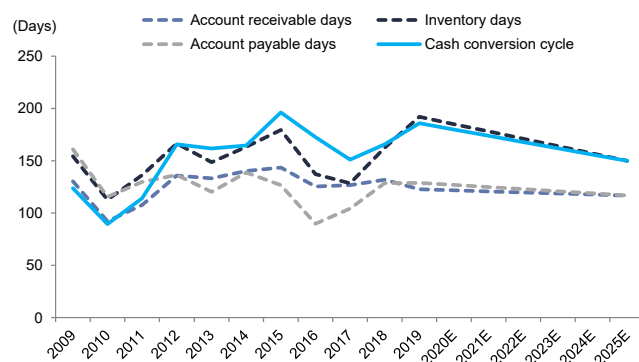
Silan's ROE and DuPont analysis



Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Cash conversion cycle: Silan's cash conversion cycle increased from 151 days in 2017 to 186 days in 2019, mainly due to longer inventory days (increased from 128 days in 2017 to 163/192 days in 2018/19 as it ramped up the new 8" fab), despite account payable days increasing from 104 days in 2017 to 129 days in 2019 due to payments to equipment suppliers. In 2019, around 94% of the company's accounts receivable were within 1 year, while receivables of 3 years and above were 2% of the total. We expect Silan's cash conversion cycle to improve from 180 days in 2020E to 150 days in 2025E, mainly driven by improving AR days and inventory days thanks to its larger scale (better bargaining power) and improving AR/inventory management.

Exhibit 549: We expect Silan's cash conversion cycle to improve on improving AR/inventory management
Silan's cash conversion cycle



Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

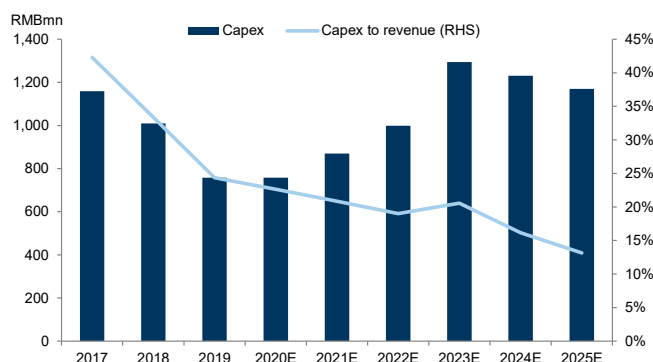
Cash flow

Capex: Silan's capex to revenue ratio declined from 42% in 2017 to 24% in 2019 as its investment in the new 8" fab peaked in 2017 and its revenue grew +10%/+3% YoY in 2018/19. We expect Silan to continue expanding capacity in coming years and model a 9% CAGR for capex in 2020-25E. With revenue growth at a faster CAGR of 22% in 2020-25E, we expect Silan's capex-to-sales ratio to gradually decline from 23% in 2020E to 21%/19% in 2021E/22E.

Free cash flow: Silan's free cash flow was negative in the past few years due to its capex for the new 8" fab, but negative free cash flow narrowed from US\$769m in 2018 to US\$625m in 2019. We expect free cash flow to turn positive by 2024E on improving operating cash flow.

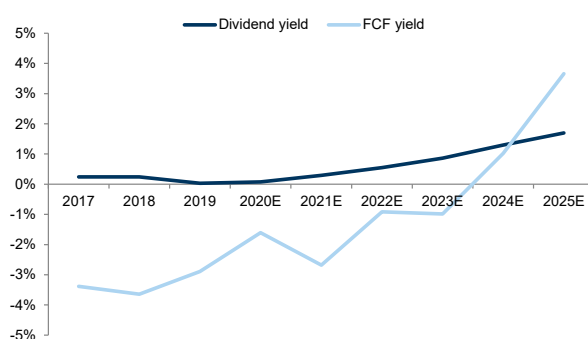
Dividend yield: Silan's dividend payout ratio was 31%/31%/45% in 2017/18/19. We expect its dividend payout to be stable at 30% in 2020E-25E, implying a dividend yield of 0.1%/0.3% in 2020E/21E.

Exhibit 550: Silan capex intensity



Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 551: Silan dividend yield and FCF yield



Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Valuation: 12m TP of Rmb21.5, implying 26% upside

Our 12M target price of Rmb21.5 (implies a 71x 2022E P/E) is derived from discounted P/E, as we believe Silan is still at an early stage of development than global leaders. Discounted P/E captures the company's long-term business opportunity to justify its current higher-than-peers' P/E multiple. We apply a 30x target P/E multiple to Silan's 2025E EPS and discount back to 2022E at a COE of 9.2% (1.0 Beta, 3% risk-free rate, and 6% market risk premium). The 30x target P/E multiple is derived from sector P/E-EPS YoY correlation, with the market generally rewarding higher EPS growth companies in the semiconductor industry based on our regression analysis. Our target price implies 71x 2022E P/E, or PEG at 1.3x based on average 2023-24E EPS YoY growth (+54%). Our valuation cross-check using DCF also shows a similar per-share theoretical value of Rmb22.2, or 74x 2022E P/E. The stock currently trades at 57x our 2022E EPS and at 1.0x our PEG based on average 2023-24E EPS YoY growth. We see these levels as attractive considering its strong earnings growth at a +55% CAGR in 2021-25E. Our 12M target price implies 7.3x 2022E P/B, higher than its historical trading avg +1std of 5.4x as we expect Silan's ROE to expand from 2% in 2020E to 6%/11% in 2021/22E. The stock is currently trading at 5.8x 2022E P/B, higher than global power semiconductor peers' trading range of 1.0x-3.3x, in our view reflecting Silan's stronger earnings growth prospects and ROE expansion in coming years.

Exhibit 552: Discounted P/E valuation: 12m TP of RMB21.5, implied 2022 P/E of 71x

(Rmb mn)	2017	2018	2019	2020E	2021E	2022E	2023E	2024E	2025E
Milestones				MOSFET expansion from low/mid-V to high-V		IGBT expansion into 1200V/1700V for EV/industrial			
Revenue	2,742	3,026	3,111	3,348	4,172	5,256	6,297	7,610	8,896
YoY	15%	10%	3%	8%	25%	26%	20%	21%	17%
Gross margin	26.7%	25.5%	19.5%	20.4%	22.2%	23.9%	25.6%	27.2%	28.0%
Operating profit	148	119	-90	-29	145	372	622	984	1,311
YoY	70%	-20%	nm	nm	nm	157%	67%	58%	33%
Pre-tax profit	119	80	-130	-78	99	312	574	934	1,265
Net profit	169	170	15	54	210	396	623	937	1,225
EPS (Rmb)	0.14	0.13	0.01	0.04	0.16	0.30	0.48	0.71	0.93
YoY	75%	-7%	-92%	309%	292%	88%	58%	50%	31%
2025E target P/E									30
Target multiple x EPS									28
Discounted back to 2022; TP (Rmb)						21.5			
Implied 2022E P/E						71			

COE assumption	
Beta	1.0
Risk free	3.0%
Market risk premium	6.0%
COE	9.2%

Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

DCF cross-check yields theoretical per-share value of Rmb22.2, slightly higher than our discounted P/E-based TP

As a valuation cross-check, our DCF analysis suggests a theoretical per-share value of Rmb22.2, implying 74x 2022E P/E, slightly higher than our target price-implied 2022E P/E of 71x. We model Silan's free cash flow to turn positive in 2024E and to grow at a 24% CAGR in 2025E-30E, with a terminal growth rate of 3%. We believe the company's free cash flow will be driven by: 1) increasing operating cash flow supported by revenue growth in IGBT and MOSFET, as well as improving margins; 2) improving cash

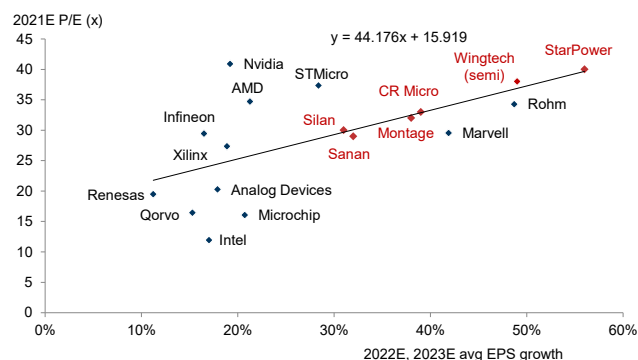
conversion days given its larger scale and improving AR/inventory management; and 3) disciplined capex and lower capex-to-sales ratio. We model WACC at 8.1%, with COE at 9.2%, derived from a beta of 1.0, a risk-free rate of 3.0%, and a market risk premium of 6.0%.

Exhibit 553: DCF-based per-share valuation RMB22.2, implied 74x 2022E P/E

Rmb mn	2017	2018	2019	2020E	2021E	2022E	2023E	2024E	2025E	2026E	2027E	2028E	2029E	2030E
P&L														
Revenue	2,742	3,026	3,111	3,348	4,172	5,256	6,297	7,610	8,896					
YoY	15%	10%	3%	8%	25%	26%	20%	21%	17%					
GM	26.7%	25.5%	19.5%	20.4%	22.2%	23.9%	25.6%	27.2%	28.0%					
Opex ratio	21.3%	21.5%	22.4%	21.3%	18.8%	16.8%	15.7%	14.3%	13.2%					
Opex YoY	17%	11%	7%	2%	10%	13%	12%	10%	8%					
OP income	148	119	(90)	(29)	145	372	622	984	1,311					
YoY	70%	-20%	nm	nm	nm	157%	67%	58%	33%					
Pretax income	119	80	(130)	(78)	99	312	574	934	1,265					
Net income	169	170	15	54	210	396	623	937	1,225					
YoY	77%	1%	-91%	269%	292%	88%	58%	50%	31%					
Cash flow														
CCC	151	166	186	180	174	168	162	156	150					
Capex	1,160	1,010	758	758	870	999	1,295	1,230	1,170					
Capex to revenues	42%	33%	24%	23%	21%	19%	21%	16%	13%					
Free cash flow	(697)	(769)	(625)	(348)	(581)	(198)	(214)	222	792	1,030	1,339	1,606	1,928	2,313
YoY									257%	30%	30%	20%	20%	20%
Terminal growth														3%
Terminal value														47,134
Discount factor							0.93	0.86	0.79	0.73	0.68	0.63	0.58	0.54
Present value of FCF							(198)	190	628	755	909	1,009	1,121	1,245
Enterprise value 2022E (Rmb m)						31,020								
Cash and equivalents						329								
Debt						2,198								
Equity value in 2022E (Rmb m)						29,151								
Value per share (Rmb)						22.2								
Implied 2022E P/E						74x								
WACC assumption (2022E)														
Risk free rate		3.0%												
Beta		1.0												
Market risk premium		6.0%												
Cost of equity		9.2%												
Cost of debt		7.0%												
Tax rate		13%												
Debt / (debt+equity)		36%												
Equity / (debt+equity)		64%												
WACC		8.1%												

Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

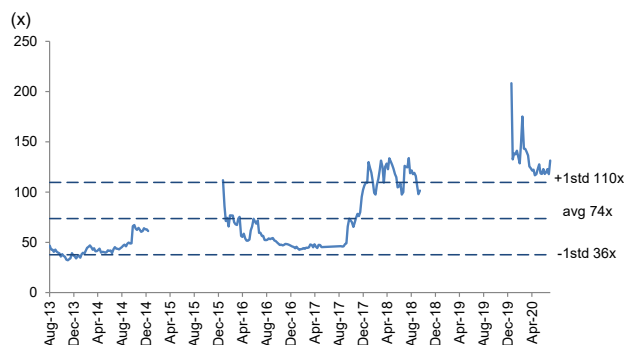
Exhibit 554: Global semiconductor peers' P/E vs. EPS growth to update



Names with 2025E PE and EPS forecast marked in red; Bloomberg estimates for Renesas, others are GSe.

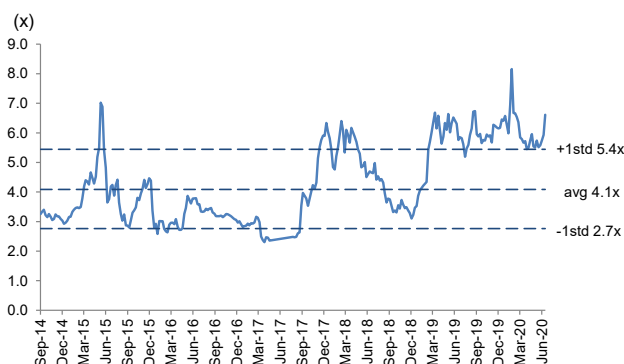
Source: Bloomberg, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 555: Silan 12M forward P/E ratio



Source: Bloomberg

Exhibit 556: Silan 12M forward P/B ratio



Source: Bloomberg

Downside risks

Key downside risks to our investment thesis are:

1) Weaker than expected IGBT market growth: We forecast a 7% China IGBT market CAGR in 2020-25E, mainly driven by EV and home appliance applications. If the penetration of EV and inverter-base home appliances are slower than our forecast, or if the usage of IGBT in EV/inverter-base home appliances is lower than our expectations, IGBT market growth could be weaker than our current forecast.

2) Weaker than expected MOSFET market growth: We forecast a 5% China MOSFET market CAGR in 2020-25E, mainly driven by automotive and EV charging. If the penetration of EV is slower than our forecast, or if the usage of MOSFET in automotive and EV charging systems is lower than our expectations, MOSFET market growth could be weaker than our current forecast.

3) Slower than expected new design-win and market share gain: We model Silan to increase market share in China's IGBT market from 1.9% in 2020E to 7.6% in 2025E, and in the China MOSFET market from 3.6% to 8.5%, mainly in EV, home appliances, and industrial applications. If Silan's new design-wins (orders won from customers for specific products) or market share gains are slower than our expectations, there could be downside to our earnings estimates.

4) Potential impact from COVID-19: Silan's revenue is mainly from the domestic market (~98% of 2019 revenue) but its customers' end products could be sold globally, and therefore Silan could be indirectly impacted by the macro economic slowdown globally in 2020.

Silan

600460.SS	12m Price Target: Rmb21.5	Price: Rmb17.04	Upside: 26.2%		
Buy	GS Forecast				
		12/19	12/20E	12/21E	12/22E
Market cap: Rmb22.4bn / \$3.2bn	Revenue (Rmb mn)	3,110.6	3,348.1	4,171.5	5,255.9
Enterprise value: Rmb25.1bn / \$3.6bn	EBITDA (Rmb mn)	307.8	575.6	842.1	1,205.5
3m ADTV :Rmb488.9mn/ \$69.1mn	EPS (Rmb)	0.01	0.04	0.16	0.30
China	P/E (X)	NM	NM	106.2	56.5
Greater China Technology	P/B (X)	5.7	6.5	6.3	5.8
	Dividend yield (%)	0.0	0.1	0.3	0.5
M&A Rank: 3	Net debt/EBITDA (X)	5.3	3.3	2.4	1.6
	CROCI (%)	3.2	8.6	10.5	12.7
	FCF yield (%)	(3.1)	(1.5)	(2.5)	(0.8)
		3/20	6/20E	9/20E	12/20E
	EPS (Rmb)	0.00	0.02	0.01	0.01

Source: Company data, Goldman Sachs Research estimates, FactSet. Price as of 10 Jul 2020 close.

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StarPower (603290.SS): Local IGBT leader, expanding into high-growth EVs and home appliances; Buy (add to CL)

IGBTs generally function as “on/off” switches for electrical devices, and with their ability to handle large electric currents, they are ideally suited to the power needs of industrial controls, electric vehicles, and many consumer electronics. **We view IGBTs as a promising semiconductor sub-sector** with a global/China TAM reaching US\$10.5bn/3.5bn over the next five years (8%/7% CAGR).

Primary analysts:

Allen Chang, Jin Guo

We initiate StarPower, an IGBT pure play with a leading customer base and advanced technology among domestic peers, at Buy and add to our Conviction List. As it benefits from exposure to growth in IGBTs for industrial, EV, and home appliance applications, we like the company for its improving margins, as its product mix shifts to higher GM EVs and home appliances, as well as its greater revenue scale (2.5x domestic #2), competitive pricing (c.10-15% lower than foreign peers), and more diversified product offerings versus domestic peers. Consequently, we expect the company's market share in China's IGBT market to reach 25% in 2025E, from 5% in 2020E (vs. 8% share for domestic No. 2 in 2025E).

We forecast a **solid revenue/net income** CAGR of +61%/65% in 2020-25E and model earnings growth of +59%/+82% in 2021E/22E (vs. consensus +39%/+39%) mainly on stronger revenue growth assumptions. While StarPower's core industrial IGBT business is a stable cash cow (+25% sales CAGR in 2020-25E), we believe EVs and home appliances are key revenue growth areas (59%/108% sales CAGRs in 2020-25E) where we expect **new design-wins to drive share gains** with new and existing customers. For EVs in particular, we believe cuts to government subsidies in China's EV market could help StarPower gain market share as OEM customers look to reduce costs.

With the company still at an early growth stage and to capture its long-term business opportunities, we derive our **12-month Rmb402 TP (52% upside)** on a discounted PE (target multiple of 40x 2025E EPS based on our sector P/E-EPS YoY correlation analysis; discounted back to 2022E at a 9% COE). We believe the TP implied 2022E P/E of 130x can be supported by strong earnings growth at a +65% CAGR in 2020-25E. We view 2Q results in August and the company's new design-wins in 2H19 as potential near-term catalysts for the shares. Risks: 1) slowing growth in EV and inverter-based home appliances; 2) intensifying competitive pressure; and 3) slower-than-expected new design-wins and market share gains.

PM Summary: Description and top seven questions

Initiate at Buy with a 12-month TP of Rmb402: StarPower is China's domestic leader in IGBT with 2%/4% market share in global/China IGBT market in 2019. IGBTs are used as switches (controlling power on or off) in power electronics, typically for high-voltage applications such as EV, industrial converters, home appliances, etc. The company is expanding from IGBTs for industrial applications into fast-growing EVs and home-appliance applications, and expanding from 600-1700V IGBT to higher voltage (3300V and above) IGBTs for power generation, grid, railway applications.

1. Why are we positive on China's IGBT market? *7% sales CAGR driven by EVs and home appliances; low domestic supply*

We expect China's IGBT market to see sales grow at a 7% CAGR in 2020-25E, mainly driven by growth in the automotive (+19% CAGR, 14% of total market) and home appliance (+7% CAGR, 24% of total market) sectors, while the growing penetration of EV and inverter-based home appliances should drive an increase in IGBT usage as well. StarPower is the IGBT leader in China with only 2%/4% share in the global/China IGBT markets in 2019, and is expanding from industrial controls to EV and home appliance applications, implying significant upside to grow from a low base with technological capability improvements, new design-wins, and share gains.

2. Where we are different from the market? *Stronger earnings growth in 2021-22E driven by 600-1200V IGBTs*

We model stronger EPS growth at +59%/+82% in 2021E/22E (vs. Bloomberg consensus at +39%/+39%) mainly on stronger revenue growth assumptions as we expect StarPower to gain share in 600-1200V IGBT modules for EV and 600V IPMs for home appliance markets with new design-wins, customized solutions, and competitive pricing. Our net income forecast is 46% higher than Bloomberg consensus for 2022E mainly on higher margins as we expect a more favorable product mix to drive margin expansion. Our revenue forecasts are lower than consensus for 2020E as we are more cautious on the prospect of a near-term end-demand slowdown due to COVID-19, which does not impact our constructive view on StarPower's long-term growth outlook with solid market growth and market share gains.

3. What are StarPower's near-term and long-term drivers? *New design-wins, market share gains, expansion into IGBTs above 3300V.*

In the near term, we expect StarPower to gain share with new design-wins in IGBT for NEVs and IPMs for home appliances. StarPower's key customers have 26%/51% aggregated market share in China NEV/home appliances markets, while StarPower only has 7%/1% market share in China IGBT markets for NEV/home appliances in 2019. For the long term, we expect StarPower to expand into 3300V and higher voltage IGBT for power generation, grid, railway applications in 2022E, contributing 6-16% of total revenue in 2022-25E.

4. What are the company's new design-wins? *IGBTs for high-V converters, elevator controllers, BSG in MHEV, IPM for home appliances.*

StarPower achieved new design-wins on 1700V Trench Field Stop IGBT for wind power and high-voltage converter, and penetrated into IGBT modules for elevator controllers and central air conditioning systems for commercial buildings in 2019. In NEV market, the company won new design-wins with its Trench Field Stop 650/750V IGBT chips for NEV customers, and penetrated into power modules for 48V BSG (belt-driven starter generators) in MHEV (mid hybrid electric vehicles) in 2019. StarPower's 600V IPM products were also qualified (i.e., passed its customers' product verification tests) by major home appliance brands in 2019.

5. Technology gap between StarPower vs. global leaders? *Narrowing from >10 years to 5 years*

StarPower has started shipments of Field Stop Trench IGBT technology in 2015, lagging behind global leaders by 10-15 years. The company is developing seventh generation IGBT technology (global leaders launched in 2017-18) and targets to start volume shipments by 2022, which should shrink the gap with global leaders to five years. In terms of the voltage of IGBTs, StarPower can currently supply 100-1700V IGBT (vs. global peers up to 6500V IGBT), and is developing 3300-6500V IGBTs, targeting shipments by 2022.

6. How do we value the stock? *P/E at 130x our 2022E EPS*

Our target price of Rmb402 (implies a 130x 2022E P/E) is derived from a discounted P/E methodology, as we believe StarPower is still at an early stage compared to global leaders. In our view, a discounted P/E approach captures the company's long-term business opportunities which helps to justify its current P/E multiple which is higher than peers (avg. 29x 2022E P/E). We apply a 40x target P/E multiple to StarPower's 2025E EPS and discount it back at a COE of 9% (1.0 Beta, 3% risk-free rate, and 6% market risk premium). Our 40x target P/E multiple is derived from the sector's P/E-EPS YoY growth correlation, and we note that the market has generally rewarded higher EPS growth companies in the semiconductor industry based on our regression analysis. Our target price implies 130x 2022E P/E, or PEG of 2.0x based on average 2023-24E EPS YoY growth (64%). Our crosscheck DCF valuation also shows a similar theoretical share value of Rmb406, or 131x 2022E P/E. The stock currently trades at 85x our 2022E EPS and at a 1.3x PEG based on average 2023-24E EPS YoY growth, which we believe is attractive considering its strong earnings growth at a +65% CAGR in 2020-25E.

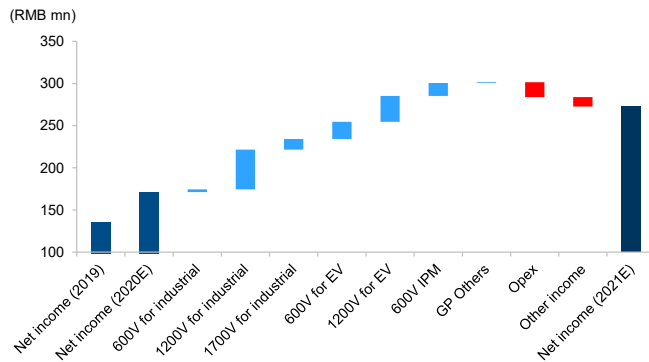
7. Potential downside risks from COVID-19? *Slower revenue growth of +10% YoY in 2020E*

StarPower's revenue comes mainly from the domestic market (~95% of revenue) but its customers' end products are sold globally. We therefore believe StarPower could be impacted by the macro economic slowdown globally in 2020. StarPower's revenue declined 7% YoY in 1Q20 due to reduced production in February and early-March, and we model slower revenue growth of +10% YoY in 2020E (vs. +54%/+15% YoY in 2018/19).

Our thesis in six charts

Exhibit 557: 1200V IGBT for EV and industrial applications are key drivers in 2021E

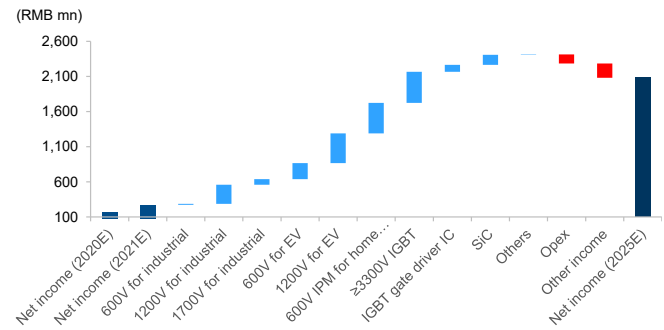
Net profit waterfall chart 2020-21E



Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

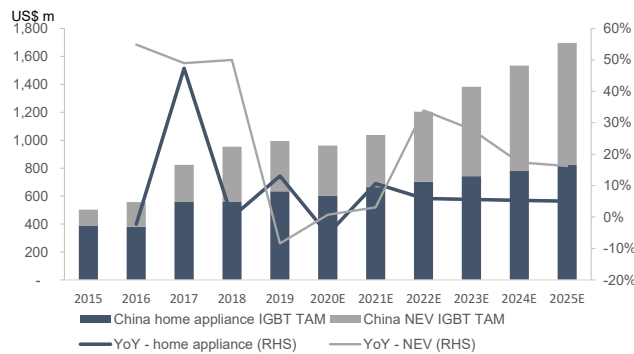
Exhibit 558: We expect StarPower's earnings to grow at a 65% CAGR in 2020-25E

Net profit waterfall chart 2021-25E



Source: Goldman Sachs Global Investment Research, Gao Hua Securities Research

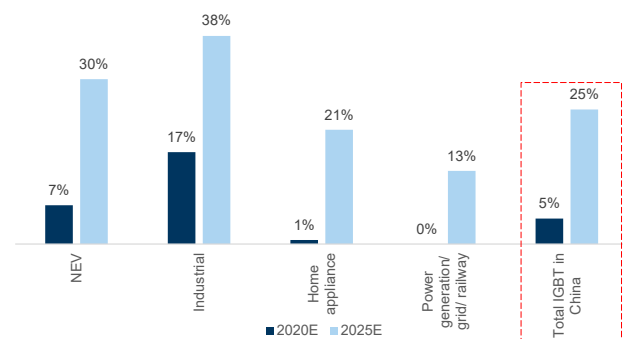
Exhibit 559: China NEV/ home appliance IGBT TAM at +19%/ +7% CAGR in 2020-25E



Source: Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 560: We expect StarPower to reach 25% market share in China IGBT market by 2025E

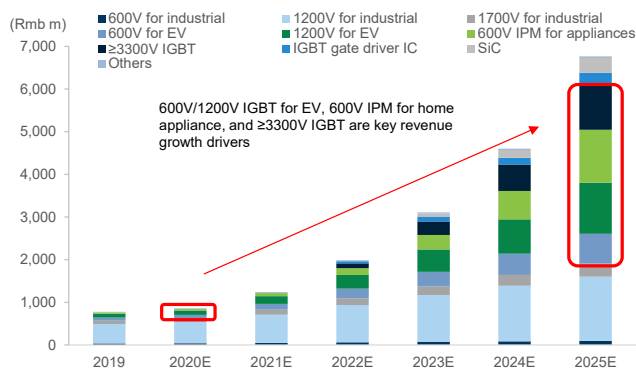
Starpower market share trend by applications



Source: Goldman Sachs Global Investment Research, Gao Hua Securities Research

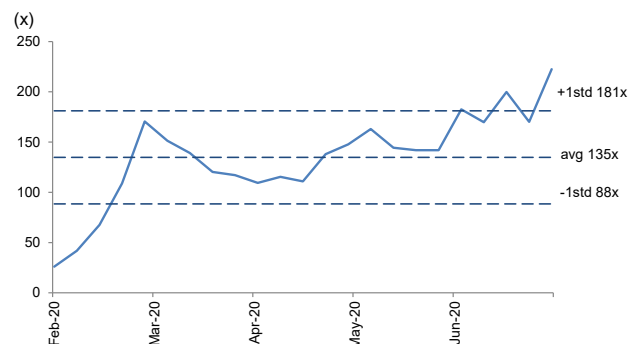
Exhibit 561: We model 51% revenue CAGR in 2020-25E

Revenue mix 2019-25E



Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 562: StarPower 12M forward PE ratio



Source: Bloomberg, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Leading Chinese supplier; stable cash-cow core business: 1200V IGBT for industrial market

StarPower is an IGBT pure play (IGBT comprised 98% of its 2020E revenues) and a leading IGBT supplier for industrial applications, with customers including Innovance (covered by Jacqueline Du) and INVT (Not Covered), two of China's top industrial control suppliers. StarPower's core business is 600-1700V IGBT for the industrial market, mainly used in converters and inverter welding machines, which accounted for 73% of 2019 revenues. The core business is a stable cash cow, with a +32% revenue CAGR in 2016-19 and stable GM at 27-29%, and we expect revenue growth at a +25% CAGR in 2020-25E with GM at 29-32% given: 1) leading market position among Chinese peers in the industrial market, with a leading customer base and technology (1700V in shipment and 3300-6500V under R&D); and 2) rising demand for 1700V IGBTs for use in high-voltage frequency converters, a technology area with high entry barriers; and 3) new design-wins of IGBT modules for elevator controllers and central air conditioning systems.

Starpower IGBT business model snapshot

StarPower is an IGBT chip design house and module maker, with foundry partners Hua Hong and ASMC. Founded in 2005, StarPower is an early entrant with larger scale among domestic peers. In 2019, StarPower's IGBT revenue was Rmb762m (vs. Silan at Rmb260m (including IPM)). The company started shipments of its fourth generation (NPT or Non Punch-Through) IGBTs in 2012 and sixth generation (Field Stop Trench) IGBTs in 2016. It currently supplies 1200V NPT IGBT modules and 650V, 750V, 1200V, and 1700V FS-Trench IGBT modules.

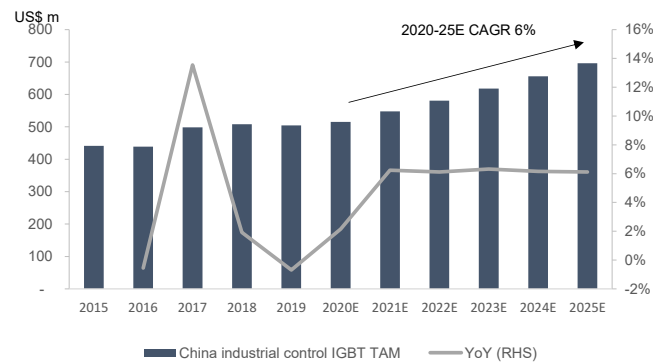
IGBT for industrial market: 73% of 2019 StarPower's revenues; to grow at a 25% CAGR in 2020-25E

Industrial is a key market for IGBT, accounting for 28% of the global IGBT market and 20% of China's IGBT market revenue in 2019. Within industrial applications, StarPower mainly provides IGBTs for converters and inverter welding machines. Looking ahead, we expect a 6% revenue CAGR for China's industrial IGBT market in 2020-23E, driven by growing demand for high-voltage converters in China given their energy-efficiency and the expansion of applications to new power generation markets and transportation as China continues to urbanize.

Converters: We expect revenue in China's IGBTs for converter market to grow from US\$467m in 2020E to US\$621m in 2025E, or a 6% CAGR in 2020-25E. The growing R&D capabilities of Chinese firms are driving the domestic supply of converters, which is favorable to StarPower as domestic customers are more likely to source IGBTs from domestic suppliers. The trends of energy-saving and improving power efficiency should drive the usage of high-performance, high-voltage converters, benefiting StarPower's 1700V IGBT, which is mainly used in high-voltage converters. We also expect IGBTs for low-voltage converters to grow at a 7% CAGR in 2020-25E driven by growing domestic supply, which should benefit StarPower's 1200V/600V IGBTs used in low-voltage converters.

Welding machines: The current migration of welding machines to DC Arc Inverter formats is driving IGBT demand. Specifically, IGBTs can turn 50Hz AC voltage to 1,000-10,000Hz AC voltage. Such welding machines are energy-efficient, with smaller size, lighter weight, and greater portability.

Exhibit 563: China industrial control IGBT TAM



Source: Goldman Sachs Global Investment Research, Gao Hua Securities Research

StarPower’s new design-wins and strong customer base to support market share gains

We expect StarPower’s market share to expand from 16% in 2019 to 38% in 2025E in IGBTs for the industrial market in China. The IGBT market in China is dominated by foreign suppliers while, as of 2019, Chinese suppliers have a combined market share in the low single digits. Its key competitors include Infineon (35% market share in the global IGBT module market in 2018), Mitsubishi Electric (10%), Fuji Electric (10%), etc. Compared with the diversified end-market exposure of global peers, StarPower’s revenue is still relatively concentrated in industrial applications (73% of revenue in 2019).

In 2019, StarPower gained new design-wins with its 1700V Trench Field Stop IGBT for wind power and high-voltage converters, which should contribute to StarPower’s revenue from 2020. The company also penetrated into IGBT modules for elevator controllers and central air conditioning systems for commercial buildings in 2019. As a market share and technology leader in China, we expect StarPower to gain share in China given its advantages of competitive pricing (possibly 10-15% lower than foreign peer solutions based on our supply chain checks), a wide product portfolio covering 600V/1200V/1700V IGBTs for industrial applications, customized solutions, and well-developed relationships with domestic customers. StarPower’s key customers in industrial applications include INVT, Inovance, Zhongchen Electronic Technology, Jee Power System, Hiconics Eco-energy Technology, etc.

StarPower’s products in industrial applications include: 1700V IGBTs for mid-/high-V converters, 1200V IGBTs for low-V converters, welding machines, UPS (Ultraviolet Photoelectron Spectroscopy), and 600V for low-V converters and UPS. In comparison, Infineon makes 3300V-6500V IGBTs for industrial traction applications, as well as industrial-use IGBTs in the 600V-1700V range. Mitsubishi also manufactures 2500V-6500V IGBTs for railway traction inverters and power transmission applications, as well as 100V-1700V IGBTs for industrial applications. While StarPower still lags behind

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global peers in higher voltage IGBTs for industrial applications, the company is also developing higher voltage IGBTs (3300-6500V) for smart grids, railways, and wind power, etc.

StarPower focuses on IGBT chip design and module design/manufacturing, while it outsources the chip manufacturing process to foundry partners, Hua Hong and ASMC. In contrast, most global peers use IDM business models and engage in chip design, chip manufacturing, chip packaging, and module manufacturing. StarPower's business model enables it to focus resources on IGBT technology R&D, module design, and customer engagement, while reducing its capex burden.

'Green' opportunities: Expansion in IGBTs for EV, energy-efficient home appliances, and new energy power generation

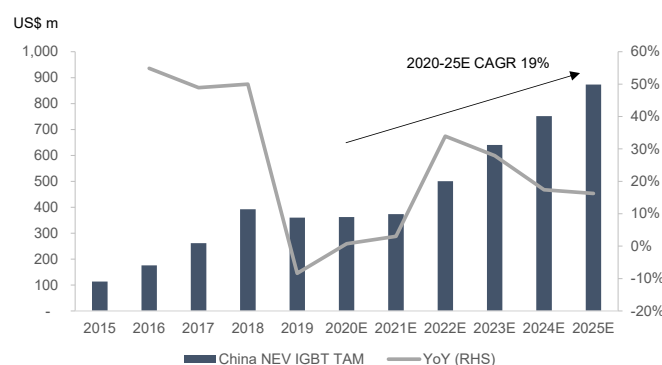
Apart from its core business and leading market position among Chinese peers in the industrial IGBT market, we also see emerging markets as opportunities for StarPower in the context of the 'Green / New energy' trend: 1) EVs use IGBTs for in-car AC control systems and charging piles; 2) frequency conversion / energy-efficient home appliances, including air conditioners, refrigerators, laundry machines, etc; and 3) new energy power generation, including photovoltaic and wind power generation. We see the rising green trend as likely to broaden the scope of IGBT applications and as supportive of StarPower's IGBT revenue growth opportunities. We model revenue growth CAGRs for StarPower's IGBT for EVs and home-appliance IPMs at 59% and 108%, respectively, in 2020-25E. The company has also allocated 27% of its IPO funds to product expansion in the IPM for home appliances space, to gain exposure to the rising energy-efficiency trend in that market.

IGBTs for the EV market: 21% of StarPower's 2019 revenues; to grow at a 59% CAGR in 2020-25E

We expect revenue in China's NEV IGBT market to grow from US\$362m in 2020E to US\$873m in 2025E, or a +19% CAGR in 2020-25E with YoY growth of +3%/+34%/+28%% in 2021/22/23E. We expect the penetration rate of NEVs in the China market will increase from 7% in 2020E to 25% in 2025E, driving NEV unit growth from 1.7m units to 6.4m units, or a +30% CAGR in 2020-25E, with the average EV/PHEV/48v HEV consuming IGBT content of roughly US\$308/\$269/\$79 per vehicle.

Growing EV penetration will also drive demand of EV charging piles, which require IGBTs as a key component. We expect EV charging to contribute 1% of global IGBT market revenue in 2020E, and we model growth at an +8% CAGR, from US\$102m in 2020E to US\$146m in 2025E. In China's IGBT market, EV charging applications should account for 3% of revenue in 2020E, and we model a +2% CAGR, from US\$70m in 2020E to US\$78m in 2025E. Shipment growth for fast charging systems with IGBT content ranging from US\$300-3500 is a key growth driver for this segment.

Exhibit 564: China NEV IGBT TAM



Source: Goldman Sachs Global Investment Research, Gao Hua Securities Research

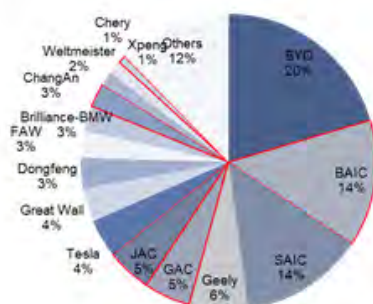
StarPower's new design-wins and strong customer base to support market share gains

In 2019, StarPower completed R&D on key technologies in the next generation of automotive power modules such as double-sided welding, high-temperature molding processes, and double-sided heat dissipation technology, all of which increase the power density of IGBT modules for EV significantly. StarPower also entered mass production of new generation double-sided welding IGBT modules for EVs, and penetrated into power modules for 48V BSG (belt-driven starter generator) in MHEV (mid hybrid electric vehicle) in 2019, which should drive new design-wins and bring revenue streams from 2020E. The company achieved new design-wins with its Trench Field Stop 650/750V IGBT chips for NEV customers in 2019.

StarPower's key EV customers include BAIC, GAC, JAC, Changan, Chery, and these companies had 26% aggregated market share in China's NEV market in 2019. Based on StarPower's shipments in 2019, we estimate it has <30% allocation with these existing customers, and we see upside for StarPower to increase allocations and become a second supplier (i.e., top domestic supplier) for existing customers in the next three to five years as customers seek to diversify supply chain risks and StarPower can offer customized designs with timely service. We also see upside for StarPower to further penetrate into other NEV customers in China as Chinese brands have >70% market share in China's NEV market.

Exhibit 565: StarPower's key NEV customers have 26% aggregated market share

StarPower NEV customer



Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

StarPower provides 100V/150V/600V/650V/1200V IGBT modules for EV applications such as main motor drives in vehicles, air conditioners, electric power steering, charging piles, etc. On top of market growth, we expect StarPower to expand EV IGBT module capacity from 0.6m units in 2019 to 8.2m units in 2025E and expand its IGBT product portfolio into DC/DC converters, high-voltage heaters, and auxiliary inverters, driving YoY revenue growth for StarPower's EV IGBT business of +15%/+70%/+74% in 2020-22E.

Expanding capacity in IGBT modules for EVs

StarPower's overall IGBT module capacity was 4.28m units in 2018 and 4.7m units in 2019, with capacity utilization at 93% and 89%, respectively. With its IPO funding, the company plans to expand capacity for its IGBT modules for EVs by 1.2m units with a total investment of Rmb250m (US\$35m). The new capacity is targeted to start mass

production in two years and management targets annual revenue of Rmb420m and annual profit at Rmb64m (or a net margin of 15%) once the new capacity comes fully online.

Lower EV subsidies likely to encourage sourcing from domestic suppliers to secure cost competitiveness

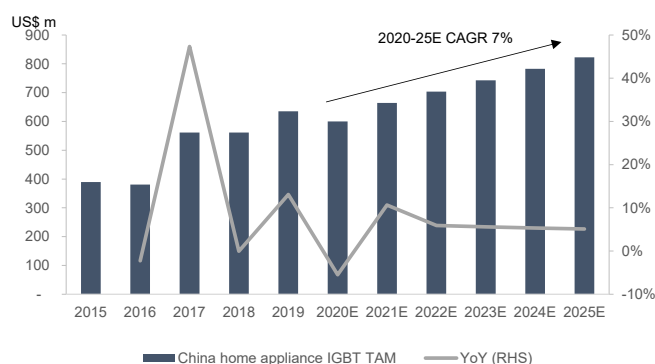
Cuts to government subsidies in China's EV market could help StarPower gain market share as customers look to reduce costs. Based on our supply chain checks, we estimate StarPower's products can be 10-15% cheaper than those of foreign peers with similar performance. We believe customers will likely have an incentive to collaborate more with StarPower to bring down their IGBT costs and diversify their supply chains. StarPower's key customers in the EV market include Shanghai Electric Drive Engineering and Jee Power System.

StarPower's key competitors in the automotive IGBT market are Infineon, Fuji Electric, STMicro, BYD, etc. Compared with BYD (covered by Fei Fang), StarPower has more advanced technology with its sixth generation FS-Trench (BYD uses fourth generation NPT), and unlike BYD, StarPower is not a vehicle OEM and therefore does not compete with other EV OEMs to whom it markets its IGBT products.

IGBT for home appliances: 4% of 2019 revenues; to grow at +108% CAGR in 2020-23E

In China's IGBT market, we expect consumer electronics applications to account for 24% of revenue in 2020E, and we model a +7% revenue CAGR from US\$600m in 2020E to US\$823m in 2025E, making it the second largest revenue growth contributor for China's IGBT market. In the consumer electronics space, we expect inverter-based home appliances to see growing market penetration given their enhanced energy efficiency. In particular, IPMs are key components of inverter-based devices, providing smaller insertion loss and protecting appliances from short circuits. Therefore, as an IPM solutions provider (discussed in detail below), we see StarPower as positioned to benefit from increasing demand for inverter-based air conditioners, refrigerators, and washing machines.

Exhibit 566: China home appliance IGBT TAM

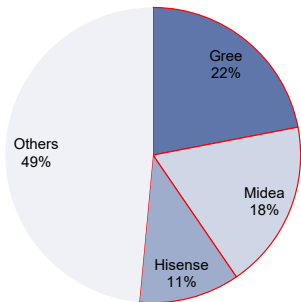


Source: Goldman Sachs Global Investment Research, Gao Hua Securities Research

IPM is one of type of IGBT module. StarPower’s IPM is currently in small volume production, and the company plans to invest Rmb220m (US\$31m) to expand its annual capacity by 7m units in the next two years. Management expects the additional capacity to generate incremental annual revenues of Rmb315m (vs. Rmb779m revenues in 2019) and net income of Rmb50m, or a net margin at 16%. The company expects strong market growth in IPMs for home appliances in China, driven by rising penetration rate of ‘green’ home appliances and a scarcity of domestic suppliers in this market (main suppliers are Infineon, ABB, Mitsubishi, Fuji Electric).

StarPower’s key customers in home appliances include Midea, Gree Electric, and Hisense, with these companies having 51 % aggregated market share in China’s home appliances market as of 2019. StarPower’s 600V IPM products were qualified for use by major home appliance brand customers in 2019. Accordingly, we see upside for StarPower, with its customized designs and timely service, to increase allocations and become the second supplier (and main domestic supplier) for existing customers in the next three to five years as these customers seek to diversify supply chain risks. We also see upside for StarPower to further penetrate into other home appliance customers in China as Chinese brands have majority market share in the domestic home appliances market.

Exhibit 567: StarPower’s key home appliance customers have 51% aggregated market share
China’s home appliance market share 2019



Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Peer comparison in scale, product offerings, and technology

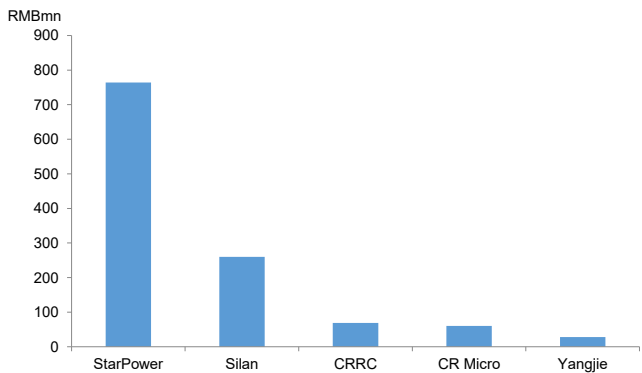
StarPower is the IGBT leader among Chinese players in terms of: 1) revenue scale, 2) product offerings, 3) technology, and 4) customer base. Although StarPower still lags behind global leaders in these aspects, we see StarPower catching up in technology (from Gen 6 to Gen 7/8) and product offerings (expanding into higher voltage 3300-6500V IGBT).

Revenue scale - StarPower is a leader in China, but its revenues are only 5% of the global leader's

StarPower's revenue from IGBT modules was Rmb762m in 2019, or 2% of global market share in IGBT modules, making it the largest supplier among Chinese names. The closest Chinese peer is Silan, who reported Rmb260m revenue from IGBT (including discrete, IGBT modules, and IPMs) in 2019. Other key IGBT suppliers in China include CR Micro (Rmb60m revenue from IGBT in 2019), Yangjie (Rmb28m revenue from IGBT in 2019), Sino-Micro, CRRC, BYDE, etc. Compared with global leaders, StarPower's IGBT module revenue in 2019 was only 5% of market leader Infineon's IGBT module revenue.

Exhibit 568: StarPower has the largest IGBT revenue scale among Chinese players

Key Chinese IGBT suppliers' IGBT revenue in 2019

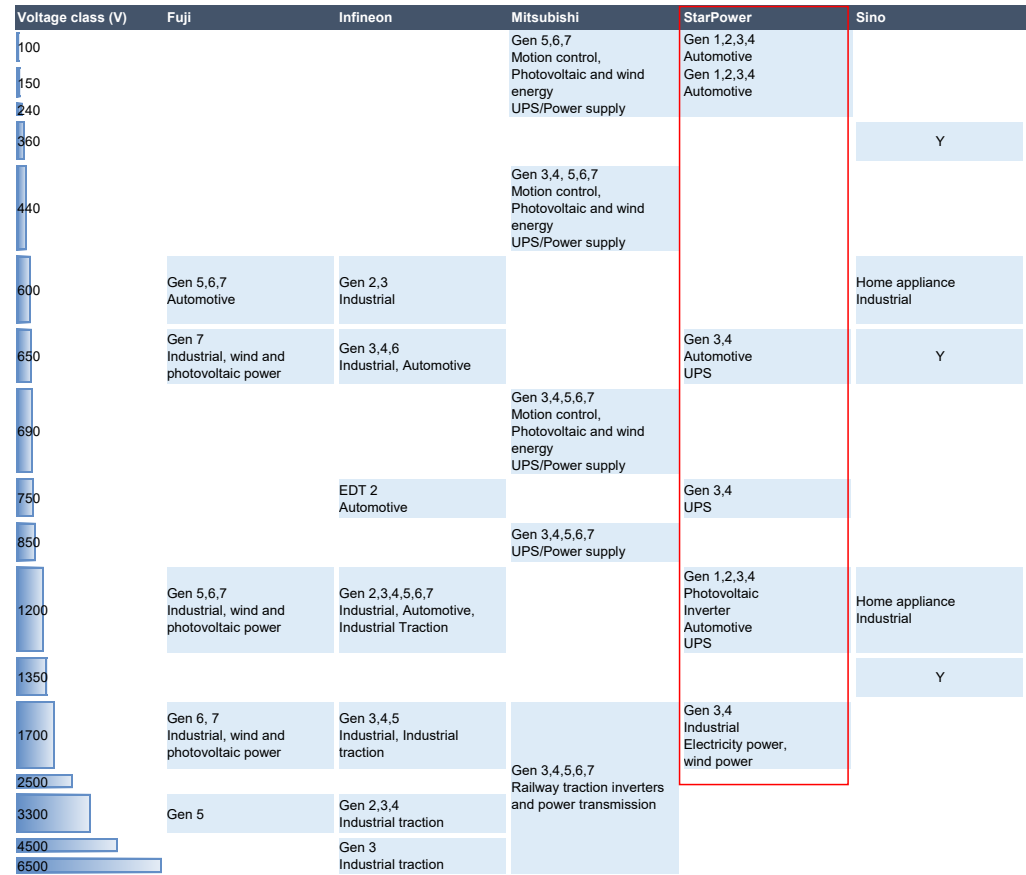


Source: Company data

Product offerings - StarPower has more diversified applications among Chinese peers

Among Chinese peers, StarPower has more diversified product offerings and end-market exposure in industrial, automotive, home appliances, wind power, PV (Photovoltaics), and smart grid. By end market applications, StarPower started with industrial applications in 2008 and gradually expanded into automotive applications and home appliances. The company has also developed an SiC device for solar and an SiC module for EVs in 2019, and has started small volume production of IPMs for home appliances. In comparison, Silan's offerings are currently limited to IGBTs for industrial applications and IPMs for home appliances, and it has not yet entered the automotive market.

Exhibit 569: StarPower IGBT product comp



Source: Company data

Technology migration roadmap - StarPower is shrinking the gap with global peers from >10 years to 5 years

IGBT (Insulated Gate Bipolar Transistor) is a power semiconductor device that was developed by combining BJT and MOSFET. It retains competitive edges from both: 1) BJT: small insertion loss, largest on-state current, and low turn-on voltage; and 2) MOSFET: fast switch speed, small insertion loss, simple drive circuit, low control power, and high input resistance. IGBTs stand out among power semiconductor devices in high voltage, large current and high speed, and thus are the key components for industrial control and automated production. IGBTs are also widely used in energy-efficient equipment, transportation, smart grids, home appliances, automotive electronics, new energy generation, etc. There are six generations of IGBTs from the PT type (first generation) which emerged in 1988 to the FS-Trench type (sixth generation) which emerged in 2003. StarPower was established in 2005 and started to mass produce FS-Trench type IGBT in 2016.

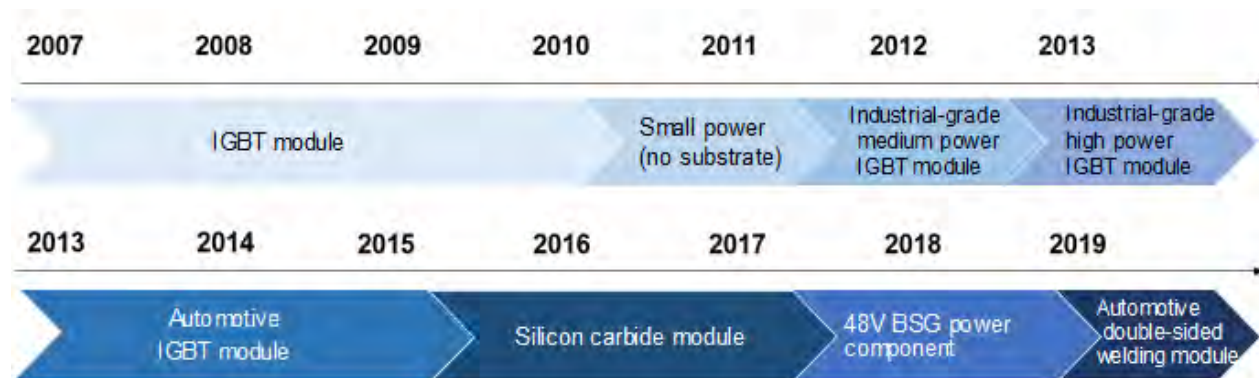
Exhibit 570: IGBT Technology evolution

Year	Tech	Chip area (relative value)	Process line width (μm)	On-state saturation voltage drop (V)	Turn-off time (ms)	Power loss (relative value)	Off-state electricity voltage (V)
1988	PT	100	5	3.0	0.50	100	600
1990	Advanced PT	56	5	2.8	0.30	74	600
1992	Trench	40	3	2.0	0.25	51	1200
1997	NPT	31	1	1.5	0.25	39	3300
2001	FS	27	0.5	1.3	0.19	33	4500
2003	FS-Trench	24	0.5	1.0	0.15	29	6500

Source: Company data

StarPower completed development and started shipments of fourth generation (NPT or Non Punch-Through) IGBT technology in 2011 and sixth generation (Field Stop Trench) IGBT technology in 2015. It currently has 1200V NPT IGBT chips and 650V/750V/1200V/1700V FS-Trench IGBT chips. StarPower is also developing next generation IGBT technology and targets to start mass production by 2022. It will also expand from 1700V IGBT to higher voltage IGBTs (3300-6500V) for smart grid, railway, wind power, etc.

StarPower started shipments of Field Stop Trench IGBT technology in 2015, lagging behind global leaders by 10-15 years. The company is developing seventh generation IGBT technology (global leaders launched in 2017-18) and targets to start volume shipments by 2022, which should shrink the gap with global leaders to five years.

Exhibit 571: StarPower IGBT module technology development

Source: Company data

Exhibit 572: IGBT technology roadmap

Local players shortening tech gap vs. global leaders

Tech Generation	IGBT 1/2 Non Punch Through	IGBT3 Trench+Field-Stop	IGBT4 Trench+Field-Stop	IGBT5 Trench+Field-Stop III	IGBT6 TrenchStop	IGBT7
Infineon	1990-1997		2000-2006			2018
Fuji	1997	2002	2008	2012		2017
StarPower	2011		2015	2014		2022E
CR Micro			2019			
Silan				2020		
BYDE	2009-2012		2017			
CRR	2011		2017			
China players gap vs. global	>10 years	>10 years	< 10 years	< 5 years		

Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

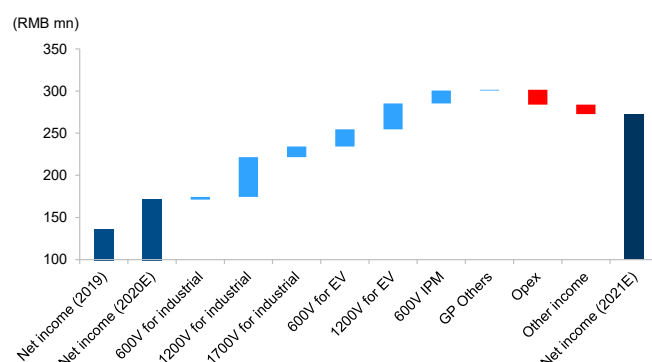
Earnings estimates: +65% NI CAGR in 2020-25E, mainly driven by IGBTs for EVs and IPMs for home appliances

Income statement

We model StarPower's net income growth at a +65% CAGR in 2020-25E, with revenue growth at a +51% CAGR and operating income at a +77% CAGR. We expect revenue growth will be mainly driven by IGBTs for EVs and IPMs for home appliances, markets in China for which we expect revenue growth at a 59% CAGR and 108% CAGR in 2020-25E, respectively. Growth in IGBTs for EVs is likely to be driven by growing EV penetration, which should drive IGBT market growth. We expect StarPower to achieve market share gains from a low base, leading to revenue growth of +70%/+74%/+59% YoY for StarPower's IGBTs for EV in 2021-23E. In addition, we expect growth in IPMs for home appliances to be driven by the increasing penetration of inverter-based home appliances and StarPower's IPM module capacity expansion, which should drive StarPower's IPM revenue growth in this area at +139%/+110%/+115% in 2021-23E.

Exhibit 573: 1200V IGBT for EV and industrial applications are key drivers in 2021E

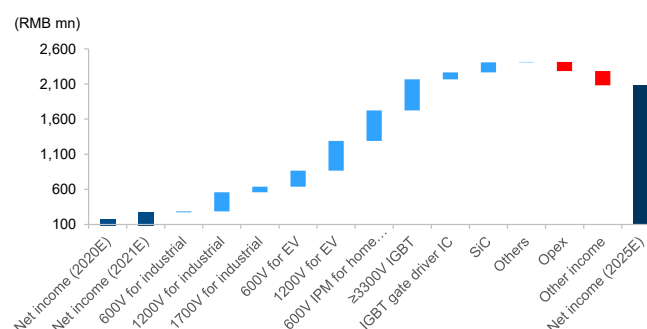
Net profit waterfall chart 2020-21E



Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 574: We expect StarPower's earnings to grow at a 65% CAGR in 2020-25E

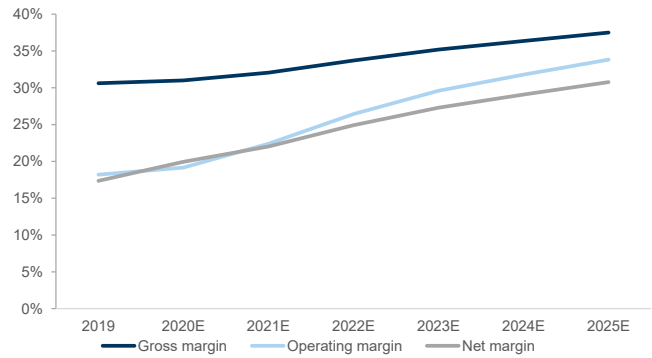
Net profit waterfall chart 2021-25E



Source: Goldman Sachs Global Investment Research, Gao Hua Securities Research

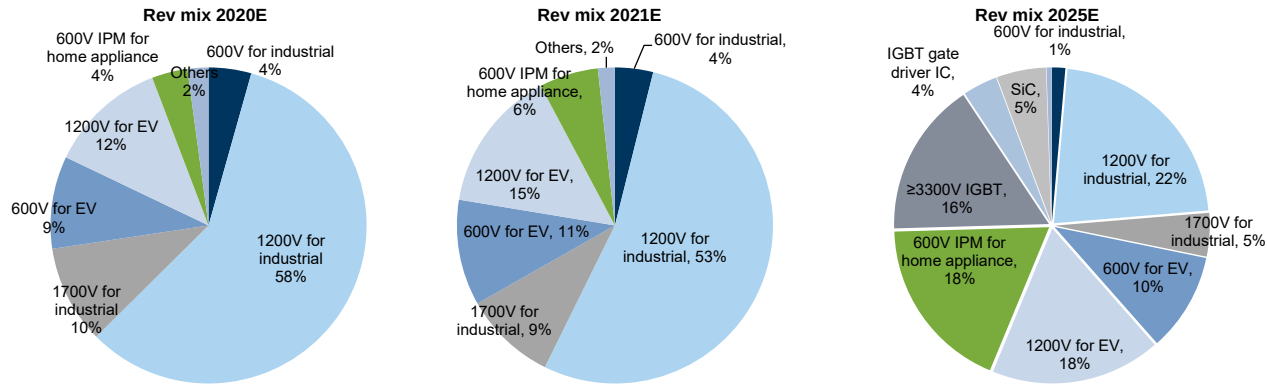
We model GM expansion from 31.0% in 2020E to 32.0%/33.7%/35.2% in 2021-23E on the back of product mix improvement and migration to 12" fabs. By product, IGBT modules for EVs (GM at 38% in 2020E) and IPMs for home appliances (GM at 34% in 2020E) carry higher GM than IGBT modules for industrial applications (GM at 29% in 2020E). We expect the increasing revenue contribution from IGBT modules for EVs (from 21% in 2020E to 28% in 2023E) and IPMs for home appliances (from 4% in 2020E to 11% in 2023E) will drive GM expansion. We also expect StarPower to work with Hua Hong to migrate its IGBT chips to Hua Hong's 12" fab, as the 12" fab could offer 20-30% cost savings to StarPower vs. 8" fabs. We model the company's opex ratio to decline from 12% in 2020E to 10%/7%/6% in 2021-23E, thanks to strong revenue growth.

Exhibit 575: StarPower margin expansion on product mix and operating leverage



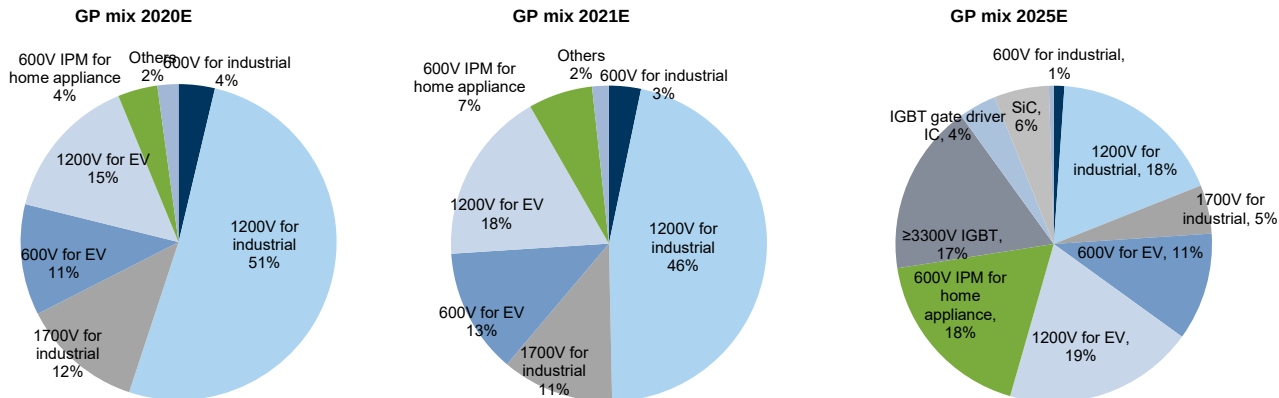
Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 576: 600V/1200V IGBT for EV, 600V IPM for home appliance and ≥3300V IGBT are key revenue growth drivers
StarPower revenue mix in 2020E, 2021E, 2025E



Source: Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 577: 600V/1200V IGBT for EV, 600V IPM for home appliance and ≥3300V IGBT are key profit drivers
StarPower GP mix in 2020E, 2021E, 2025E



Source: Goldman Sachs Global Investment Research, Gao Hua Securities Research

Where we are different from the Street

Our net income is 12%/46% higher than Bloomberg consensus for 2021-22E mainly on higher revenue (for 2022E) and higher margins as we expect a more favorable product

mix to drive margin expansion. Our revenue is lower than consensus for 2020E as we are more cautious on a near-term end-demand slowdown due to COVID-19, which does not impact our constructive view on StarPower's long-term growth outlook with solid market growth and market share gains.

Exhibit 578: Our EPS are 12%/46% higher than consensus for 2021-22E

(Rmb bn)	2020E			2021E			2022E		
	GS	Con	Diff	GS	Con	Diff	GS	Con	Diff
Revenue	859	952	-10%	1,239	1,246	-1%	1,988	1,670	19%
Gross profit	266	293	-9%	397	391	2%	670	540	24%
Operating income	165	191	-14%	277	267	4%	525	370	42%
Pre-tax profit	189	193	-2%	303	269	13%	550	372	48%
Net income	171	175	-2%	273	244	12%	495	339	46%
EPS	1.07	1.10	-2%	1.70	1.53	12%	3.10	2.12	46%
Margins									
Gross margin	31.0%	30.7%		32.0%	31.4%		33.7%	32.4%	
Operating margin	19.2%	20.1%		22.4%	21.4%		26.4%	22.2%	
Net margin	19.9%	18.4%		22.0%	19.6%		24.9%	20.3%	

Source: Bloomberg, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 579: StarPower P&L summary

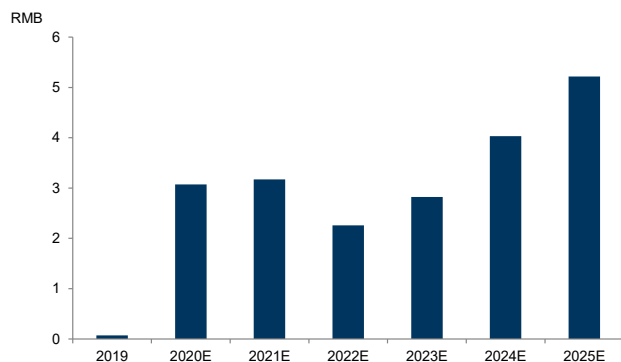
(Rmb m)	1Q19	2Q19	3Q19	4Q19	1Q20	2Q20E	3Q20E	4Q20E	2016	2017	2018	2019	2020E	2021E	2022E
Revenue	149	217	199	214	138	212	234	276	301	438	675	779	859	1,239	1,988
Gross profit	43	68	62	66	43	65	73	86	84	134	199	239	266	397	670
Operating expense	(20)	(23)	(27)	(27)	(22)	(23)	(29)	(29)	(56)	(73)	(90)	(97)	(102)	(119)	(145)
Operating income	23	45	34	39	21	42	44	58	28	61	109	142	165	277	525
Pre tax profit	22	50	42	31	33	46	49	62	24	59	109	145	189	303	551
Net income	19	45	39	32	27	42	45	57	21	53	97	135	171	273	495
EPS (Rmb)	0.16	0.38	0.33	0.26	0.17	0.26	0.28	0.36	0.18	0.44	0.81	1.13	1.07	1.70	3.10
Margins / ratio															
Gross margin	28.8%	31.2%	30.9%	31.0%	30.9%	30.5%	31.2%	31.3%	28.0%	30.6%	29.4%	30.6%	31.0%	32.0%	33.7%
Opex ratio	-13.2%	-10.4%	-13.6%	-12.7%	-15.6%	-10.9%	-12.2%	-10.4%	-18.6%	-16.6%	-13.3%	-12.4%	-11.8%	-9.6%	-7.3%
Operating margin	15.6%	20.8%	17.3%	18.3%	15.3%	19.7%	19.0%	20.9%	9.3%	14.0%	16.1%	18.2%	19.2%	22.4%	26.4%
Net margin	14.5%	23.2%	21.2%	14.4%	24.1%	21.6%	20.7%	22.4%	8.1%	13.4%	16.1%	18.6%	22.0%	24.5%	27.7%
QoQ															
Revenue		46%	-8%	7%	-36%	54%	10%	18%							
Gross profit		58%	-9%	8%	-36%	52%	12%	18%							
Operating income		95%	-24%	14%	-46%	98%	6%	30%							
Pre tax profit		133%	-16%	-27%	8%	38%	6%	27%							
Net income		137%	-13%	-19%	-14%	56%	6%	29%							
EPS		137%	-13%	-19%	-36%	56%	6%	29%							
YoY															
Revenue					-7%	-2%	17%	29%	19%	46%	54%	15%	10%	44%	61%
Gross profit					-1%	-5%	18%	30%	15%	59%	48%	20%	12%	49%	69%
Operating income					-9%	-8%	29%	47%	71%	119%	77%	30%	16%	68%	89%
Pre tax profit					54%	-9%	15%	101%	70%	142%	86%	33%	31%	60%	82%
Net income					42%	-7%	14%	81%	66%	146%	84%	40%	27%	59%	82%
EPS					6%	-30%	-15%	36%	64%	144%	84%	40%	-5%	59%	82%

Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research, Gao Hua Securities Research

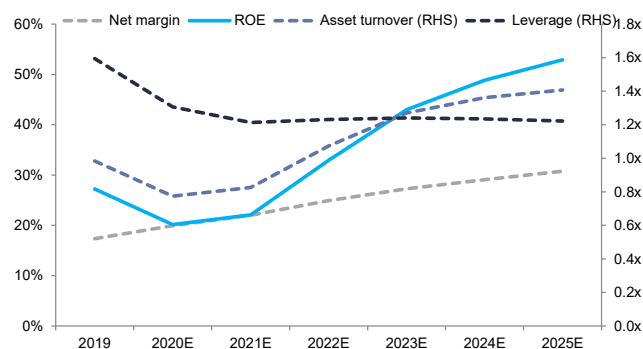
Balance sheet

Net cash per share: StarPower was in a net debt position in 2015-18 and turned net cash in 2019 thanks to improving operating cash flow. We model the company to remain in a net cash position in 2020-2025E, with net cash per share increasing from Rmb3.0 in 2020E to Rmb6.9 in 2025E, driven by increasing operating cash flow.

ROE: StarPower's ROE improved from 8% in 2016 to 27% in 2019, mainly driven by improving net margin (from 7% in 2016 to 27% in 2019) and asset turnover (from 0.5x in 2016 to 1.0x in 2019). Its asset to equity ratio has declined from 2.0x in 2016 to 1.6x in 2019 as it gradually reduced its debt position. For the coming years, we expect StarPower's ROE to improve from 20% in 2020E to 22%/33%/43% in 2021E/22E/23E, mainly driven by improving net margin (20%/22%/25%/27% in 2020E/21E/22E/23E) and better efficiency in asset turnover (0.8x/0.8x/1.1x/1.3x in 2020E/21E/22E/23E).

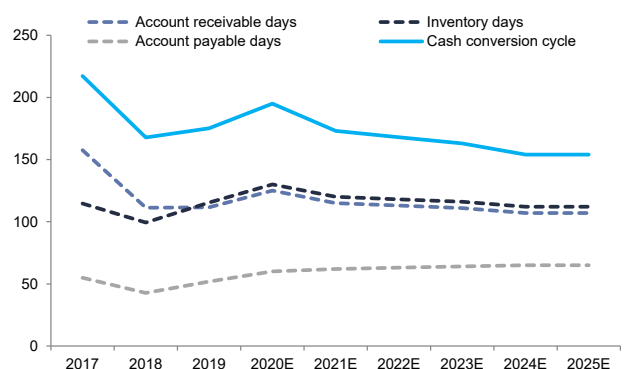
Exhibit 580: StarPower net cash per share

Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 581: Dupont analysis

Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Cash conversion cycle: StarPower's cash conversion cycle improved from 282 days in 2016 to 175 days in 2019, mainly due to lower accounts receivable days (from 200 days in 2016 to 112 days in 2019) and lower inventory days (from 148 days in 2016 to 115 days in 2019), while accounts payable days have shortened from 66 days in 2016 to 52 days in 2019. In 2019, around 98% of the company's accounts receivable were aged within one year, while those aged five years and above remained at <1%. For the coming years, we expect StarPower's cash conversion cycle to improve from 195 days in 2020E to 154 days in 2025E, mainly driven by improving AR days and inventory days thanks to its larger scale (better bargaining power) and improving AR/inventory management.

Exhibit 582: StarPower cash conversion cycle

Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Cash flow

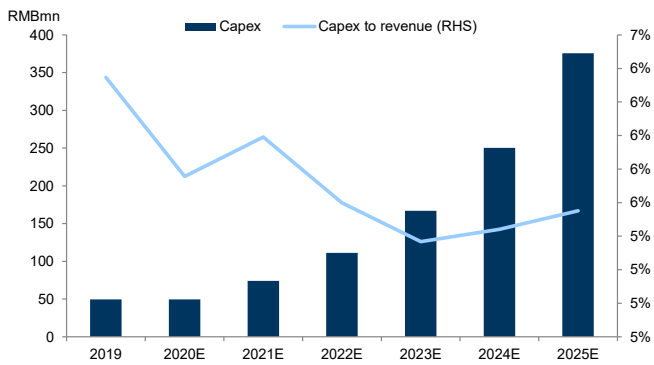
Capex: StarPower's capex to revenue ratio declined from 14% in 2016 to 6% in 2019 given its business model of fabless IC design and module manufacturing, which requires lower capex intensity than foundry/IDMs. We expect the ratio to remain stable at 5-6% in 2020-25E as the company will continue to expand module capacity for growing demand and new product line expansion.

Free cash flow: StarPower's free cash flow was positive during 2018-19 with an annual amount of Rmb54mn on average, or 0.1% free cash flow yield on average. We expect

the yield to rise to 0.5%/0.9%/1.3% in 2023E/24E/25E, driven by rising operating cash flow.

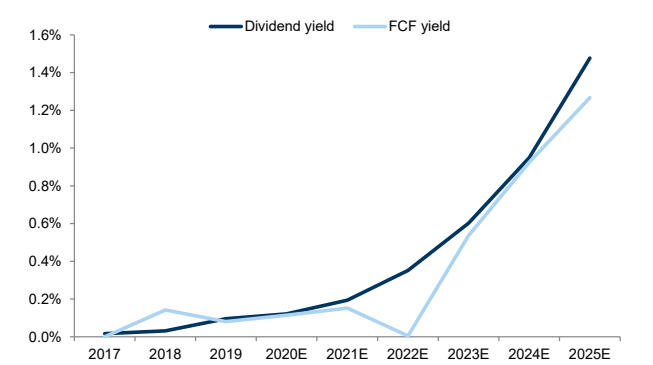
Dividend yield: StarPower’s dividend payout ratio was at 10%/10%/30% in 2017/18/19. We expect its dividend payout to be stable at 30% in 2020E-25E, implying a dividend yield of 0.2%/0.4% in 2020E/21E.

Exhibit 583: StarPower capex intensity



Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 584: StarPower dividend and FCF yield



Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Valuation: TP at Rmb402, implying 52% upside potential

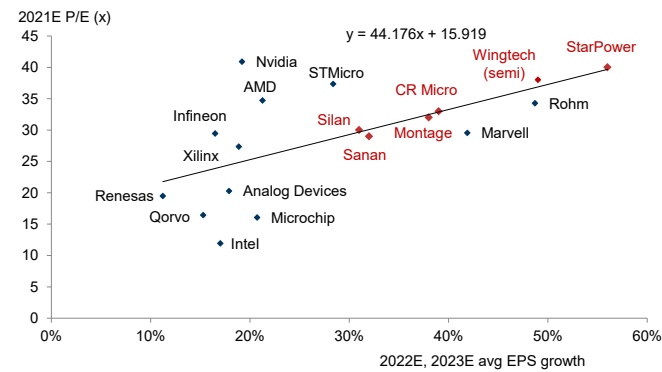
Our 12-month target price of Rmb402 (implies a 130x 2022E P/E) is derived from discounted P/E methodology, which we believe is appropriate considering StarPower is still at an early growth stage compared to global leaders. Specifically, we believe a discounted P/E approach captures the company's long-term business opportunities and helps to justify its current P/E multiple which is higher than peers. We apply a 40x target P/E multiple to StarPower's 2025E EPS and discount back to 2022E at COE of 9% (1.0 Beta, 3% risk-free rate, and 6% market risk premium). Our 40x target P/E multiple is derived from the sector's P/E-EPS YoY growth correlation, and our regression analysis suggests that higher EPS growth companies in the semiconductor industry have generally been rewarded with higher multiples. Our target price implies 130x 2022E P/E, or PEG at 2.0x based on average 2023-24E EPS YoY growth (64%). Our DCF valuation crosscheck also shows a similar theoretical share value of Rmb405, or 131x 2022E P/E. This compares with a peer average 29x 2022E P/E and the stock's current multiple of 85x our 2022E EPS or 1.3x PEG based on average 2023-24E EPS YoY growth, which we believe is attractive considering the company's strong earnings growth at a +65% CAGR in 2020-25E.

Exhibit 585: StarPower discounted P/E valuation: TP at RMB402, implied 130x 2022E P/E

(Rmb mn)	2017	2018	2019	2020E	2021E	2022E	2023E	2024E	2025E
Milestones				Design-wins in 1200V IGBT for industrial		650V/1200V IGBT for EV / home appliances		≥3300V IGBT for power generation, traction	
Revenue	438	675	779	859	1,239	1,988	3,111	4,603	6,767
YoY	46%	54%	15%	10%	44%	61%	56%	48%	47%
Gross margin	30.6%	29.4%	30.6%	31.0%	32.0%	33.7%	35.2%	36.4%	37.5%
Operating profit	61	109	142	165	277	525	920	1,463	2,288
YoY	119%	77%	30%	16%	68%	89%	75%	59%	56%
Pre-tax profit	59	109	145	189	303	551	943	1,487	2,313
Net profit	53	97	135	171	273	495	849	1,338	2,082
YoY	146%	84%	40%	27%	59%	82%	71%	58%	56%
EPS (Rmb)	0.44	0.81	1.13	1.07	1.70	3.10	5.30	8.36	13.01
YoY	144%	84%	40%	-5%	59%	82%	71%	58%	56%
2025E target P/E									40
Target multiple x EPS									520
Discounted back to 2022; TP (Rmb)						402			
Implied 2022E P/E						130			
COE assumption									
Beta		1.0							
Risk free		3.0%							
Market risk premium		6.0%							
COE		9.0%							

Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 586: Global semiconductor peer P/E vs. EPS YoY



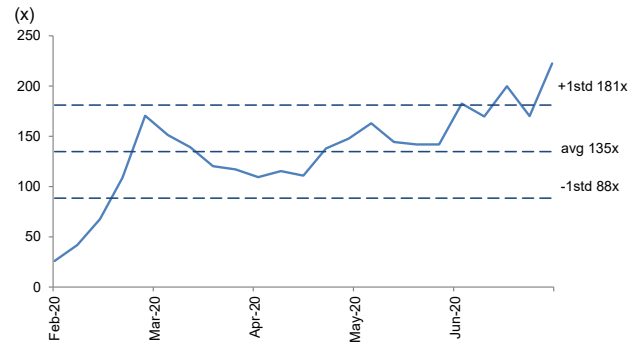
Names with 2025E PE and EPS forecast marked in red; Bloomberg estimates for Renesas, others are GSe.

Source: Bloomberg, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Our target price implies 130x 2022E P/E and 2.0x 2022E PEG, which we view as reasonable given: 1) strong earnings growth of +65% in 2020-25E (versus global peer average of 33% CAGR in 2020-23E); and 2) StarPower’s scarcity value as the domestic leader in IGBT and the only pure-play IGBT supplier in A-share market. Indeed, several A-share semiconductor names with scarcity value are trading at 53-131x 2022E P/E, Anji (leading CMP slurry supplier in China), AMEC (leading SPE supplier in China), SG Micro (leading analog IC supplier in China; covered by Lynn Luo and Jin Guo), NAURA (leading SPE supplier in China; covered by Jin Guo), Montage (one of three memory interface IC suppliers globally). These companies are trading at an average 2022E PEG of 1.2x, largely in-line with StarPower’s 1.3x.

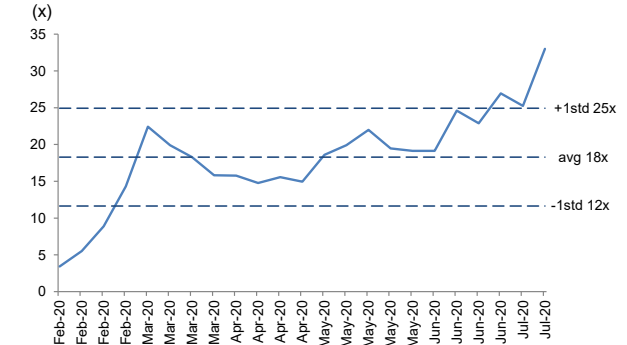
Our 12-month target price implies 38x 2022E P/B, higher than its historical trading range of 3-33x since listing in February 2020, as we expect StarPower’s ROE to expand from 20% in 2020E to 22%/33% in 2021/22E. The stock is currently trading at 25x 2022E P/B, higher than the average of global power semiconductor peers trading in a range of 1.0x-3.3x, largely given StarPower’s stronger earnings growth and higher ROE driven by its fabless business model (vs. most global peers with IDM models). The A-share semiconductor names with scarcity value (identified above) are trading at 12-25x 2022E P/B, lower than the implied P/B multiple (38x) of our target price for StarPower.

Exhibit 587: StarPower 12M forward PE ratio



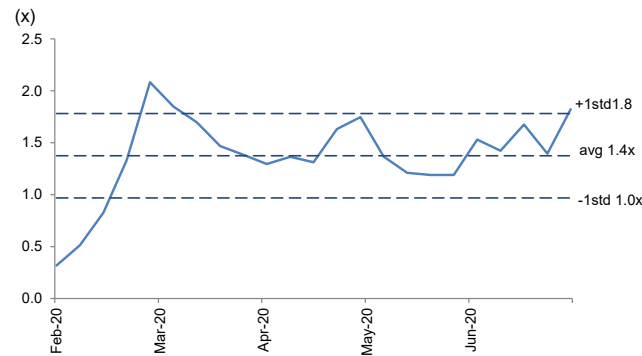
Source: Bloomberg, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 588: StarPower 12M forward PB ratio



Source: Bloomberg, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 589: StarPower PEG ratio



Source: Bloomberg, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 590: Power semi valuation comparison table

Ticker	Rating	Analyst	Pricing currency	PX (LCY)	TP (LCY)	Upside (%)	Market cap (US\$m)	EV (US\$m)	LTM PX move (%)	LTM ADTV (US\$m)	NI growth			Trading P/E			Trading P/B			ROE			Div Yield				
											2020E	2021E	2022E	2020E	2021E	2022E	2020	2021	2022	2020	2021	2022					
Power Semi																											
Local																											
StarPower	603290.SS	Buy*	Allen Chang, Jin Guo	CNY	264.6	402	52%	6,049	6,048	1,981	108	27%	59%	82%	247.3	155.2	85.5	37.1	31.8	25.2	20%	22%	33%	0.1%	0.2%	0.4%	
CR Micro	688396.SS	Buy	Allen Chang, Jin Guo	CNY	96.2	88	57%	9,415	9,512	340	163	17%	74%	65%	145.9	84.0	50.9	6.8	6.3	5.7	6%	8%	12%	0.1%	0.1%	0.2%	
Wingtech	600745.SS	Buy	Verena Jeng, Jin Guo	CNY	160.0	189	18%	25,599	27,669	347	281	143%	54%	18%	59.1	38.5	32.6	7.6	6.5	5.5	14%	18%	16%	0.2%	0.3%	0.4%	
Silan	600460.SS	Buy	Lynn Luo, Jin Guo	CNY	17.0	21.5	26%	3,194	3,615	12	115	269%	292%	88%	416.9	106.2	56.5	6.5	6.3	5.8	2%	6%	11%	0.1%	0.3%	0.5%	
SG Micro	300661.SZ	Buy	Lynn Luo, Jin Guo	CNY	337.0	353	5%	7,484	7,425	453	69	38%	87%	70%	215.2	115.1	67.7	39.8	31.0	22.5	20%	30%	38%	0.1%	0.2%	0.3%	
Yangjie	300373.SZ	NC	NA	CNY	36.4	NA	NA	2,452	2,447	154	57	27%	28%	35%	59.6	46.5	34.4	6.0	5.4	4.7	10%	12%	14%	0.6%	0.7%	NA	
Jiejie	300929.SZ	NC	NA	CNY	33.2	NA	NA	2,313	2,131	182	52	12%	27%	26%	67.5	53.2	42.1	6.5	5.8	5.2	10%	11%	13%	0.3%	0.4%	0.7%	
Sino-Micro	600360.SS	NC	NA	CNY	10.4	NA	NA	1,428	1,386	76	67	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
Good-Ark	002079.SZ	NC	NA	CNY	14.0	NA	NA	1,459	1,389	101	75	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
Jinglai	Private	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
WeEn	Private	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
CNR Yongdian	Private	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
Macmic	Private	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
NCE Power	Private	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
Chinese peers avg.																											
Global																											
ON Semi	ON	Buy	Tozhiya Hari	USD	20.5	22	7%	8,401	11,290	4	137	-94%	2333%	87%	42.9	18.0	11.6	2.7	2.5	2.2	6%	14%	20%	0.0%	0.0%	0.0%	
Infineon	IFXGn.DE	Neutral	Alexander Duval	EUR	22.5	22.5	0%	33,210	31,393	43	159	-27%	21%	18%	47.4	37.9	32.4	3.0	2.8	2.7	6%	8%	9%	1.3%	1.3%	1.3%	
Mitsubishi	6503.T	Buy*	Yuichiro Isayama	JPY	1,378.5	1,650	20%	27,646	26,136	(2)	61	-59%	133%	16%	32.6	14.0	12.1	1.2	1.1	1.1	4%	8%	8%	2.9%	2.9%	NA	
Rohm	6963.T	Neutral	Daiiki Takayama	JPY	7,030.0	7,200	2%	6,773	4,229	(1)	52	-81%	772%	26%	144.6	16.2	12.5	1.0	0.9	0.9	1%	6%	7%	2.1%	2.1%	2.1%	
Cree	CREE	Neutral	Brian Lee	USD	63.0	56	-11%	6,815	6,469	5	73	151%	-37%	-85%	nm	nm	73.5	3.6	3.6	3.7	-11%	-7%	-1%	0.0%	0.0%	0.0%	
ST Micro	STM.PA	Sell	Alexander Duval	EUR	25.4	20.5	-19%	26,112	25,509	(3)	79	-52%	40%	36%	55.8	39.9	29.4	3.9	3.7	3.4	7%	9%	12%	0.5%	0.6%	0.7%	
Renesas	6723.T	Neutral	Daiiki Takayama	JPY	592.0	490	-17%	9,495	15,244	(3)	65	NM	69%	NA	24.2	14.3	NA	1.6	1.4	NA	7%	10%	NA	0.0%	0.0%	NA	
LFUS	NC	NA	NA	USD	166.6	NA	NA	4,045	4,222	(3)	25	-38%	72%	20%	47.8	27.8	23.1	NA	NA	NA	8%	10%	NA	1.2%	1.3%	NA	
Diodes	DIOD	NC	NA	USD	50.6	NA	NA	2,504	2,519	(4)	17	-38%	27%	NA	23.4	18.4	NA	NA	NA	NA	6%	10%	NA	NA	NA	NA	
Vishay	VSH	NC	NA	USD	15.1	NA	NA	2,187	2,025	(4)	20	-42%	61%	33%	22.9	14.3	10.7	1.7	1.8	NA	6%	13%	NA	2.5%	2.5%	NA	
Parit	2481.TW	NC	NA	TWD	29.0	NA	NA	326	478	(4)	4	40%	27%	5%	13.8	10.9	10.4	1.3	1.3	1.2	10%	11%	12%	4.2%	5.9%	6.7%	
Taiwan Semi	5425.TW	NC	NA	TWD	41.0	NA	NA	346	467	(16)	3	-24%	36%	NA	23.5	17.4	NA	1.9	1.8	NA	8%	11%	NA	3.4%	4.6%	NA	
Toshiba	6502.T	CS	NA	JPY	3,510.0	NA	NA	14,938	18,159	3	71	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
Fuji	6504.T	NC	NA	JPY	2,781.0	NA	NA	3,884	5,685	(23)	21	-16%	-8%	24%	11.8	12.8	10.3	1.0	1.0	NA	7%	9%	NA	2.9%	3.2%	1.0%	
Microchip	MCHP	Buy	Tozhiya Hari	USD	106.6	121	13%	26,155	35,373	11	66	-14%	46%	24%	29.2	21.5	18.9	2.4	2.2	2.7	9%	11%	14%	2.0%	2.3%	2.2%	
Global peers avg. excl. outliers											159	86	18%	109%	34%	89.7	44.5	34.7	7.5	6.5	6.3	8%	12%	15%	1.2%	1.4%	1.1%
Median											21	69	12%	60%	33%	47.8	27.8	32.4	3.7	3.8	4.2	7%	11%	12%	0.9%	0.6%	0.5%

Prices as of Jul 10, 2020. NC = Not Covered, CS = Coverage Suspended. Target prices are based on a 12-month time frame; * denotes on Conviction List

Source: Bloomberg, Goldman Sachs Investment Research

DCF cross-check: implying theoretical valuation of Rmb405, similar to our discounted P/E TP

We use DCF as our valuation crosscheck, which suggests a theoretical valuation of Rmb405, implying 131x 2022E P/E — slightly higher than our target price implied 2022E

P/E of 130x. We model StarPower's free cash flow to grow at a 62% CAGR in 2020E-25E, which then declines to 50% CAGR in 2025E-30E, with a terminal growth rate of 3%. We believe the company's free cash flow in 2020E-25E would be driven by: 1) increasing operating cash flow from revenue growth in industrial/EV IGBT applications and IPM for home appliances, as well as improving margins; 2) improving cash conversion days given StarPower's larger scale and improving AR/inventory management; and 3) disciplined capex. We model WACC at 9.0%, with COE at 9.0%, derived from a beta of 1.0, a risk-free rate of 3.0%, and a market risk premium of 6.0%.

Exhibit 591: StarPower DCF implied valuation: RMB405, implied 131x 2022E P/E

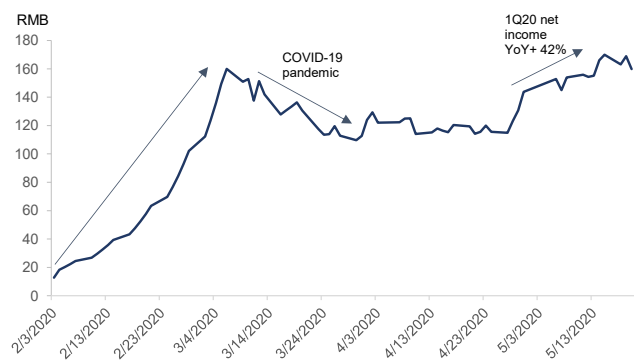
Rmb mn	2017	2018	2019	2020E	2021E	2022E	2023E	2024E	2025E	2026E	2027E	2028E	2029E	2030E
P&L														
Revenue	438	675	779	859	1,239	1,988	3,111	4,603	6,767					
YoY	46%	54%	15%	10%	44%	61%	56%	48%	47%					
GM	30.6%	29.4%	30.6%	31.0%	32.0%	33.7%	35.2%	36.4%	37.5%					
Opex ratio	16.6%	13.3%	12.4%	11.8%	9.6%	7.3%	5.6%	4.6%	3.7%					
Opex YoY	30%	24%	8%	5%	17%	21%	21%	21%	18%					
OP income	61	109	142	165	277	525	920	1,463	2,288					
YoY		77%	30%	16%	68%	89%	75%	59%	56%					
Pretax income	59	109	145	189	303	551	943	1,487	2,313					
Net income	53	97	135	171	273	495	849	1,338	2,082					
YoY		84%	40%	27%	59%	82%	71%	58%	56%					
Cash flow														
CCC	217	168	175	195	173	168	163	154	154					
Capex	48	52	49	49	74	111	167	250	376					
Capex to revenues	11%	8%	6%	6%	6%	6%	5%	5%	6%					
Free cash flow	(24)	68	39	74	98	3	345	595	815	1,225	1,841	2,767	4,160	6,252
YoY			-43%	90%	33%	-97%	12428%	72%	37%	50%	50%	50%	50%	50%
Terminal growth														3%
Terminal value														107,323
Discount factor							0.92	0.84	0.77	0.71	0.65	0.60	0.55	0.50
Present value of FCF							317	501	629	868	1,197	1,650	2,275	3,138
Enterprise value 2022E (Rmb m)						64,436								
Cash and equivalents						361								
Debt						-								
Equity value in 2022E (Rmb m)						64,798								
Value per share (RMB)						405								
Implied 2022E P/E						131								
WACC assumption (2022E)														
Risk free rate	3.0%													
Beta	1.0													
Market risk premium	6.0%													
Cost of equity	9.0%													
Cost of debt	0.2%													
Tax rate	10%													
Debt / (debt+equity)	0.0%													
Equity / (debt+equity)	100.0%													
WACC	9.0%													

Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Share price movement

Despite a short listing history, we believe earnings growth will be a key growth driver for the share price, similar to other A-share semiconductor names. StarPower was listed on 3 February 2020 and the share price went limit up for 22 days in a row from Rmb12.74 on 3 February to Rmb149.46 on 5 March 2020 (vs. CSI 300 Index +14%), which we attribute largely to its leading position and the only pure-play IGBT supplier in China. The stock then declined from Rmb160 on 6 March to Rmb109.7 on 30 March as the broader market corrected with the impact of the COVID-19 outbreak. Following strong 1Q20 earnings growth of +42% YoY (announced on 30 April), the stock rebounded from Rmb130.37 on 29 April to >Rmb160 in mid-May.

Exhibit 592: StarPower share price movement



Source: Company data, Bloomberg

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Downside risks

Key downside risks to our investment thesis are:

1. Weaker-than-expected IGBT market growth: We forecast China's IGBT market to see revenues grow at a 7% CAGR in 2020-25E, mainly driven by EV and home appliance applications. If the penetration of EV and inverter-based home appliances is slower than our forecast, or if the usage of IGBT in EV/inverter-based home appliances is lower than our expectation, IGBT market growth could be weaker than our current forecasts.

2. Slower-than-expected new design-wins and market share gains: We model StarPower to gain market share in China's IGBT market from 4% in 2020E to 25% in 2025E, mainly in EV and home appliances applications. If StarPower's new design-wins or market share gains are slower than our expectation, there could be downside to our earnings estimates.

3. New product ($\geq 3300V$ IGBT) development progress: We expect StarPower to start shipments of $\geq 3300V$ IGBT for power generation application in 2022E, and model $\geq 3300V$ IGBT to contribute 6-16% of total revenue in 2022-25E. If the R&D progress or customer qualification of $\geq 3300V$ IGBT is slower than our expectation, it could result in slower earnings growth in 2022-25E.

4. Intensifying competitive pressure: New entrants into the IGBT market in China include CR Micro, Wingtech, Silan, etc. We expect StarPower to have 25% market share in China IGBT market by 2025E. If other domestic competitors demonstrate faster R&D/new design-wins/market share gains from StarPower, there could be downside risk to our earnings estimates.

5. Potential impact from COVID-19: StarPower's revenues come mainly from the domestic market (~95% of revenue) but its customers' end products could be sold globally, we therefore believe StarPower could be impacted by the macro economic slowdown globally in 2020. StarPower's revenue declined 7% YoY in 1Q20 due to reduced production in February and early-March, and we model slower revenue growth of +2% YoY in 2020E (vs +15% YoY in 2019).

Company history and management background

Exhibit 593: StarPower management background

Name	Position	Joined year	Industry experience	Education background
Shen Hua	Chairman, CEO	2005	1999 - 2006: XILINX, Senior Project Manager	Ph.D. of Materials Science, MIT
Hu Wei	Director, Vice President	2005	1995 - 2001: Providian Financial, Marketing Director, Executive Senior Vice President Assistant, Strategic Planning Manager	Master of Engineering Economic System, Stanford University
Tang Yi	Vice President	2015	2003 - 2015: International Rectifier, Senior Supervisor Engineer, Senior Manager for IGBT design, etc. 2015 - now: StarPower, responsible for IGBT chip technology R&D	Ph.D. of Electronic engineering, RPI
Li Yunchao	Vice President	2009	2005 - 2009: Jiaxing Kailong Plastic Manufacturing, Executive Deputy General Manager	Secondary education
Dai Zhizhan	Vice President	2009	2002 - 2009: Qiankun Technology, Manager of R&D Department, Senior Manager of Power Supply Application Department	Master of Electronic engineering, National Tsinghua University
Xu Haoping	Vice President	2009	2001 - 2009: Huateng Electronic Technology (Suzhou), Senior Manager of Business Department	Bachelor, Nanjing University

Rensselaer Polytechnic Institute (RPI)

Source: Company data

StarPower

603290.SS		12m Price Target: Rmb402		Price: Rmb264.63		Upside: 51.9%	
Buy - CL		GS Forecast					
			12/19	12/20E	12/21E	12/22E	
Market cap: Rmb31.8bn / \$4.5bn		Revenue (Rmb mn)	779.4	859.3	1,238.6	1,988.2	
Enterprise value: Rmb31.3bn / \$4.5bn		EBITDA (Rmb mn)	170.1	202.9	322.6	578.6	
3m ADTV :Rmb780.7mn/ \$110.3mn		EPS (Rmb)	1.13	1.07	1.70	3.10	
China		P/E (X)	NM	NM	155.2	85.5	
Greater China Technology		P/B (X)	NM	37.1	31.8	25.2	
		Dividend yield (%)		0.1	0.2	0.4	
M&A Rank: 3		Net debt/EBITDA (X)	(0.1)	(2.4)	(1.6)	(0.6)	
Asia ex. Japan Conviction List		CROCI (%)	22.9	18.9	20.6	29.6	
		FCF yield (%)		0.2	0.2	0.0	
			3/20	6/20E	9/20E	12/20E	
		EPS (Rmb)	0.10	0.24	0.26	0.34	

Source: Company data, Goldman Sachs Research estimates, FactSet. Price as of 10 Jul 2020 close.

Wingtech (600745.SS): Riding on supply chain diversification trend in China with innovative technology and scale; initiate at Buy

Primary analysts:

Verena Jeng, Jin Guo

We initiate coverage on Wingtech with a Buy rating, given its innovative technology, in-house equipment and large SKUs to expand its semiconductor market share in China. We believe its ODM business would also ride on the 5G smartphone trend in the near term, driving earnings growth.

Growing semiconductor: Wingtech merged with Nexperia in late 2019, extending itself from a smartphone ODM to a power semiconductor supplier and riding on the supply chain diversification trend among Chinese brand customers. Nexperia is a global leader in diode & transistor (25% global market share in 2019), electrostatic discharge (ESD) protection (32%), logic IC (26%), and MOSFET (4%); it is ranked top 2 in automotive MOSFET and top 3 in small signal MOSFET globally) with the following competitive edges:

- **Innovative technology with over 60 years of experience:** Strong in innovative packing technology, enabling semiconductor devices to be smaller, better heat dissipation, lower power consumption and lower costs.
- **In-house equipment R&D center:** More than an integrated device manufacturer (IDM), which controls the designing, manufacturing, packaging and testing, the company also develops packaging and testing equipment in house, driving its production yield rate and allowing it to offer cost competitive products.
- **Larger SKUs:** The company's SKU stands at 16k currently, which is lower than global leaders such as Infineon (60k) and On Semi (30k); however, it is higher than the Chinese suppliers, which mostly have yet to reach 10k.

NI to grow at 22% CAGR in 2020E-25E: We believe this would be driven by: (1) expansion of semiconductor market share, which currently stands at only 10% in China; (2) semiconductor product line expansion to GaN FET, SiC and power management IC; (3) ODM business, which rides on the 5G smartphone trend, with expansion into notebooks and true wireless stereo (TWS); and (4) growing semiconductor support GM as we forecast semiconductor GM at 30.7% on average in 2020E-25E vs. ODM at 9.3%.

Initiate at Buy with 12-month target price of Rmb189: We derive our target price using discounted P/E, with our target P/E multiple set in line with the sector's correlation between earnings growth and P/E (33x 2025E PE). Our target price implies 39x 2022E P/E. Risk are slower-than-expected: GM expansion, semiconductor revenue growth, ODM revenue growth, ODM product line expansion; and less-than-expected synergy between Wingtech and Nexperia.

PM summary: Five key questions**1. Near-term drivers?** *Semiconductor market share expansion; ODM to ride on 5G smartphone trend*

We model revenue/net income CAGR of 16%/35% respectively in 2020E-22E, GM to expand from 12.8% in 2020E to 13.7% in 2022E, and opex ratio to improve from 6.4% in 2020E to 6.2% in 2022E.

We expect the company's revenue growth in 2020E-22E to be mainly driven by its semiconductor market share expansion, along with its ODM business, which we believe would ride on the 5G smartphone trend. For semiconductor, we expect its market share to expand on the back of: (1) innovative technology with over 60 years of experience; (2) in-house equipment R&D center, driving its production yield rate and allowing it to offer cost competitive products; and (3) larger SKUs. Underpinned by the above competitive edges, we expect Wingtech to ride on the trend of supply chain diversification among Chinese brand customers.

For its ODM business, we expect the smartphone ODM ratio to gradually rise from 27% in 2020E to 30% in 2022E, driven by the competitive smartphone market and new 5G era, which triggers brand makers to launch more models rapidly to earn consumers' mind share. We expect Wingtech's smartphone ODM ASP to continue to increase by 39% YoY in 2020E, driven by the increasing 5G smartphone models; however, the growth rate is lower than that in 2019 (68% YoY), considering the higher base and growing mid-end 5G smartphone models. For 2021E and onward, we model a 0-1% YoY decline in ASP, as we expect 5G smartphones to become mainstream with prices getting more and more attractive.

With the growing semiconductor business, we model the blended GM to expand from 12.8% in 2020E to 13.7% in 2022E. We expect the semiconductor business GP exposure to rise to 42% in 2022E from 34% in 2020E. We also expect the opex ratio to gradually improve from 6.4% in 2020E to 6.2% in 2022E, back to the level in 2016-17, driven by the enlarging revenue scale and rising synergy between Wingtech and Nexperia.

2. Long-term drivers? *Semiconductor business product line expansion; business toward semiconductors*

In a longer term, we expect the company's business to more focus on semiconductors, considering the ODM is a lower GM business with fierce competition and 5G smartphone shipment growth is likely to peak out in 2021E, while semiconductors enjoy upside in specification upgrades, product line expansion, and market share gains in China. We expect the semiconductor GP contribution to reach 86% by 2025E vs. 34% in 2020E.

We expect the company's semiconductor revenue growth in 2022E-25E at 22% CAGR, mainly driven by the semiconductor business product line expansion to GaN FET, SiC and power management IC. Wingtech stated that its GaN FET products started mass production in October 2019 at 650V, and the company targets to introduce its 900V product by end 2020E, and its 1200V product by end 2021E. The target end markets

include EVs (e.g. ON-Board Controller module, or OBC module), data centers, telecom equipment, industrial automation, and high-end power supply. For SiC, the company is currently engaged in R&D, and targets to launch products in the coming 2-3 years. For management IC, the company plans to expand through in-house R&D or M&A.

With the growing semiconductor business, we model the blended GM to expand from 13.7% in 2022E to 24% in 2025E. We also expect the opex ratio to gradually improve from 6.2% in 2022E to 6.0% in 2025E, driven by the enlarging revenue scale and the rising synergy between Wingtech and Nexperia.

3. Where are we different from the Street? *Positive on their long term opportunities in semiconductors*

Our net income is largely in line with Bloomberg consensus for the near term (2020-22E); however, over the longer term, we believe the company will gradually move toward the semiconductors business, given the upside in product line expansion, product specification upgrades, market share gains, while the ODM business is lower in GM with flattish market growth and fierce competition. We assume the semiconductor business to contribute 86% of GP by 2025E, driving its GM up to 24% by 2025E vs. 12.8% in 2020E. We are positive on its semiconductor market share expansion given: (1) innovative technology with over 60 years of experience; (2) in-house equipment R&D center, driving its production yield rate and allowing it to offer cost competitive products; and (3) larger SKUs.

4. How do we value the stock? *Discounted P/E to capture its long term opportunities in semiconductors*

We use discounted P/E to capture Wingtech's long-term business opportunities in semiconductors (i.e. market share and product line expansion). We derive our target P/E multiple from the sector's correlation between earnings growth and P/E, and we accordingly apply 33x target P/E multiple on Wingtech's 2025E EPS. Our 12-month target price of Rmb189 implies 39x 2022E P/E.

We also cross-check our 12-month target price with the 10-year DCF method. We model 13% free cash flow CAGR in 2022E-25E, 4% free cash flow CAGR in 2026E-30E, and terminal growth rate of 3%. We then discount the terminal value to 2022E based on a WACC of 8.2%, which is derived from 9% COE and 5% COD. The implied value per share of Rmb190, or implied 39x 2022E P/E, is similar to our 12-month target price of Rmb189 (implied 39x 2022E P/E).

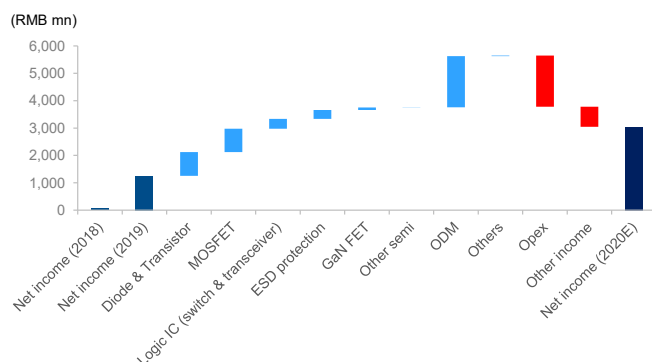
5. Downside risks? *Slower-than-expected GM expansion, slower-than-expected semiconductor revenue growth, slower-than-expected synergy/integration between Wingtech and Nexperia*

Key downside risks to our investment thesis include: (1) slower-than-expected GM expansion, which could be caused by fiercer-than-expected competition in the semiconductor or ODM businesses, slower-than-expected market share gain in the semiconductor business, slower-than-expected roll out of new semiconductor products, or change in the company's strategy, such as to shift its focus back to the ODM

business. (2) Slower-than-expected semiconductor revenue growth, which could be caused by fiercer-than-expected competition in the semiconductor business, slower-than-expected market share gain in the semiconductor business, or slower-than-expected roll out of new semiconductor products. (3) Slower-than-expected ODM revenue growth, which could be caused by fiercer-than-expected competition, lower-than-expected ODM ratio or slower-than-expected market share expansion. (4) Slower-than-expected expansion of ODM product lines. (5) Slower-than-expected synergy/integration between Wingtech and Nexperia.

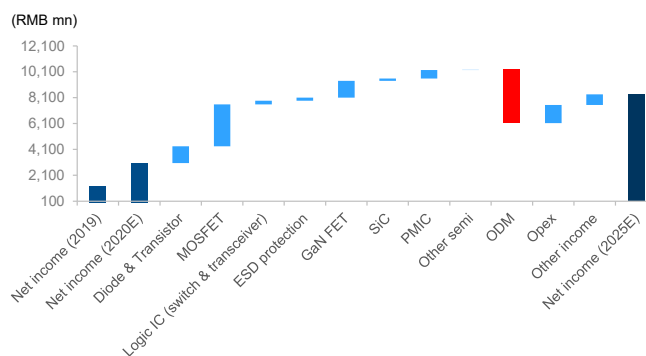
PM summary: Investment thesis in six charts

Exhibit 594: Near-term drivers: Semiconductor market share expansion; ODM to ride on 5G smartphone trend
Waterfall chart for 2019-20E



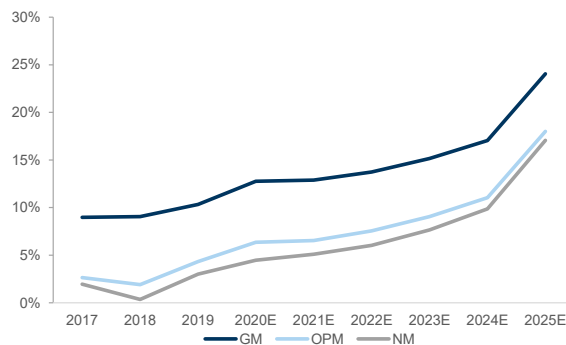
Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 595: Long-term drivers: Semiconductor product expansion; toward semiconductor business
Waterfall chart for 2020-25E



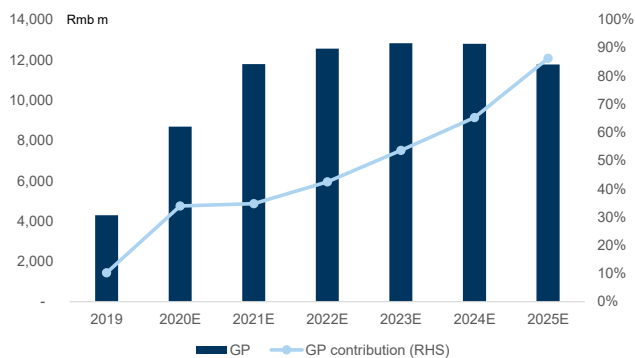
Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 596: Growing semiconductor business supports margins...
Wingtech margins trend



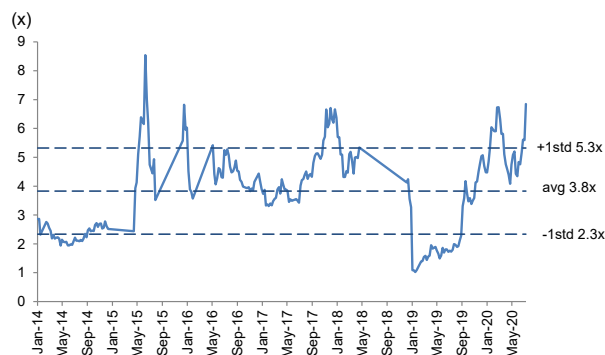
Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 597: ...as well as blended GM
Wingtech semiconductor business GP and GP contribution



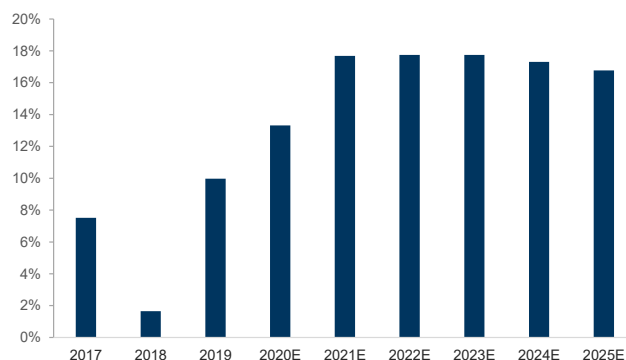
Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 598: Wingtech 12m forward P/B ratio



Source: Bloomberg

Exhibit 599: Wingtech ROE trend



Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 600: P&L summary (quarterly)

Rmb mn	1Q19	2Q19	3Q19	4Q19	1Q20	2Q20E	3Q20E	4Q20E	1Q21E	2Q21E	3Q21E	4Q21E	1Q22E	2Q22E	3Q22E	4Q22E
Income statement																
Revenues	4,886	6,548	10,440	19,704	11,340	15,562	20,405	20,781	18,904	22,056	24,485	26,076	18,746	22,327	24,167	26,150
Gross profits	343	608	797	2,544	2,013	1,966	2,372	2,338	2,446	2,922	3,083	3,344	2,595	3,177	3,251	3,539
Selling expense	17	19	42	406	277	233	204	208	265	309	343	339	244	290	314	340
G&A expense	101	96	133	285	292	249	306	312	321	375	416	417	300	357	387	418
R&D expense	159	217	253	690	490	622	612	416	586	684	759	808	581	692	749	811
OP income	61	270	331	1,138	930	845	1,175	1,377	1,235	1,532	1,476	1,747	1,432	1,815	1,713	1,937
Government subsidies	26	26	(5)	(5)	-	-	-	-	-	-	-	-	-	-	-	-
Pretax income	95	185	397	796	844	670	1,000	1,206	1,102	1,400	1,344	1,614	1,306	1,689	1,587	1,811
Net income	43	153	334	723	635	543	840	1,026	932	1,200	1,149	1,393	1,116	1,461	1,369	1,570
EBITDA	142	351	533	1,340	1,647	1,562	1,892	2,094	2,070	2,367	2,311	2,581	2,340	2,723	2,621	2,845
EPS (RMB)	0.1	0.2	0.5	0.6	0.6	0.5	0.7	0.9	0.8	1.1	1.0	1.2	1.0	1.3	1.2	1.4
Ratios																
R&D ratio	3%	3%	2%	4%	4%	4%	3%	2%	3%	3%	3%	3%	3%	3%	3%	3%
Opex ratio	6%	5%	4%	7%	10%	7%	6%	5%	6%	6%	7%	6%	6%	6%	6%	6%
Tax rate	6%	28%	25%	-8%	18%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%
Margins																
GM	7.0%	9.3%	7.6%	12.9%	17.8%	12.6%	11.6%	11.3%	12.9%	13.2%	12.6%	12.8%	13.8%	14.2%	13.5%	13.5%
OPM	1.2%	4.1%	3.2%	5.8%	8.2%	5.4%	5.8%	6.6%	6.5%	6.9%	6.0%	6.7%	7.6%	8.1%	7.1%	7.4%
Pretax margin	2%	3%	4%	4%	7%	4%	5%	6%	6%	6%	5%	6%	7%	8%	7%	7%
EBIT margin	1.2%	4.1%	3.2%	5.8%	8.2%	5.4%	5.8%	6.6%	6.5%	6.9%	6.0%	6.7%	7.6%	8.1%	7.1%	7.4%
Net margin	0.9%	2.3%	3.2%	3.7%	5.6%	3.5%	4.1%	4.9%	4.9%	5.4%	4.7%	5.3%	6.0%	6.5%	5.7%	6.0%
EBITDA margin	2.9%	5.4%	5.1%	6.8%	14.5%	10.0%	9.3%	10.1%	10.9%	10.7%	9.4%	9.9%	12.5%	12.2%	10.8%	10.9%
YoY																
Revenues	185%	77%	87%	211%	132%	138%	95%	5%	67%	42%	20%	25%	-1%	1%	-1%	0%
Gross profits	66%	157%	147%	216%	487%	223%	198%	-8%	22%	49%	30%	43%	6%	9%	5%	6%
OP income	na	na	394%	242%	1428%	214%	255%	21%	33%	81%	26%	27%	16%	18%	16%	11%
EBIT / OP income	na	na	394%	242%	1428%	214%	255%	21%	33%	81%	26%	27%	16%	18%	16%	11%
Pretax income	na	na	2734%	262%	791%	262%	152%	52%	31%	109%	34%	34%	19%	21%	18%	12%
Net income	na	na	4121%	214%	1380%	254%	151%	42%	47%	121%	37%	36%	20%	22%	19%	13%
QoQ																
Revenues	-23%	34%	59%	89%	-42%	37%	31%	2%	-9%	17%	11%	6%	-28%	19%	8%	8%
Gross profits	-57%	77%	31%	219%	-21%	-2%	21%	-1%	5%	19%	6%	8%	-22%	22%	2%	9%
OP income	-82%	343%	23%	244%	-18%	-9%	39%	17%	-10%	24%	-4%	18%	-18%	27%	-6%	13%
Pretax income	-57%	95%	115%	100%	6%	-21%	49%	21%	-9%	27%	-4%	20%	-19%	29%	-6%	14%
Net income	-81%	257%	118%	116%	-12%	-15%	55%	22%	-9%	29%	-4%	21%	-20%	31%	-6%	15%
EBITDA	-65%	146%	52%	151%	23%	-5%	21%	11%	-1%	14%	-2%	12%	-9%	16%	-4%	9%

Source: Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Investment thesis

We expect Wingtech's net income to grow at a 22% CAGR in 2020E-25E, with GM to expand to 24% in 2025E (vs. 10.3%/12.8% in 2019/20E), driven by:

- **Semiconductor market share expansion:** We are positive on the market share expansion given Wingtech's: (1) large SKUs (16k vs. Chinese peers which are hardly at 10k); (2) leading technology (innovative packaging to shrink size, enhance heat dissipation, lower costs, and in-house equipment R&D center to enhance product yield rate and production stability); and (3) upside in Chinese brand customers given that Nexperia has become a Chinese supplier, participating in the Chinese brand customers' trend of supply chain diversification due to trade tensions to lower the single country supply risk.
- **Semiconductor product line expansion:** Wingtech's semiconductor business/Nexperia enjoyed a 14% global market share in 2019, with four main products: diode & transistor, logic IC, ESD protection and MOSFET. In the future, management targets to expand products to GaN FET, SiC and power management IC. Wingtech stated that its GaN FET products started mass production in October 2019 at 650V, and the company targets to introduce its 900V product by end 2020E, and its 1200V product by end 2021E. The target end markets include EVs (e.g. ON-Board Controller module, or OBC module), data centers, telecom equipment, industrial automation and high-end power supply. For SiC, the company is currently engaged in R&D, and targets to launch its products in the coming 2-3 years. For management IC, the company plans to expand through in-house R&D or M&A.
- **Growing semiconductor support GM:** We expect Wingtech's semiconductor gross profit contribution to rise from 10%/34% in 2019/20E to 86% in 2025E driven by market share gain and product line expansion, while we forecast a declining GM trend for the ODM business given the fierce competition. Our semiconductor GM estimate stands at 30.7% on average in 2020E-25E vs. ODM at 9.3% on average during the same period. Consequently, we expect the blended GM to rise to 24% in 2025E from 10.3%/12.8% in 2019/20E.

MOSFET: Higher market share upside vs. other semiconductor products

Wingtech consolidated Nexperia in 4Q19, with the latter accounting for 4% of Wingtech's 2019 revenue, and we expect this to increase to 15% in 2020E. MOSFET is one of the key products of Nexperia, with 31% revenue contribution to Nexperia in 2019, while the remaining revenues came from: diode and transistor (39%), logic IC (16%), and ESD protection (14%). In terms of MOSFET, Wingtech mainly provides three types of product: automotive, small signal/small power, and power MOSFET. Below, we explain what these three segments are, and highlight Wingtech's SKU, competitive edge, and product examples.

Products:

- **Automotive MOSFET:** Used to turn on and off the power rails in certain units in cars, such as: (1) body control, for example, fan control, door control, seat control, windows control, etc.; (2) infotainment system, for example, audio control, GPS control, etc.; and (3) safety system, for example, airbag control, LED lighting control, etc.
- **Small signal/small power MOSFET:** Used in non-automotive applications, such as TVs, set-top boxes, tablets, PCs, etc.
- **Power MOSFET:** Used in DC-to-DC communication solutions, voltage regulator modules (VRMs), power supply modules (POLs), synchronous rectifier controllers, etc.

SKU and competitive edge:

- **Automotive MOSFET:** Wingtech has over 400 product types, ranging from 20 to 100V with drain currents from 0.3 to 425A, housed in leading package technologies.
- **Small signal/small power MOSFET:** Wingtech offers a broad portfolio, which includes both leaded and leadless options with high power density.
- **Power MOSFET:** Wingtech offers power MOSFET with super junction technology along with leading packaging technology of LPAK, and its products could operate up to 100V.

Product examples:

- **Automotive MOSFET:** An example would be LPAK56D. The product is equal to two MOSFETs in one package without compromising on performance, saving 77% space. The product could be used in engine management, antilock brake system (ABS)/electronic stability program (ESP) systems, transmission control, body control, and LED lighting.
- **Small signal/small power MOSFET:** An example would be PMN30XPA. Launched in April 2020, the product is a 20V, P-channel Trench MOSFET used in relay driver (IC to drive or operate a relay appropriately, open or close for example), high-speed line driver (device amplifies a signal), high-side load switch (connect/disconnect a power source), and switching circuits.
- **Power MOSFET:** An example would be PSMN2R6 - 100SSF. Launched in June 2020, the product is a 100V, N-channel MOSFET in LPAK88 package used in industrial and

consumer applications, for example: synchronous rectifier in AC-DC and DC-DC, primary side switch in DC-DC, BLDC (brushless DC) motor control, full-bridge and half-bridge applications, and battery protection.

Exhibit 601: Wingtech product examples (ASP and key features)

Category	Products	ASP (US\$)	Key features			Others
			Voltage	Power	Current	
Diode	Voltage regulator diode	0.02	27V	250mW	50mA	
Diode	Schottky barrier diode	0.01	30V		200mA	
Transistor	NPN switching transistor	0.01	40V	250mW	200mA	
Transistor	NPN medium power transistor	0.06	80V	1.25W	1A	
MOSFET	N-channel Trench MOSFET	0.02	60V	830mW	300mA	
MOSFET	N-channel Trench MOSFET	0.03	60V	350mW	360mA	
Logic IC	4-bit bus switch	0.25	2.3V~3.6V		250 mA	
Logic IC	Single 2-input multiplexer	0.08	1.65V~5.5V		250 mA	
Logic IC	Shift register with output latches	0.09	2V ~ 6V			8 inputs/bits per element
Logic IC	Quad 2-input AND gate	0.10	2V ~ 6V			2 inputs/bits per element
ESD protection	Low capacitance bidirectional ESD protection diode	0.05	3.3V		18A	
ESD protection	Low capacitance bidirectional ESD protection diode	0.04	5V		15A	

Source: Company data

Customers

Wingtech's semiconductors are mainly exposed to automotive electronics (44% of 2019 Nexperia revenues), followed by mobile and wearables at 21%, industrial and power supply at 20%, and PC and consumer electronics at 15%.

- **Automotive electronics:** Bosch, BYD, Continental, Delphi, Denso, etc.
- **Mobile and wearables:** Apple, Google, Fitbit, Huawei, Samsung, Xiaomi, etc.
- **Industrial and power supply:** Emerson, Cisco, Delta, Schneider, etc.
- **PC and consumer electronics:** ASUS, Dell, HP, Amazon, DJI, Dyson, LG, etc.

Growth drivers

We are positive on Wingtech's MOSFET business segment and expect its global market share to rise from 4.8% in 2019 to 5.1%/7%/10% in 2020E-22E and to 17% in 2025E, driven by:

1. Growing SKU

Wingtech's overall semiconductor SKU is currently at 16k, which is lower than global leaders such as Infineon (60k) and On Semi (30k); however, it is higher than the Chinese suppliers, which have mostly yet to reach 10k. Wingtech will continue to expand its SKU, targeting to expand by c.60% in the coming 3-5 years to drive its market share gain.

2. Innovative technology

Nexperia has over 60 years of experience in the semiconductor industry with leading global market shares in: (1) discrete devices (global top 1); (2) ESD protection (global top 1); (3) logic IC (global top 2, only after TI); (4) automotive MOSFET (global top 2, only after Infineon); and (5) small signal/small power MOSFET (global top 3, only after On Semi and Rohm).

We see its leading technology as enhancing its global market position. The company is strong in innovative packaging technology, enabling smaller size, better heat dissipation, lower power consumption, and lower costs.

Apart from its innovative technology, Nexperia also has an equipment R&D center, ITEC, which was established in 1991. The center mainly develops packaging and testing equipment, along with revision and maintenance. The R&D center enables Nexperia to provide cost competitive products with mass production at a high yield rate and efficiency. ITEC also continues to upgrade its equipment to support higher automated production and AI (image comparison, big data analysis, etc.) to further drive the yield rate, efficiency and production stability.

3. China market share upside

Nexperia's market share in China stood at only 10% in 2019, and management targets to drive it up to 30%-40% in 3-5 years via expanding SKUs, product lines, and synergies with Wingtech to introduce more Chinese customers to Nexperia. Wingtech is the global leader in smartphone ODM, with customers including Samsung, Huawei, Xiaomi, OPPO, etc., which could help boost demand for Nexperia's consumer electronic products in China.

In addition, Wingtech believes Chinese customers in automotive and industrial are looking to diversify their supply chain amid the trade tensions, to lower the single country supplier risk. Nevertheless, the automotive and industrial segments typically require higher reliability in product performance, stable production and in time services. Given that Nexperia has merged into Wingtech, we believe the latter would help lower Chinese customers' supply chain risks and provide a wide range of products, higher product performance, stable production (IDM, in house foundry and OSAT), and in time services.

Wingtech's MOSFET only garnered a 4.8% global market share in 2019, vs. other products at 25%+: 32% global market share in ESD protection, 26% in logic IC, and 25% in diode & transistor. We believe Wingtech would target to boost its MOSFET market share next in the coming years.

Semiconductor business overview

Almost all leading semiconductor companies of discrete and logic devices globally are IDM companies, such as Texas Instruments, Infineon, ON Semiconductor, Rohm, etc. Generally, IDM models can help control costs, enable more flexible production, and improve the utilization of equipment output. IDM companies tend to master the entire production process, and produce devices with different functions based on different requirements.

Exhibit 602: Wingtech's business model vs. peers

Company	Country	IDM / Fabless	Founded year
Wingtech	China	IDM	1993
Rohm	Japan	IDM	1958
ON Semi	US	IDM	1999
Semtech	US	IDM	1960
ST Micro	Europe	IDM	1987
TI	US	IDM	1951
Infineon	Europe	IDM	1999

Source: Company data

Below, we highlight the 2019 global market share ranking (according to IHS and Nexperia) of the main products:

- **Discrete device:** Wingtech has the largest market share, followed by Rohm and On Semi, etc.
- **ESD protection device:** Wingtech has the largest market share, followed by Semtech and ST Micro, etc.
- **Logic device:** TI has the largest market share, followed by Wingtech and On Semi, etc.
- **Small signal MOSFET device:** On Semi has the largest market share, followed by Rohm and Wingtech, etc.
- **Automotive power MOSFET device:** Infineon has the largest market share, followed by Wingtech and On Semi, etc.

Exhibit 603: Wingtech's customers by application

Application	Rev % 2019	Customer	End product
Automotive	44%	Bosch, BYD, Continental, Delphi, Denso	Active safety, PMIC, EPS (Electric Power Steering), LED
Consumer & wearables	21%	Apple, Google, Fitbit, Huawei, Samsung Xiaomi, Amazon, DJI, Dyson, LG	Pad, wearables, UAV, E-cigarette, set-top box
Industrial	20%	Emerson, Cisco, Delta, Schneider	Motor controller, electric gauge
Computing	15%	ASUS, Dell, HP	PC board, SSD, USB Type-C

Source: Company data

Exhibit 604: Wingtech's product portfolio

Product line	Product series	Main products	Key applications
Bipolar transistor and diode	Bipolar transistor	General bipolar transistor	General-purpose switch and amplifier, current mirror, LED driver, reference voltage source (TL431), Darlington transistor
		Low VCEsat (BISS) transistor	Power management, electric devices, load switches, linear regulators, LED lighting
		Resistor equipped transistor (RET)	Control IC input, switch load
		General Zener Diode	Universal regulation and voltage reference function, overvoltage protection
	Diode	Switching diode	General switch, ultra high speed switch
		Schottky diodes	Reverse polarity protection, power management
		Schottky rectifier	Low voltage rectification, high efficiency DC-DC conversion, reverse polarity protection, low power consumption applications
		PN rectifier ≥ 1 A	Polarity protection, high-frequency converters, free-wheeling applications in switching power supplies, LED backlight
Logic and ESD protection device	ESD protection devices and TVS	Three-terminal adjustable shunt regulator	Multiple protection circuits such as overload protection, safety zone protection, etc.
		ESD solutions for specific applications	Audio interface protection, automotive line protection, data and audio interfaces such as automotive multimedia line protection, overvoltage protection such as airbag controller, ABS, ESC, automotive driving interface protection such as dashboard, mobile phone interface, portable consumer electronics interface, consumer electronics interface, computing interface, high-definition multimedia interface, NFC antenna protection, high-voltage (>5 V) level high-speed data line protection
		EMI solution with integrated protection	MIPI CSI camera interface, MIPI DSI display interface, HDMI, all LVDS signals requiring up to 2GHz passband
		General ESD protection device	Cameras, printers, portable media players, hard drives and other electronic products
		Low capacitance ESD protection device for high speed interface	Portable electronic equipment, including mobile phones and accessories, audio and video equipment, antenna protection, USB interface, high-speed data lines
	Logic device	Transient voltage surge (TVS)	Mobile applications, power supplies, power management, automotive applications, telecommunications circuit protection
		Buffer, driver, transceiver	Noise eliminations, display dashboard, infotainment, visual control, battery management system
		Counter, crossover	Automotive timing applications
		Trigger, latch, register device	Timing synchronization in body control and central gateway module, increased controlled delay in dashboard module, synchronization of signals from the display driver, warning lights and light controller
		Logic gate	Electric power steering, interior lighting, infotainment systems, engine monitoring, navigation and dashboard
		Logic voltage converter	IC, display instrument panel, infotainment, visual control, battery management system
		Professional logic device	Phase-locked loop (PLL), digital comparator, printer interface,
		Switch, multiplexer, solution multiplexer	Power window, power door lock and power mirror control, advanced diagnosis and engine control module, traction and stability control module
	MOSFET device	Automotive MOSFET	Load switches used in power management, including various body control units (doors, seat control, window lifts), entertainment systems (car audio, navigation), security control systems (airbags, LED lighting)
		Small signal MOSFET	TVs, set-top boxes, flat panel displays, power supplies, computer motherboards
		Power MOSFET	Telecom DC-to-DC solution, voltage regulation module (VRM), point of load module (POL), secondary side synchronous rectification, etc.

Source: Company data

ODM business overview

Wingtech's ODM business garnered the largest market share globally at 33% in 2019, and we expect this to increase to 37%/38% in 2020E/21E-driven by its large scale, vast industry experience, and industry consolidation/taking market share from smaller vendors. The company's ODM business is mainly for smartphones, with customers including Samsung, Xiaomi, OPPO, Huawei, Meizu, Lenovo, China Mobile, ASUS, TCL, etc. With the competitive smartphone market, we see growing mid/low-end smartphone models, leading to a growing ODM ratio. We model the ODM ratio to increase from 27% in 2019 to 27%/30% in 2020E/21E benefiting Wingtech, the global leader.

We model Wingtech's ODM business to register a 13% revenue CAGR in 2020E-22E, driven by rising ODM ratio given fierce competition in the smartphone market, which we believe would lead brand makers to raise their outsourcing ratio to accelerate new product/model launches to attract customers. In addition, we believe the new 5G era would encourage brand makers to increase new product launches via increased outsourcing to earn consumers' mind share in the new segment. According to Wingtech, it is also expanding its ODM business to notebooks and true wireless stereo (TWS), to support its revenue growth. Given the competitive ODM market, we model Wingtech's ODM GM to gradually decline to 8.5% in 2025E vs. 9.4%/9.6% in 2019/20E.

5G smartphone shipments in China returned to growth, up 12% MoM in June: 5G smartphones in June returned to growth as we expected ([report link](#), published on June 11), up 12% MoM to 18m or a 61% penetration rate in China. 1H20 5G smartphone shipments in China came in at 64m, tracking 42% of 2020 consensus of 150m 5G smartphone shipments in China. Compared to the first year of the 4G cycle in China: 1H14 was 24% of 2014 4G smartphone shipments in China; we see a stronger cycle in 5G.

Smartphone shipment growth in China in June further decelerated, echoing our concerns on potential consumption weakness under COVID-19: The overall smartphone shipments in China decelerated to -17% YoY in June (vs. -10% YoY in May), at 28m units. Sunny Optical's handset lens shipments outperformed the market at +16% YoY in June, while Largan's June revenues were up 1% YoY. Largan's underperformance echoes our concerns of 1) rising competition, especially in China, the home market of Sunny Optical, AAC, and O-Film, 2) smartphone camera design trends changing with growing 2/5/8MPx, which increased to 57% of Huawei / Xiaomi / OPPO / Vivo smartphone cameras in 2Q20 vs. 50% in 1Q20, with cameras per model stayed at 4.5 cameras in 2Q20 vs. 4.5 cameras in 1Q20.

Selective in smartphone components: With market demand uncertainties remaining in 2H, we continue to be selective in smartphone components, and like 5G beneficiaries or market share gainers. We are Buy rated on Maxscend, SMIC (on CL), SG Micro, Will Semi, Win Semi, Luxshare (on CL), Mediatek (on CL) and TSMC (on CL); and Sell-rated on ASMPT, JCET, AAC, Largan, BOE, and O-Film.

Key China smartphone data in June

China 5G phone market in June

- 5G phone shipments in China were at 18m in June, or 12% MoM, or a 61% penetration rate, per MIIT.
- 5G phone shipments in China were at 64m in 1H20, or a 42% penetration rate, per MIIT.
- 5G phone shipments in China in 1H20 (64m) tracked 42% of 2020 market consensus of 150m, which is stronger than the first year of the 4G cycle: 1H14 tracked 24% of 2014 4G phone shipments in China, per MIIT.
- 58 5G models passed the 3C certification in China in June (vs. 45 models in May), from Huawei (44 models), Vivo (6), Samsung (2), OPPO (1), Xiaomi (1), Lenovo (1) and Gree (1), per China Quality Certification Center.
- 6 5G models passed the 3C certification in China in July (by July 9), from Huawei (3 models), Samsung (1), ZTE (1), Motorola (1), per China Quality Certification Center.

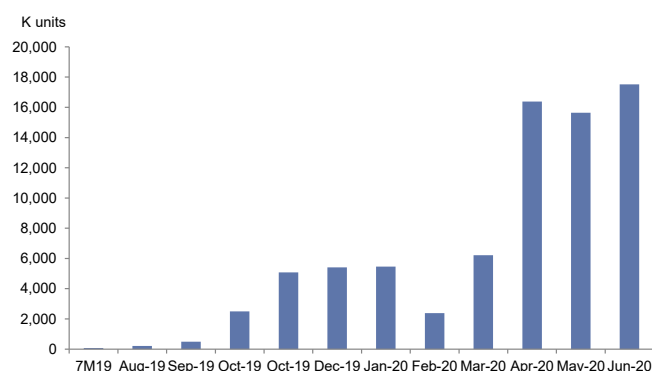
China smartphone market in June

- Smartphone shipments in China were down 17% YoY in June vs. down 10% YoY in May, leading to a 16% YoY decline in 1H20 shipments, according to MIIT.
- The number of new smartphone models launched in China was up 33% YoY to 36 models in June vs. down 24% YoY in May, according to MIIT.

Smartphone camera pixel in leading China smartphone brands in 2Q20

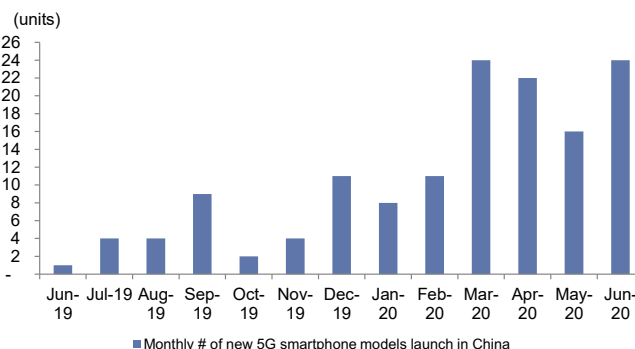
- We reviewed the 73 models launched by Huawei, Xiaomi, OPPO, Vivo in 2Q20, with 330 cameras.
- Cameras per model was at 4.5 cameras, the same as 4.5 cameras in 1Q20. However, among the 330 cameras, 57% of the cameras were 2MPx/5MPx/8MPx, vs. 50% in 1Q20.
- 34 models were launched by Huawei in 2Q20 with 141 cameras, or 4.1 cameras per model, vs. Xiaomi at 5.1 cameras, OPPO at 4.7 cameras, and Vivo at 4.8 cameras.
- Among the 141 cameras in the 34 models that Huawei launched in 2Q20, 57% of the cameras were 2MPx/5MPx/8MPx, vs. Xiaomi at 59%, OPPO at 55%, and Vivo at 56%.

Exhibit 605: 5G smartphone shipments in China: 17.5m in June



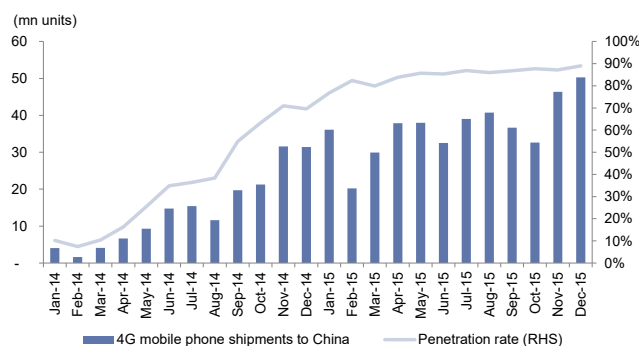
Source: MIIT

Exhibit 606: Monthly # of new 5G smartphone models launched in China



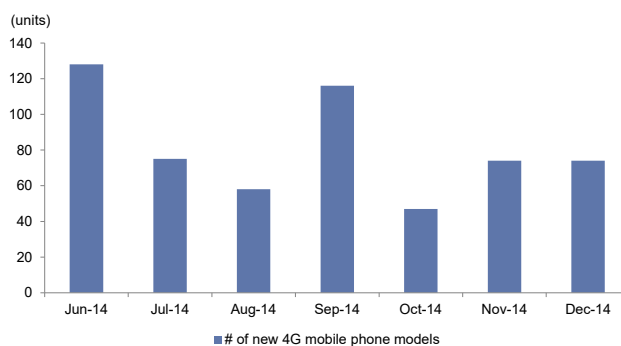
Source: MIIT

Exhibit 607: 2014-15 4G mobile phone shipments and penetration rates



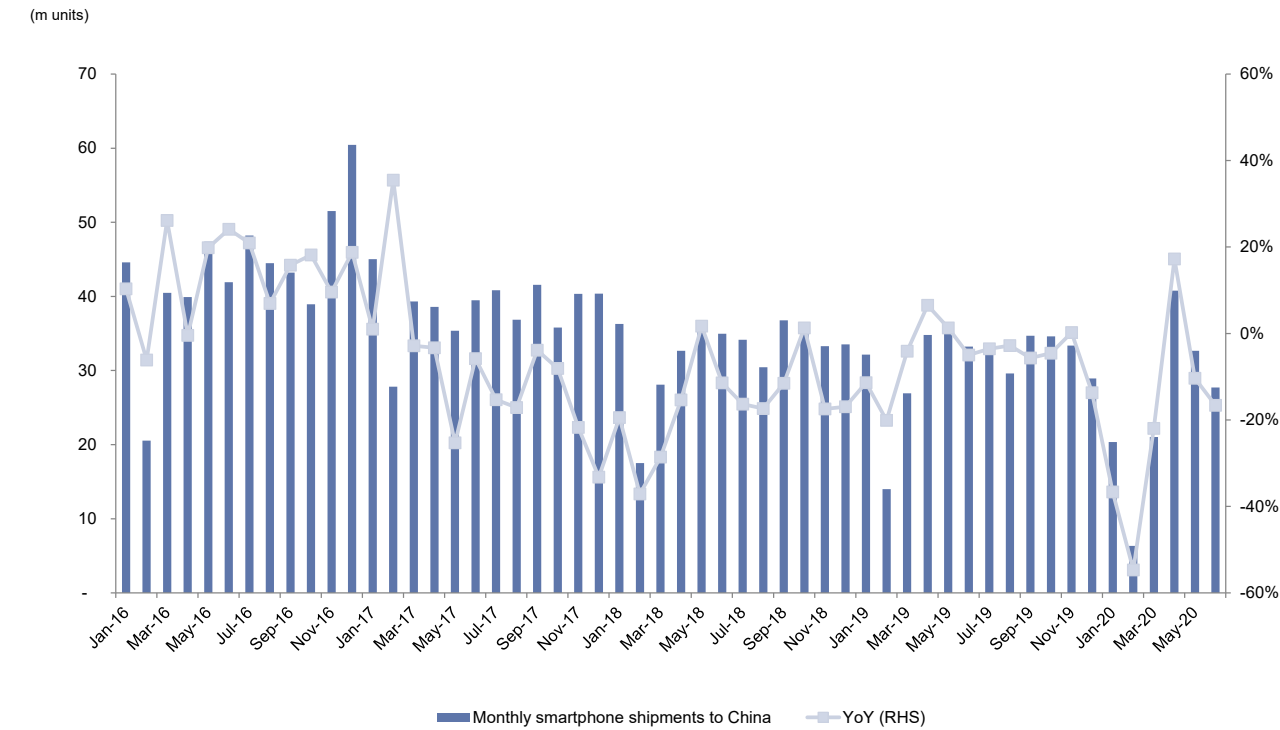
Source: MIIT

Exhibit 608: Monthly # of new 4G mobile phone models launched in China



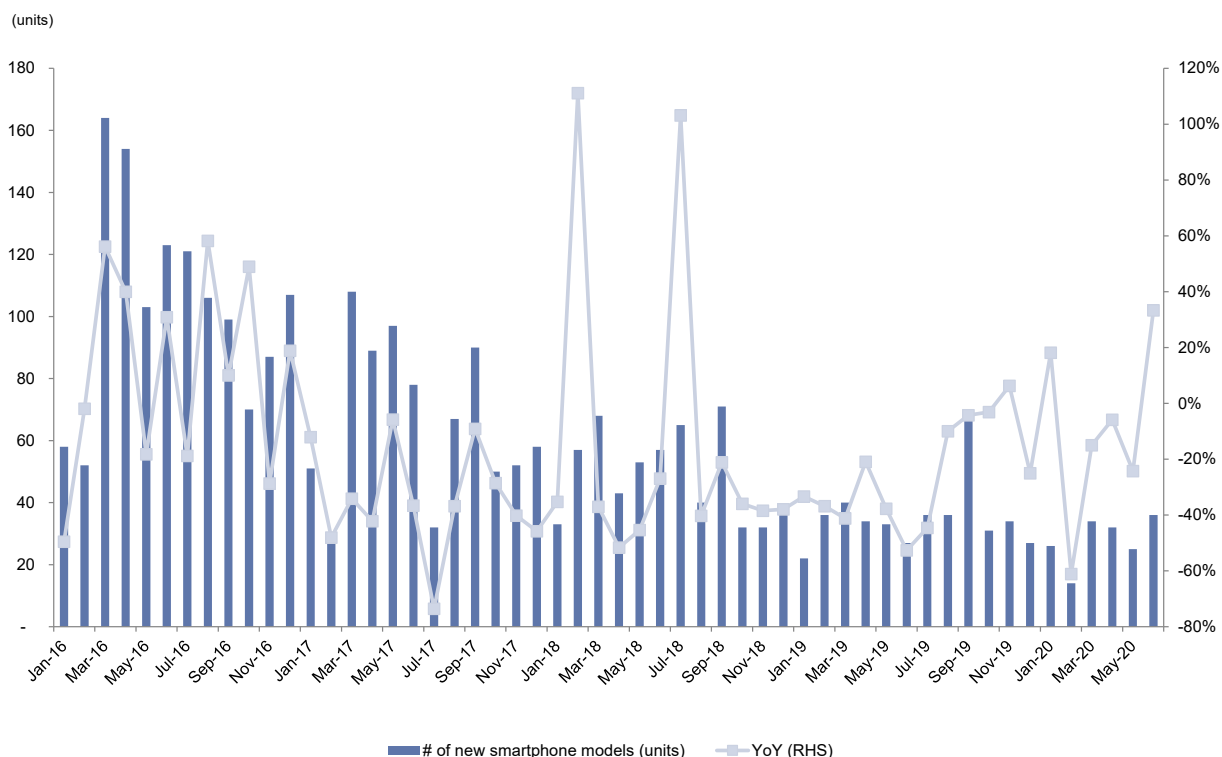
Source: MIIT

Exhibit 609: Smartphone shipments in China



Source: MIIT

Exhibit 610: Number of new smartphone models launched in China



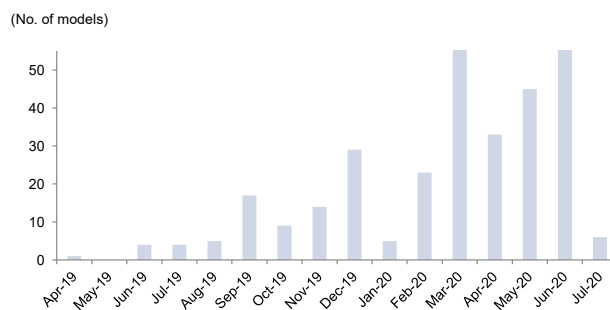
Source: MIIT

Exhibit 611: Mobile phones shipments in China

m units	Jun-19	Jul-19	Aug-19	Sep-19	Oct-19	Nov-19	Dec-19	Jan-20	Feb-20	Mar-20	Apr-20	May-20	Jun-20
Mobile phones	34	34	31	36	36	35	30	21	6	22	42	34	29
YoY	-6%	-8%	-5%	-7%	-7%	-1%	-15%	-39%	-56%	-23%	14%	-12%	-17%
MoM	-10%	0%	-10%	17%	-1%	-3%	-13%	-32%	-69%	241%	92%	-19%	-15%
5G			0.2	0.5	2.5	5.1	5.4	5.5	2.4	6.2	16.4	15.6	17.5
5G to mobile phones			1%	1%	7%	15%	18%	26%	37%	29%	39%	46%	61%
4G	33	33	29	34	32	28	24	15	4	15			
4G to mobile phones	97%	96%	95%	95%	90%	81%	77%	72%	62%	68%			
Chinese Brands	33	32	29	31	31	31	27	18	6	19	38	31	27
Chinese Brands to mobile phones	95%	93%	94%	84%	85%	90%	87%	88%	92%	87%	91%	92%	95%
Smartphone	33	33	30	35	35	33	29	20	6	21	41	33	28
YoY	-5%	-4%	-3%	-6%	-5%	0%	-14%	-37%	-55%	-22%	17%	-10%	-17%
MoM	-9%	-1%	-10%	17%	0%	-4%	-13%	-30%	-69%	232%	94%	-20%	-15%
Smartphone to mobile phones	97%	96%	96%	96%	96%	96%	95%	98%	99%	97%	98%	97%	97%
Android smartphone	32	31	28	30	30	30	26	18	6	18			
YoY	-3%	-7%	-2%	-10%	-4%	3%	-16%	-40%	-55%	-25%			
MoM	-4%	-4%	-8%	5%	1%	2%	-15%	-30%	-68%	216%			
Android smartphone to smartphone	96%	93%	95%	85%	86%	91%	89%	89%	92%	88%			
# of new smartphone models (units)	27	36	36	68	31	34	27	26	14	34	32	25	36
YoY	-53%	-45%	-10%	-4%	-3%	6%	-25%	18%	-61%	-15%	-6%	-24%	33%
MoM	-18%	33%	0%	89%	-54%	10%	-21%	-4%	-46%	143%	-6%	-22%	44%
% to the year	6%	8%	8%	16%	7%	8%	6%	NA	NA	NA	NA	NA	NA
# of new mobile models (units)	38	52	45	90	49	56	35	34	16	39	48	32	47
2/3G	9	16	9	22	16	21	7	8	1	4			
4G	28	32	32	59	31	31	17	18	4	11			
5G	1	4	4	9	2	4	11	8	11	24	22	16	24
5G to total new mobile models	3%	8%	9%	10%	4%	7%	31%	24%	69%	62%	46%	50%	51%
China 4G mobile subscribers (m)	1,230	1,240	1,257	1,264	1,269	1,276	1,280		1,262	1,280	1,273	1,279	
Net adds	121	114	118	115	111	117	115		73	76	63	59	
China 4G phones replacement ratio	24%	24%	23%	23%	23%	22%	21%		22%	20%	18%	15%	

Source: MIIT

Exhibit 613: Number of 5G models passing 3C certification in China



Data as of July 9

Source: China Quality Certification Center

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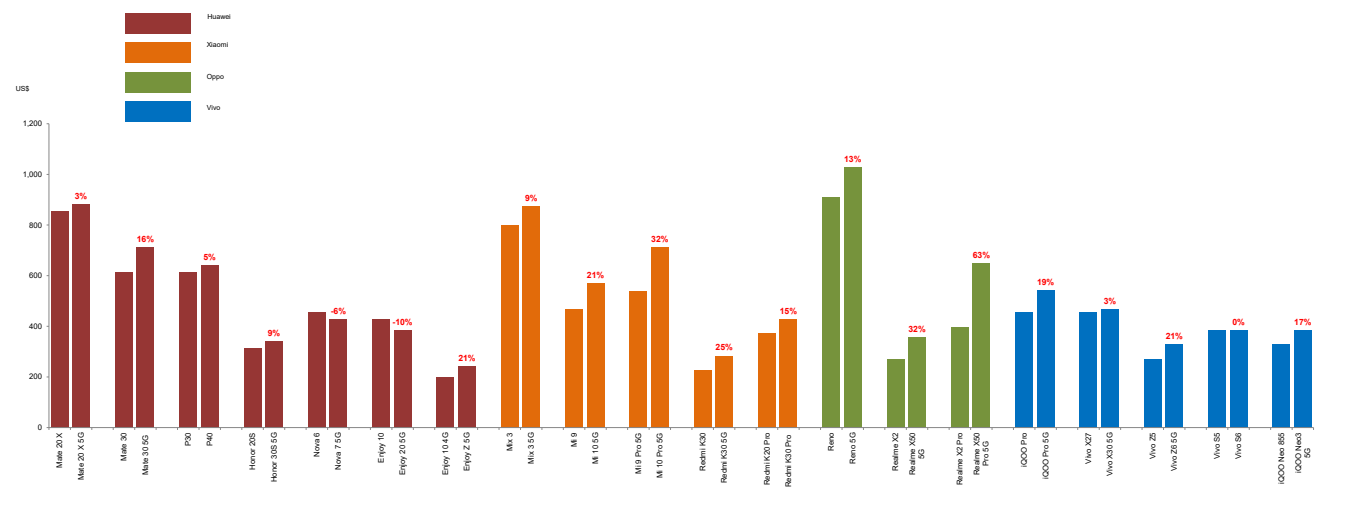


For the exclusive



13 July 2020

Exhibit 616: 5G vs. 4G smartphone prices (as of July 9, 2020)



Source: Company data

Exhibit 617: 5G vs. previous 4G/5G smartphone spec comparison (as of July 9, 2020)

Huawei			Huawei	
Brand				
Model	Honor 9X 4G	Honor X10 5G	Enjoy 10 4G	Enjoy Z 5G
Launch date	Oct, 2019	May, 2020	Oct, 2019	May, 2020
Price	RMB1,599	RMB1,899 (+19%)	RMB 1,399	RMB1,699 (+21%)
Display	LCD	LCD	LCD	LCD
CPU	Kirin 710F (12 nm, Octa-core)	Kirin 820 5G (7nm, Octa-core)	Kirin 710F (12 nm, Octa-core)	MediaTek Dimensity 800 5G (7 nm, Octa-core)
Memory: RAM (GB)	4 or 6	6 or 8	4 or 6	6 or 8
Memory: ROM (GB)	64 or 64 /128	64 / 128 or 128	64 / 128 or 64	64 / 128 or 128
Camera – front (MPx)	16	16	8	16
Camera – rear (MPx)	2+8+48	2+8+40	2+48	2+8+48

Huawei			Xiaomi	
Brand				
Model	Enjoy 10 4G	Enjoy 20 5G	Redmi Note 9 Pro 4G	Redmi 10X 5G
Launch date	Oct, 2019	June, 2020	Apr, 2020	May, 2020
Price	RMB2,999	RMB2,699 (-10%)	RMB 1,399	RMB 1,599 (+14%)
Display	LCD	LCD	LCD	AMOLED
CPU	HiSilicon Kirin 710F (12 nm, Octa-core)	HiSilicon Kirin 980 (7 nm, Octa-core)	Qualcomm Snapdragon 720G (8 nm, Octa-core)	MediaTek Dimensity 820 5G (7 nm, Octa-core)
Memory: RAM (GB)	6	8	6	6 or 8
Memory: ROM (GB)	64 or 128	128 / 256	64 or 128	64 / 128 or 128 / 256
Camera – front (MPx)	24	32	16	16
Camera – rear (MPx)	16+24	2+2+16+48	2+5+8+64	2+8+48

Vivo			Vivo	
Brand				
Model	Vivo iQOO Pro 5G	Vivo iQOO Z1 5G	X30 5G	X50 5G
Launch date	Aug, 2019	May, 2020	Dec, 2019	June, 2020
Price	RMB 3,798	RMB1,998 (-47%)	RMB 3,298	RMB 3,498 (+6%)
Display	AMOLED	LCD	AMOLED	AMOLED
CPU	Qualcomm Snapdragon 855+ (7 nm, Octa-core)	Mediatek Dimensity 1000+ (7nm, Octa-core)	Exynos 980 (8 nm, Octa-core)	Qualcomm Snapdragon 765G (7 nm, Octa-core)
Memory: RAM (GB)	8 / 12 or 8	6 or 8	8	8
Memory: ROM (GB)	128 or 256	128 or 128 / 256	128 / 256	128 / 256
Camera – front (MPx)	12	16	32	32
Camera – rear (MPx)	2+13+48	2+8+48	8+32+64	5+8+13+48

Vivo			Oppo	
Brand				
Model	Y7s 4G	Y70s 5G	Reno3 5G	Reno4 5G
Launch date	July, 2019	May, 2020	Mar, 2020	June, 2020
Price	RMB1,798	RMB1,998 (+11%)	RMB 3,399	RMB 2,999 (-12%)
Display	AMOLED	LCD	AMOLED	AMOLED
CPU	Mediatek Helio P65 (12nm, Octa-core)	Exynos 880 (Process node TBA, Octa-core)	Mediatek Helio P90 (12 nm, Octa-core)	Qualcomm Snapdragon 765G (7 nm, Octa-core)
Memory: RAM (GB)	6	6 / 8	8	8
Memory: ROM (GB)	128	128	128	128 / 256
Camera – front (MPx)	16	16	44	2+32
Camera – rear (MPx)	2+8+16	2+8+48	2+8+13+48	2+8+48

Source: Company data

Financials

Income statement

Near-term earnings estimates

We model revenue/net income CAGR of 16%/35% in 2020E-22E, GM to expand from 12.8% in 2020E to 13.7% in 2022E, and opex ratio to improve from 6.4% in 2020E to 6.2% in 2022E.

We believe revenue growth in 2020E-22E would be mainly driven by the company's semiconductor market share expansion, along with its ODM business, which would ride on the 5G smartphone trend, in our view. For the semiconductor business, we expect its market share to expand on the back of: (1) innovative technology with over 60 years of experience; (2) in-house equipment R&D center, driving its production yield rate and allowing it to offer cost competitive products; and (3) larger SKUs. Underpinned by the above competitive edges, we believe the company would ride on the trend of supply chain diversification among Chinese brand customers.

For the ODM business, we expect the smartphone ODM ratio to gradually rise from 27% in 2020E to 30% in 2022E, driven by the competitive smartphone market and the new 5G era, which we believe would trigger brand makers to accelerate the launch of new models to earn consumers' mind share. We expect Wingtech's smartphone ODM ASP to continue to increase, by 39% YoY in 2020E, driven by the increase in 5G smartphone models; however, the growth rate is lower than that in 2019, considering the higher base and the growing mid-end 5G smartphone models. For 2021E and onward, we model a 0-1% YoY ASP decline, as we expect 5G smartphones to become mainstream with prices getting more and more attractive.

With the growing semiconductor business, we model the blended GM to expand from 12.8% in 2020E to 13.7% in 2022E. We expect the semiconductor business GP exposure to rise to 42% in 2022E from 34% in 2020E. We also expect the opex ratio to gradually improve from 6.4% in 2020E to 6.2% in 2022E, back to the level in 2016-17, driven by its enlarged revenue scale and rising synergies between Wingtech and Nexperia.

Long-term earnings estimates

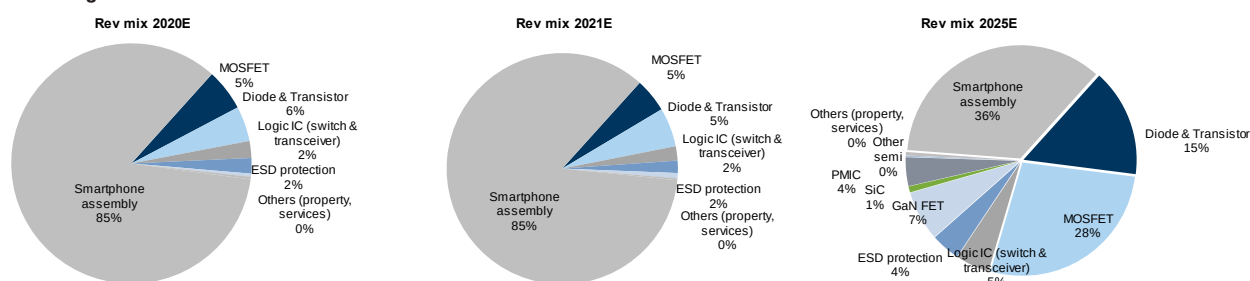
In the longer term, we expect the company's business to more focus on semiconductors, considering the ODM is a lower GM business with fierce competition and 5G smartphone shipment growth is likely to peak out in 2021E, while semiconductors enjoy upside in specification upgrades, product line expansion, and market share gains in China. We expect semiconductors GP contribution to up to 86% by 2025E vs. 34% in 2020E.

We believe revenue growth in 2022E-25E would be driven by the semiconductor business product line expansion, to GaN FET, SiC and power management IC. Wingtech stated that its GaN FET products started mass production in October 2019 at 650V, and the company targets to introduce its 900V product by end 2020E, and its 1200V product by end 2021E. The target end markets include EVs (e.g. on-board controller module, or

OBC module), data centers, telecom equipment, industrial automation, and high-end power supply. For SiC, the company is currently engaged in R&D, and targets to launch its products in the coming 2-3 years. For management IC, the company plans to expand through in-house R&D or M&A.

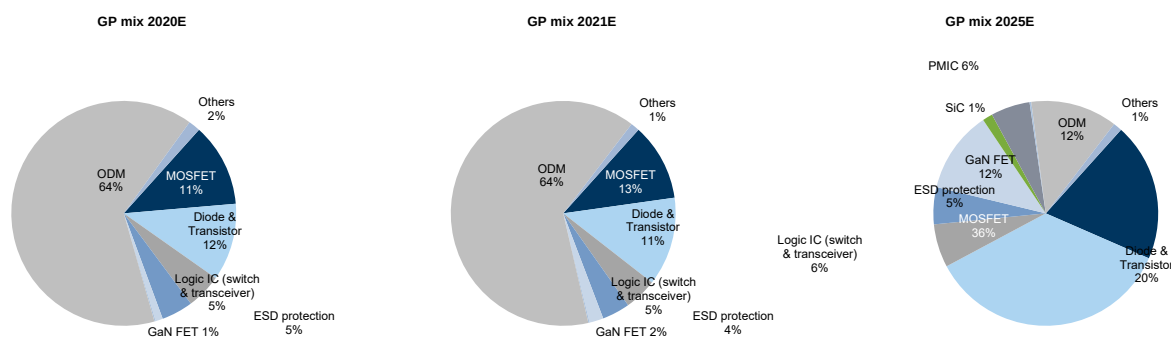
With the growing semiconductor business, we model the blended GM to expand from 13.7% in 2022E to 24% in 2025E. We expect the semiconductor business GP exposure to rise to 86% in 2025E from 42% in 2022E. We also expect the opex ratio to gradually improve from 6.2% in 2022E to 6.0% in 2025E, driven by its enlarged revenue scale and rising synergies between Wingtech and Nexperia.

Exhibit 618: Wingtech's revenue mix



Source: Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 619: Wingtech's gross profit mix



Source: Goldman Sachs Global Investment Research, Gao Hua Securities Research

Where are we different from the Street?

Our net income is largely in line with Bloomberg consensus for near term (2020-22E); however, in the longer term, we believe the company will gradually move toward the semiconductor business, given the upside in product line expansion, product specification upgrades, market share gains, while the ODM business is lower in GM with flattish market growth, and fierce competition. We assume semiconductors to contribute 86% of GP by 2025E, driving its GM up to 24% by 2025E vs. 12.8% in 2020E. We are positive on its semiconductor market share expansion given: (1) innovative technology with over 60 years of experience; (2) in-house equipment R&D center, driving its production yield rate and allowing it to offer cost competitive products; and (3) larger SKUs.

Balance sheet

Net cash per share: Wingtech gearing ratio was at 15% on average in past five years. We model the company to turn to net cash position in 2022E, driven by increased operating cash flow supported by better product mix (more semiconductors, which carries higher GM).

ROE: Wingtech's ROE improved from 8% in 2017 to 10% in 2019, mainly driven by an improved net margin (from 2% in 2017 to 3% in 2019) and higher leverage (from 2.7x in 2017 to 3.3x in 2019). For the coming years, we expect Wingtech's ROE to improve from 14% in 2020E to 18% in 2021-25E on average, mainly driven by an improving net margin.

Cash conversion cycle: Wingtech's cash conversion cycle improved from 82 days in 2017 to 13 days in 2019, mainly due to longer payable days (from 68 days in 2017 to 107 days in 2019), despite an improvement in inventory days (from 92 days to 36 days). For the coming years, we expect Wingtech's cash conversion cycle to gradually extend to 16 days on average in 2020-25E, driven by shorter accounts payable days to 84 days in 2025E from 86 days in 2020E.

Cash flow

Capex: Wingtech's capex to revenue ratio was stable at 1%-2% in 2016-19 as it had limited capacity expansion in the past few years. We expect the ratio to increase to 4% in 2020E as the company plans to expand capacity to fulfill the growing demand of MOSFET, IGBT, power IC, etc. We model Wingtech's capex to grow at a 15% CAGR in 2020E-25E, and the capex to revenue ratio to gradually increase from 2% in 2019 to 4% in 2025E on the back of capacity expansion for its semiconductor business.

Free cash flow: Wingtech's free cash flow was positive in 2018-19 with an annual amount of Rmb3.4bn on average, or a 3% free cash flow yield on average. We expect its free cash flow to grow at an 13% CAGR in 2022E-25E, driven by rising operating cash flow.

Dividend yield: Wingtech's dividend payout ratio was 13% in 2019, and we expect this to be stable at 13% in 2020E-25E, implying a dividend yield of 0.2%/0.3% in 2020E/21E.

Valuation

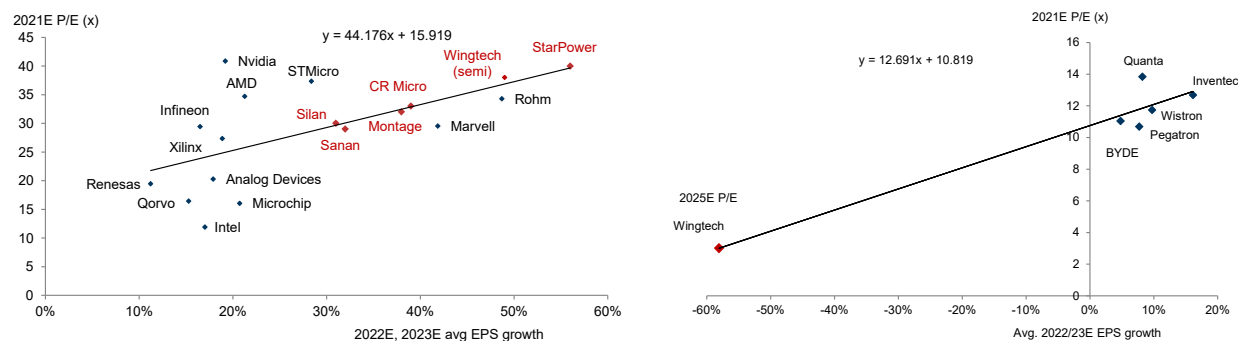
We adopt discounted P/E as our primary valuation methodology to capture Wingtech's long-term opportunities in the semiconductor market with upside in both market share and product line expansion. We derive our target P/E multiple from the sector's correlation between earnings growth and P/E, and we accordingly apply 33x target P/E multiple on Wingtech's 2025E EPS. On this basis, we derive an overall implied value of RMB189 (or 33x 2025E P/E). We then discount the implied value back to 2022E at a COE of 9%, which is derived from a 1.0x beta, a 3% risk-free rate, and a 6% market risk premium (consistent with our China Semis coverage). Accordingly, we derive a 12-month target price of Rmb189, implying 39x 2022E P/E.

Exhibit 620: Discounted P/E-based target price derivation

Rmb m	2018	2019	2020E	2021E	2022E	2023E	2024E	2025E
Milestone: semiconductor GP contribution		10%	34%	35%	42%	54%	65%	86%
Global MOSFET TAM	59,557	63,423	63,084	68,876	71,736	73,947	76,543	78,717
YoY		6%	-1%	9%	4%	3%	4%	3%
China MOSFET TAM	18,478	19,551	20,572	21,814	22,801	23,973	25,453	26,672
YoY		6%	5%	6%	5%	5%	6%	5%
Wingtech MOSFET rev	2,717	3,071	3,223	5,020	7,505	9,840	11,772	13,545
Global market share	5%	5%	5%	7%	10%	13%	15%	17%
China market share	6%	7%	7%	10%	14%	18%	21%	23%
Other standard semi devices global market share	26%	26%	26%	29%	31%	33%	33%	35%
Revenues	17,335	41,578	68,089	91,522	91,389	84,610	75,064	48,978
Rev YoY	2%	140%	64%	34%	0%	-7%	-11%	-35%
Rev YoY - Semi			549%	30%	29%	28%	20%	18%
Rev YoY - ODM	4%	139%	46%	34%	-5%	-16%	-23%	-64%
GM	9.1%	10.3%	12.8%	12.9%	13.7%	15.2%	17.0%	24.0%
GM - Semi			28.5%	30.4%	30.6%	30.9%	31.2%	32.2%
GM - ODM	7.6%	9.4%	9.6%	9.7%	9.6%	9.3%	8.9%	8.5%
Opex ratio	7.2%	6.0%	6.4%	6.3%	6.2%	6.1%	6.0%	6.0%
OP income	331	1,799	4,327	5,990	6,897	7,668	8,295	8,817
YoY	-26%	444%	140%	38%	15%	11%	8%	6%
Pretax income	64	1,473	3,720	5,459	6,394	7,466	8,488	9,550
Net income	61	1,254	3,044	4,674	5,515	6,480	7,400	8,355
EPS (Rmb)	0.10	1.48	2.71	4.16	4.91	5.77	6.58	7.43
EPS - Semi				1.44	2.08	3.09	4.30	6.41
EPS - ODM				2.66	2.77	2.61	2.21	0.93
EPS YoY	-81%	1441%	84%	54%	18%	18%	14%	13%
EPS YoY - Semi					44%	48%	39%	49%
EPS YoY - ODM					4%	-6%	-15%	-58%
Target multiple - semi								38
Target multiple - ODM								3
Target multiple x EPS								245
Discounted back to 2022; TP (Rmb)					189			
Implied 2022E PE					39			
COE assumption								
Beta	1.0							
Risk free	3.0%							
Market risk premium	6.0%							
COE	9.0%							

Source: Bloomberg, Company data, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 621: Peers we have used to derive our P/E multiples for Wingtech's business segments



Names with 2025E PE and EPS forecast marked in red; Bloomberg estimates for Renesas, others are GS&P.

Source: Bloomberg, Goldman Sachs Global Investment Research

Exhibit 622: Summary of Wingtech's semiconductor business peers

	Ticker	Rating	Analyst	Pricing currency	PX (LCY)	TP (LCY)	Upside (%)	Market cap (US\$m)	LTM PX move (%)	LTM ADTV (US\$m)	EPS growth	Trading P/E	Trading P/B	ROE	Div Yield										
											2020E	2021E	2022E	2020E	2021E	2022E	2020E	2021E	2022E	2020E	2021E	2022E			
Semiconductor																									
Local																									
StarPower	603290.SS	Buy*	Allen Chang, Jin Guo	CNY	264.6	402	52%	6,049	1,981	108	-5%	59%	82%	247.3	155.2	85.5	37.1	31.8	25.2	20%	22%	33%	0.1%	0.2%	0.4%
Sanan	600703.SS	Buy	Allen Chang, Jin Guo	CNY	28.3	40	41%	18,098	159	324	-14%	40%	42%	77.5	55.3	39.0	5.1	4.8	4.4	7%	9%	12%	0.4%	0.6%	0.8%
CR Micro	688398.SS	Buy	Allen Chang, Jin Guo	CNY	56.2	98	57%	9,415	340	163	-15%	74%	65%	145.9	84.0	50.9	6.8	6.3	5.7	6%	8%	12%	0.1%	0.1%	0.2%
Wingtech	600745.SS	Buy	Verena Jeng, Jin Guo	CNY	160.0	189	18%	25,699	347	281	84%	54%	18%	59.1	38.5	32.6	7.6	6.5	5.5	14%	18%	18%	0.2%	0.3%	0.4%
Montage	688008.SS	Buy	Lynn Luo, Jin Guo	CNY	117.2	161	37%	18,918	374	80	25%	43%	51%	106.5	74.7	49.6	16.3	14.3	12.1	16%	20%	26%	0.3%	0.5%	0.7%
Silan	600460.SS	Buy	Lynn Luo, Jin Guo	CNY	17.0	21.5	26%	3,194	12	115	269%	292%	88%	416.9	106.2	56.5	6.5	6.3	5.8	2%	6%	11%	0.1%	0.3%	0.5%
Global																									
Microchip	MCHP	Buy	Toshiya Hari	USD	106.6	121.0	13%	26,155	21	267	-17%	3%	32%	21.5	20.8	15.8	4.9	4.1	3.4	23%	21%	24%	1.6%	1.4%	1.4%
Xilinx	XLNX	Buy	Toshiya Hari	USD	99.1	113.0	14%	24,110	(14)	312	-3%	-12%	27%	29.5	33.5	26.4	11.8	12.2	11.9	33%	33%	42%	1.5%	1.5%	1.6%
Analog Devices	ADI	Buy	Toshiya Hari	USD	124.5	138.0	11%	45,869	11	270	-17%	13%	23%	29.1	25.8	20.9	4.0	4.0	4.1	14%	16%	19%	1.9%	2.1%	2.4%
ON Semi	ON	Buy	Toshiya Hari	USD	20.5	22.0	7%	8,401	4	137	-68%	138%	56%	42.9	18.0	11.6	2.7	2.5	2.2	6%	14%	20%	0.0%	0.0%	0.0%
Nvidia	NVDA	Buy	Toshiya Hari	USD	419.2	404.0	-4%	257,790	163	2,829	-23%	44%	37%	94.8	65.8	48.1	21.7	18.4	15.4	25%	30%	35%	0.3%	0.2%	0.2%
Nxp	NXPI	Buy	Toshiya Hari	USD	117.1	122.0	4%	32,675	24	379	-54%	95%	38%	40.5	20.8	15.0	3.8	4.8	5.9	9%	20%	35%	1.4%	1.8%	1.9%
Intel	INTC	Sell	Toshiya Hari	USD	59.5	54.0	-9%	252,050	26	1,347	7%	-14%	12%	11.4	13.2	11.8	2.8	2.7	2.4	27%	21%	22%	2.2%	2.4%	2.6%
Qorvo	QRVO	Buy	Toshiya Hari	USD	112.0	137.0	22%	12,817	62	156	9%	-21%	79%	19.7	24.9	13.9	3.1	3.1	2.9	16%	12%	21%	0.0%	0.0%	0.0%
Maxim	MXIM	Sell	Toshiya Hari	USD	64.1	59.0	-8%	17,088	9	122	-7%	-3%	13%	28.4	29.3	26.0	11.6	12.4	NA	37%	41%	49%	3.0%	3.1%	3.2%
Rohm	6963.T	Neutral	Daiki Takayama	JPY	7,030.0	7,200.0	2%	6,773	(1)	52	-41%	-81%	792%	144.6	16.2	NA	1.0	0.9	NA	1%	6%	6%	2.1%	2.1%	2.1%
TI	TXN	Sell	Toshiya Hari	USD	130.5	121.0	-7%	119,797	15	643	-8%	-3%	14%	27.8	28.6	25.1	16.9	16.7	19.8	55%	63%	78%	2.5%	3.1%	3.3%
Broadcom	AVGO	Neutral	Toshiya Hari	USD	319.4	322.0	1%	128,474	22	740	11%	15%	16%	16.6	14.4	12.5	5.4	6.0	6.3	33%	41%	51%	4.1%	4.9%	5.4%
AMD	AMD	Neutral	Toshiya Hari	USD	55.9	50.0	-11%	65,446	65	2,700	74%	81%	34%	65.6	36.2	27.0	16.0	10.5	7.2	30%	37%	33%	0.0%	0.0%	0.0%
Skyworks	SWKS	Buy	Toshiya Hari	USD	131.2	136.0	4%	21,892	67	224	-15%	24%	37%	27.0	21.7	15.9	5.2	5.0	4.5	20%	23%	29%	0.4%	0.4%	0.5%
Renesas	6723.T	Neutral	Daiki Takayama	JPY	582.0	480.0	-17%	9,495	(3)	65	65%	215%	NM	24.2	14.3	NA	1.6	1.4	NA	7%	10%	10%	0.0%	0.0%	NA
Marvell	MVRL	Neutral	Mark Delaney	USD	38.3	33.0	-14%	25,484	54	242	-65%	123%	50%	128.5	57.5	38.3	3.0	3.1	3.2	3%	5%	8%	1.0%	0.8%	0.8%
Global average								33	664	-3%	25%	79%	46.4	27.3	21.9	7.2	6.9	6.9	28%	32%	35%	1.5%	1.6%	1.8%	
Global median								22	270	-15%	14%	34%	29.1	23.2	20.9	4.4	4.4	4.6	23%	21%	29%	1.5%	1.5%	1.8%	
Local + global average							9%	164	537	14%	46%	75%	60.1	42.6	39.6	8.9	8.2	7.8	22%	28%	34%	1.1%	1.2%	1.4%	
Local + global median								26	267	-7%	41%	37%	40.5	28.8	26.0	5.3	5.5	5.7	16%	20%	24%	0.4%	0.6%	0.8%	

Prices are as of July 10, 2020 *denotes for stocks in our AEJ conviction list

Source: Bloomberg, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 623: Summary of Wingtech's smartphone business peers

Ticker	Rating	Analyst	Pricing currency	PX (LCY)	TP (LCY)	Upside (%)	Market cap (US\$m)	LTM PX move (%)	LTM ADTV (US\$m)	EPS growth	Trading P/E	Trading P/B	ROE	Div Yield											
										2020E	2021E	2022E	2020E	2021E	2022E	2020E	2021E	2022E	2020E	2021E	2022E				
Smartphone																									
Local																									
Wingtech	600745.SS	Buy	Verena Jeng, Jin Guo	CNY	160.0	189	18%	25,699	347	281	84%	54%	18%	59.1	38.5	32.6	7.6	6.5	5.5	14%	18%	18%	0.1%	0.0%	0.1%
BYDE	0285.HK	NC	NA	HKD	22.1	NA	NA	6,425	107	26	175%	-29%	9%	10.6	14.9	13.7	2.1	1.9	1.7	17%	14%	15%	0.4%	0.7%	1.5%
Global																									
Wistron	3231.TW	CS	NA	TWD	32.6	NA	NA	3,131	48	14	6%	12%	3%	14.6	13.0	12.6	1.2	1.2	1.1	8%	9%	9%	5.7%	6.4%	6.3%
Inventec	2356.TW	NC	NA	TWD	27.3	NA	NA	3,308	14	6	42%	-14%	13%	12.1	14.0	12.4	1.7	1.7	1.7	14%	12%	13%	6.2%	6.2%	6.5%
Pegatron	4938.TW	CS	NA	TWD	63.7	NA	NA	5,628	33	19	-12%	9%	5%	11.6	10.6	10.2	1.0	1.0	1.0	8%	9%	9%	6.4%	6.4%	7.0%
Quanta	2382.TW	CS	NA	TWD	77.0	NA	NA	10,065	34	20	6%	15%	10%	17.4	15.1	13.7	2.1	2.1	2.0	12%	14%	15%	5.1%	5.6%	6.2%
Average								9,043	97	61	50%	8%	10%	20.9	17.7	15.9	2.6	2.4	2.2	12%	13%	13%	4%	4%	5%
Median								6,026	41	19	24%	10%	10%	13.3	14.5	13.2	1.9	1.8	1.7	13%	13%	14%	5%	6%	6%

NC=Not Covered; CS=Coverage Suspended; prices are as of July 10, 2020

Source: Bloomberg, Goldman Sachs Global Investment Research, Gao Hua Securities Research

We also adopt the 10-year DCF methodology as our valuation cross-check. We model an 13% free cash flow CAGR in 2022E-25E, a 4% free cash flow CAGR in 2026E-30E, and a terminal growth rate of 3%. We then discount the terminal value to 2022E based on a WACC of 8.2%, which is derived from a 9% COE and a 5% COD. The implied value per share of Rmb190, or 39x 2022E P/E, is similar to our 12-month target price of Rmb189 (39x 2022E P/E).

Exhibit 624: DCF valuation cross-check

Rmb mn	2018	2019	2020E	2021E	2022E	2023E	2024E	2025E	2026E	2027E	2028E	2029E	2030E
Key assumptions													
Semiconductor GP contribution		10%	34%	35%	42%	54%	65%	86%					
MOSFET Global market share	5%	5%	5%	7%	10%	13%	15%	17%					
MOSFET China market share	6%	7%	7%	10%	14%	18%	21%	23%					
P&L													
Revenue	17,335	41,578	68,089	91,522	91,389	84,610	75,064	48,978					
YoY	2%	140%	64%	34%	0%	-7%	-11%	-35%					
GM	9.1%	10.3%	12.8%	12.9%	13.7%	15.2%	17.0%	24.0%					
Opex ratio	7.2%	6.0%	6.4%	6.3%	6.2%	6.1%	6.0%	6.0%					
OP income	331	1,799	4,327	5,990	6,897	7,668	8,295	8,817					
YoY	-26%	444%	140%	38%	15%	11%	8%	6%					
Pretax income	64	1,473	3,720	5,459	6,394	7,466	8,488	9,550					
Net income	61	1,254	3,044	4,674	5,515	6,480	7,400	8,355					
YoY	-81%	1954%	143%	54%	18%	18%	14%	13%					
Cash flow													
CCC	41	13	16	17	17	18	18	11					
Capex	180	965	2,724	3,661	3,656	3,384	3,003	1,959					
Capex to revenues	1%	2%	4%	4%	4%	4%	4%	4%					
Free cash flow	3,092	3,655	3,009	1,986	7,977	4,950	10,185	11,464	11,922	12,399	12,895	13,411	13,947
YoY	157%	18%	-18%	-34%	302%	-38%	106%	13%	4%	4%	4%	4%	4%
Free cash flow stage													
Free cash flow growth					Stage 1 (2022-25E)				Stage 2 (2026-30E)				
Terminal growth					13%				4%				
Terminal value													277,633
Discount factor						0.92	0.85	0.79	0.73	0.68	0.62	0.58	0.53
Present value of FCF						4,576	8,704	9,056	8,707	8,371	8,048	7,737	7,439
Enterprise value 2022E (Rmb m)					210,711								
Cash and equivalents					15,969								
Debt					13,422								
Equity value in 2022E (Rmb m)					213,258								
Value per share (Rmb)					190								
Implied 2022E P/E					39x								
WACC assumption (2022E)													
Risk free rate	3.0%												
Beta	1.0												
Market risk premium	6.0%												
Cost of equity	9.0%												
Cost of debt	5.2%												
WACC	8.2%												

Source: Company data, Goldman Sachs Global Investment Research

Exhibit 625: Wingtech's share price movements



Source: Bloomberg, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Downside risks

Slower-than-expected GM expansion: Our strong earnings growth assumption in 2020E-25E is based on the company's growing semiconductor business. A slower-than-expected GM expansion could be caused by fiercer-than-expected competition in the semiconductor business or the ODM business, slower-than-expected market share gain in the semiconductor business, slower-than-expected roll out of new semiconductor products, or changes in the company's strategy, such as shifting its focus back to the ODM business.

Slower-than-expected semiconductor revenue growth: Our strong earnings growth assumption in 2020E-25E is driven by Wingtech's strong semiconductor revenue growth. A slower-than-expected semiconductor revenue growth could be caused by fiercer-than-expected competition in the semiconductor business, slower-than-expected market share gain in the semiconductor business, or slower-than-expected roll out of new semiconductor products.

Slower-than-expected ODM revenue growth: Our strong earnings growth assumption in 2020E-25E is supported by Wingtech's ODM revenue growth. A slower-than-expected ODM revenue growth could be caused by fiercer-than-expected competition, lower-than-expected ODM ratio or slower-than-expected market share expansion.

Slower-than-expected ODM product line expansion: Our strong earnings growth assumption in 2020E-25E is also supported by Wingtech's ODM product line expansion, such as notebooks and true wireless stereo (TWS). A slower-than-expected ODM product line expansion could be caused by new notebook brand makers' slower-than-expected market share expansion, given the new entrants are mostly smartphone brand makers, including Xiaomi, Huawei, OPPO, etc. which are all Wingtech's existing smartphone ODM customers. With these smartphone brand makers' expansion into notebooks and TWS, we believe Wingtech would have greater opportunities to expand its ODM product lines, and vice versa.

Less-than-expected synergy between Wingtech and Nexperia: Wingtech acquired Nexperia in late 2019, and our strong earnings growth assumption in 2020E-25E is driven by synergies between the two entities; for example, we expect Wingtech to introduce more Chinese customers to Nexperia, while Nexperia would expand Wingtech's business from ODM to semiconductor. A slower-than-expected synergy/integration between the two entities could bring downside risks to our revenue assumptions.

Wingtech

600745.SS	12m Price Target: Rmb189	Price: Rmb160.03	Upside: 18.1%		
Buy	GS Forecast				
Market cap: Rmb179.9bn / \$25.7bn	Revenue (Rmb mn)	12/1941,578.2	12/20E68,088.5	12/21E91,522.5	12/22E91,389.4
Enterprise value: Rmb186.1bn / \$26.6bn	EBITDA (Rmb mn)	2,367.2	7,195.4	9,329.3	10,528.4
3m ADTV :Rmb2.7bn/ \$382.1mn	EPS (Rmb)	1.48	2.71	4.16	4.91
China	P/E (X)	33.1	59.1	38.5	32.6
Greater China Technology	P/B (X)	2.0	7.6	6.5	5.5
	Dividend yield (%)		0.2	0.3	0.4
M&A Rank: 3	Net debt/EBITDA (X)	3.5	0.8	0.5	(0.2)
	CROCI (%)	84.3	153.4	78.7	51.2
	FCF yield (%)		1.7	1.1	4.4
		3/200.57	6/20E0.48	9/20E0.75	12/20E0.91

Source: Company data, Goldman Sachs Research estimates, FactSet. Price as of 10 Jul 2020 close.

Glossary

- **AC:** Alternating current is an electric current which periodically reverses direction
- **ALD:** Atomic layer deposition is a thin-film deposition technology that is based on a gas phase chemical process, a subtype of chemical vapour deposition
- **Analog IC:** A type of IC that processes continuous signals and performs analog functions such as amplification, active filtering, demodulation and mixing. Analog IC includes sensors, power management circuits, and operational amplifiers (op-amps), etc.
- **BCD:** Bipolar-CMOS-DMOS, a key technology for power ICs
- **BiCMOS:** Bipolar CMOS (complementary metal-oxide-semiconductor) is a semiconductor technology that integrates two formerly separate semiconductor technologies, those of the bipolar junction transistor and the CMOS gate, in a single IC device. It offers high speed, high gain, and low output resistance for high-frequency analog amplifiers
- **Bipolar IC:** A type of IC in which the principal element is the bipolar junction transistor. It is usually used in high-speed and low-voltage applications
- **BJT:** Bipolar junction transistor (or bipolar transistor) is a type of transistor that uses both electrons and holes as charge carriers. BJTs can be used as amplifiers or switches
- **Bridge rectifiers:** An AC to DC converter that rectifies AC input to DC output
- **CCP:** Capacitively coupled plasma. One of the most common types of industrial plasma sources. It consists of two metal electrodes that are separated by a small distance, placed in a reactor.
- **CMOS:** Complementary metal-oxide-semiconductor is a type of MOSFET fabrication process. CMOS technology is used for constructing IC, including microprocessors, microcontrollers, memory chips, and other digital logic circuits
- **CMP:** Chemical-mechanical polishing, a process of smoothing surfaces with the combination of chemical and mechanical forces.
- **CMP slurry:** Liquid dispersions that contain active chemicals and microabrasive grains used for chemical mechanical planarization
- **CPU:** Central processing unit
- **DB:** Data buffer is a kind of memory interface IC
- **DC:** Direct current is the unidirectional flow of an electric charge
- **DDR:** Double data rate is a technology that doubles the output data rate for DRAM modules, which have become the mainstream standard for DRAM since early-2000s
- **Digital IC:** A type of IC that handles discrete signals such as binary values. Digital IC consists of general IC (DRAM, MPU, MCU, etc.) and application-specific IC (ASIC)
- **Diode:** A two-terminal electronic component that conducts current primarily in one direction, and it is used for radio demodulation, power conversion, over-voltage protection, etc

- **DMOS:** Double metal oxide semiconductor
- **DRAM:** Dynamic random-access memory
- **eNVM:** Embedded non-volatile memory. Non-volatile memory is a type of memory that can retrieve stored information even after having been power cycled. Types of eNVM include eFlash (embedded flash), eEEPROM (embedded electrically erasable programmable read-only memory), eMTP (emulated multiple time programmable), and eOTP (embedded one-time-programmable)
- **ETCH:** The process of selectively removing unwanted materials on the surface of silicon wafers by chemical or physical methods
- **Foundry:** Semiconductor contract manufacturers who fabricate customers' products based on customers' design
- **FRD:** Fast recovery diode is a semiconductor device which possesses short reverse recovery time for rectification purposes at high frequency. A quick recovery time is crucial for rectification of high-frequency AC signal.
- **GaAs:** Gallium Arsenide is a compound semiconductor with a mixture of two elements, Gallium (Ga) and Arsenic (As), which are used in the manufacturing of devices such as power amplifiers, microwave frequency integrated circuits, monolithic microwave integrated circuits, infrared light-emitting diodes, laser diodes, etc.
- **GaN:** Gallium Nitride, a binary III/V direct bandgap semiconductor commonly used in light-emitting diodes
- **GPP:** Glass passivation
- **HBT:** Heterojunction Bipolar Transistor is a type of manufacturing technologies for RF PA
- **HEMT:** High Electron Mobility Transistor is a type of manufacturing technologies for RF PA
- **ICP:** Inductive coupled plasma
- **IDM:** Integrated device manufacturer; semiconductor firms who design, manufacture, package, and test their own products with in-house capacity
- **IGBT:** Insulated-gate bipolar transistor is a three-terminal power semiconductor device primarily used as an electronic switch which combines high efficiency and fast switching
- **IPM:** Intelligent Power Module is a semiconductor module that integrates power switching devices and drive circuits
- **LDMOS:** Laterally-diffused metal-oxide semiconductor is a planar double-diffused MOSFET used in microwave/RF power amplifiers and audio power amplifiers
- **LED:** A light-emitting diode is a semiconductor light source that emits light when current flows through it
- **LED driver:** A self-contained power supply which regulates the power required for an LED or array of LEDs

- **LiDAR:** Light Detection and Ranging is a method for measuring distances by illuminating a target with laser light and measuring the reflection with a sensor
- **Logic IC:** IC that transfers and processes discrete signals, and uses binary as a principle to implement logical operations on digital signals
- **MCU:** A microcontroller is a small computer on a single integrated circuit, which contains one or more processor cores along with memory and programmable input/output peripherals
- **Memory interface IC:** Key logic ICs in memory modules, which act as bridges between a CPU and memory ICs to enhance the performance, speed, and stability of memory data access
- **MEMS:** Microelectromechanical systems, the technology of microscopic devices, particularly those with moving parts. MEMS are made up of components between 1 and 100 micrometers in size, and usually consist of a central unit that processes data (an integrated circuit chip such as a microprocessor) and several components that interact with the surroundings (such as microsensors)
- **MIMO:** multiple-input and multiple-output, a method for multiplying the capacity of a radio link by using multiple transmission and antennas
- **MOCVD:** Metal-organic chemical vapor deposition
- **MOSFET:** The metal oxide semiconductor field effect transistor (also known as MOS transistor or MOS) is a semiconductor device that is widely used for switching and amplifying electronic signals in electronic devices. It is fabricated by the controlled oxidation of a semiconductor, typically silicon. The ability to change conductivity with the amount of applied voltage can be used for amplifying or switching electronic signals
- **NAND:** A type of flash memory that may be erased, written and read in blocks (or pages)
- **Optical communication chip:** ICs that are used for optical–electrical signal conversions in optical communications
- **OSAT:** Outsourced semiconductor assembly and testing; companies who provide semiconductor packaging, assembly, and testing services to customers
- **PMIC:** Power management integrated circuits are ICs for power management, which perform various functions related to power requirements such as DC to DC conversions, battery charging, voltage scaling
- **PVD:** Physical vapor deposition
- **Radio Frequency (RF):** High-frequency alternating-current electromagnetic waves with a frequency range between 300KHz~300GHz
- **RCD:** Register clock driver is a kind of memory interface IC
- **Rectifier:** An electrical device that converts AC to DC. Common rectifiers include vacuum tube diodes, mercury-arc valves, stacks of copper and selenium oxide plates, semiconductor diodes, silicon-controlled rectifiers and other silicon-based semiconductor switches.

- **RF PA (radio frequency power amplifier):** A semiconductor device that can convert a low-power RF signal into a higher power signal, and is widely adopted in wireless communication networks such as base stations, smartphones, WiFi routers, CPE, etc.
- **SBD:** Schottky barrier diode, or known as Schottky diode, is a semiconductor diode formed by the junction of a semiconductor with a metal. Schottky diodes can be used as rectifiers in switched-mode power supplies, or used in voltage clamping applications, prevention of transistor saturation, stand-alone (“off-grid”) photovoltaic (PV) systems, diode-bridge based sample and hold circuits, or used to accurately load or unload single electrons in semiconductor nanostructures
- **SCR:** Silicon controlled rectifier is a four-layer solid-state current-controlling device. SCR is mainly used in electronic devices that require control of high voltage and power. It makes devices applicable in medium and high AC power operations such as motor control functions
- **SiC:** Silicon carbide
- **SiGe:** silicon-germanium, an alloy with any molar ratio of silicon and germanium
- **SoC:** System on a chip is an integrated circuit that integrates all components of a computer or other electronic systems. These components typically include a central processing unit (CPU), memory, input/output ports and secondary storage – all on a single substrate or microchip
- **SOI:** Silicon on Insulator wafers are produced by using SIMOX and wafer bonding technology to achieve thinner and more precise device layer
- **Super Junction MOSFET:** A type of MOSFET structure in which multiple vertical pn junctions are arranged. It is a representation of MOSFETs with high voltages
- **Transistor:** A semiconductor device that is used to amplify or switch electronic signals and electrical power
- **Thyristor:** A semiconductor device with four layers of alternating P- and N-type materials. Thyristors are mainly used when high currents and voltages are involved, and are often used to control alternating currents. The most common type of thyristor is the silicon-controlled rectifier (SCR)
- **TSV:** Through Silicon Via. A high-density packaging technology, a new technical solution for stacking chips in three-dimensional integrated circuits to achieve interconnection
- **UPS:** Uninterruptible power supply
- **VDMOS:** Vertical Diffused MOS is a kind of structure of power MOSFET.
- **VLSI:** Very large-scale integration (VLSI) is the process of creating ICs by combining millions of MOS transistors onto a single chip
- **Wireless IC:** A type of IC for wireless applications such as infrared, Bluetooth, Wi-Fi, GPRS, etc.
- **02 project:** A National science and technology project in Very Large Scale Integrated Circuit manufacturing equipment and complete processes, also known as 02 project

Appendix

Exhibit 626: Power Semi China and Global Peers Comp Table

Power Semi	Ticker	Rating	Analyst	Pricing currency	PX (LCY)	TP (LCY)	Upside (%)	Market cap (US\$m)	EV (US\$m)	LTM PX move (%)	LTM ADTV (US\$m)	EPS growth			Trading P/E			Trading P/B			ROE			Div Yield			
												2020E	2021E	2022E	2020E	2021E	2022E	2020E	2021E	2022E	2020E	2021E	2022E	2020E	2021E	2022E	
Local																											
StarPower	603290.SS	Buy*	Allen Chang, Jin Guo	CNY	264.6	402	52%	6,049	6,048	1,981	108	17%	59%	82%	247.3	155.2	85.5	37.1	31.8	25.2	20%	22%	33%	0.1%	0.2%	0.3%	
CR Micro	688396.SS	Buy*	Allen Chang, Jin Guo	CNY	36.2	88	57%	9,415	9,512	340	183	17%	74%	65%	145.9	84.0	50.9	6.8	5.7	6.8	8%	8%	12%	0.1%	0.1%	0.2%	
Wingtech	600745.SS	Buy	Verena Jeng, Jin Guo	CNY	160.0	189	18%	25,699	27,669	347	281	143%	54%	18%	59.1	38.5	32.6	7.6	6.5	5.5	144%	18%	18%	0.2%	0.3%	0.4%	
Starat	600490.SS	Buy	Lynn Luo, Jin Guo	CNY	17.0	21.5	26%	3,194	3,615	12	115	269%	292%	89%	416.9	106.2	66.5	6.5	6.3	5.8	2%	6%	11%	0.1%	0.3%	0.5%	
SG Micro	300661.SZ	Buy	Yi-Ling Luo, Jin Guo	CNY	337.0	400	19%	7,484	7,425	445	69	14%	93%	71%	215.2	111.7	65.5	39.8	30.7	22.2	20%	31%	39%	0.1%	0.1%	0.3%	
Yangjie	300373.SZ	NC	NA	CNY	36.4	NA	NA	2,452	2,447	154	57	27%	28%	35%	59.6	46.5	34.4	6.0	5.4	4.7	10%	12%	14%	0.6%	0.7%	NA	
Jieji	300623.SZ	NC	NA	CNY	33.2	NA	NA	2,313	2,131	182	52	12%	27%	26%	67.5	53.2	42.1	6.5	5.8	5.2	10%	11%	13%	0.2%	0.4%	0.7%	
Sino-Micro	600360.SS	NC	NA	CNY	10.4	NA	NA	1,428	1,386	76	67	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA		
GoodArk	002079.SZ	NC	NA	CNY	14.0	NA	NA	1,459	1,389	101	75	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA		
Jinglai	Private	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA		
Waferr	Private	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA		
CHP Yongdian	Private	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA		
Macmic	Private	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA		
I&E Provider																											
Global																											
ON Semi	Private	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA		
Infineon	Private	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA		
Mitsubishi	Private	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA		
Robt	Private	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA		
Cree	Private	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA		
ST Micro	Private	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA		
Recess	Private	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA		
Littelfuse	Private	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA		
Diodes	Private	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA		
Vishay	Private	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA		
Panli	Private	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA		
Taiwan Semi	Private	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA		
Yoshida	Private	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA		
Fuji	Private	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA		
Microchip	Private	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA		
Average excl. outliers											179	83	13%	49%	27%	65.9	42.2	35.2	8.0	6.8	7.0	9%	12%	16%	1.3%	1.5%	1.2%
Average											17	88	2%	59%	30%	47.6	24.3	30.9	3.6	3.7	3.7	7%	11%	12%	0.6%	0.7%	0.6%
Median											17	88	2%	59%	30%	47.6	24.3	30.9	3.6	3.7	3.7	7%	11%	12%	0.6%	0.7%	0.6%

Prices as of July 10, 2020; NC = Not Covered; CS=Coverage Suspended;*denotes for stocks in our AEJ conviction list

Source: Bloomberg, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 627: IC design China and Global Peers Comp Table

IC design	Ticker	Rating	Analyst	Pricing currency	PX (LCY)	TP (LCY)	Upside (%)	Market cap (US\$m)	EV (US\$m)	LTM PX move (%)	LTM ADTV (US\$m)	EPS growth			Trading P/E		Trading P/B			ROE			Div Yield				
	2020E	2021E	2022E	2020E	2021E	2022E	2020E	2021E	2022E	2020E	2021E	2022E	2020E	2021E	2022E	2020E	2021E	2022E	2020E	2021E	2022E	2020E	2021E	2022E			
Local	Montage	688008.SS	Buy	Lynn Luo, Jin Guo	CNY	117.2	161	37%	18,918	17,881	374	80	25%	43%	51%	74.7	49.6	16.3	14.3	12.1	16%	20%	26%	0.3%	0.5%	0.7%	
	Goodix	603160.SS	Neutral	Allen Chang, Jin Guo	CNY	259.5	252	-3%	16,930	16,369	81	164	-56%	149%	20%	46.3	38.5	16.2	12.5	9.8	15%	30%	29%	0.1%	0.3%	0.4%	
	Will Semi	603051.SS	Buy	Lynn Luo, Jin Guo	CNY	244.0	271	11%	30,104	30,401	342	125	330%	86%	35%	59.9	44.5	22.1	16.8	12.7	22%	32%	32%	0.1%	0.2%	0.3%	
	Maxsemi	300782.SZ	Buy	Verena Jeng, Jin Guo	CNY	476.8	562	18%	12,257	12,116	355	129	12%	10%	55%	68.0	44.0	29.1	28.8	20.7	44%	49%	55%	0.5%	0.6%	0.9%	
	CigaDevice	603986.SS	Buy	Lynn Luo, Jin Guo	CNY	273.8	326	19%	18,416	18,154	313	289	19%	46%	46%	77.2	53.0	21.4	17.5	13.8	25%	29%	32%	0.2%	0.3%	0.4%	
	SG Micro	300661.SZ	Buy	Lynn Luo, Jin Guo	CNY	337.0	353	5%	7,484	7,425	453	69	38%	87%	70%	115.1	67.7	39.8	31.0	22.5	20%	30%	38%	0.1%	0.2%	0.3%	
	Guoxin Micro	002049.SZ	NC	NA	CNY	129.0	NA	NA	11,184	11,152	205	237	72%	34%	37%	83.3	61.0	16.1	13.5	11.2	15%	17%	18%	0.1%	0.1%	0.2%	
	Ingenic	300223.SZ	NC	NA	CNY	125.6	NA	NA	8,091	7,982	340	110	165%	0%	29%	161.1	124.4	19.1	17.0	15.0	7%	11%	12%	NA	NA	NA	
	Jingjie Micro	300474.SZ	NC	NA	CNY	84.4	NA	NA	3,631	3,460	118	50	67%	39%	48%	62.8	42.5	9.8	8.7	7.2	11%	14%	16%	NA	NA	NA	
	Alhwiners	300458.SZ	NC	NA	CNY	45.8	NA	NA	2,165	1,953	96	55	68%	18%	19%	56.2	47.2	NA	NA	NA	NA	NA	NA	0.9%	1.0%	1.3%	
	Belling	600171.SS	NC	NA	CNY	20.8	NA	NA	2,095	1,880	39	73	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
	Fulhan	300613.SZ	NC	NA	CNY	127.9	NA	NA	1,462	1,372	149	26	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
	SinoWealth	300327.SZ	NC	NA	CNY	35.4	NA	NA	1,414	1,389	77	36	19%	31%	1%	33.5	33.1	9.0	7.8	6.2	20%	22%	19%	1.3%	1.7%	NA	
	Natanz	300077.SZ	NC	NA	CNY	8.3	NA	NA	660	676	12	27	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
	Global																										
	Rambus	Private	NA	NA	USD	14.8	NA	NA	1,680	1,438	22	10	NM	5%	10%	14.1	12.8	1.9	2.1	2.1	-5%	-3%	-2%	0.0%	0.0%	0.0%	
	Nvidia	Private	NA	NA	USD	419.2	404	-4%	257,790	249,014	163	2,829	-23%	44%	37%	65.8	48.1	21.7	18.4	15.4	25%	30%	35%	0.3%	0.2%	0.2%	
	MediaTek	2454.TW	Buy	Bruce Lu	TWD	616.0	815	32%	33,121	28,458	97	139	26%	74%	13%	18.9	16.7	2.9	2.7	2.5	8%	15%	15%	2.1%	3.6%	4.0%	
	Xilinx	Private	NA	NA	USD	96.1	113	14%	24,110	23,150	150	140	31%	-3%	-12%	33.5	26.4	11.8	12.2	11.3	33%	33%	42%	1.5%	1.6%	1.8%	
	Realtek	2329.TW	Sell	Toshiya Hari	TWD	399.5	256	-29%	6,213	5,375	70	35	14%	12%	17%	21.1	16.9	5.8	5.3	27%	28%	29%	3.5%	3.9%	4.5%		
Novatek	3034.TW	Buy	Bruce Lu	USD	285.5	319	12%	5,478	5,250	116	210	31%	7%	18%	31.6	24.6	4.6	4.6	26%	28%	28%	2.8%	4.8%	5.2%			
Silergy	6445.TW	Neutral	Bruce Lu	TWD	1,870.0	1,865	0%	5,789	5,623	207	27	28%	23%	56%	45.8	29.3	9.9	8.5	6.6	19%	20%	25%	0.6%	0.7%	0.7%		
Parade	4966.TWO	Neutral	Bruce Lu	TWD	1,060.0	1,035	-2%	2,878	2,587	104	21	20%	20%	13%	23.4	20.8	6.4	5.6	4.9	24%	25%	24%	1.7%	2.1%	2.3%		
Average excl. outliers					159	227	30%	35%	31%	56.6	41.7	14.3	12.1	10%	19%	23%	26%	11%	13%	13%	2.3%	1.3%	1.4%				
Overall					111	71	22%	31%	29%	56.2	42.5	14.4	12.3	10.5	20%	25%	26%	0.5%	0.6%	0.5%							

Exhibit 629: Silicon wafer China and Global Peers Comp Table

	Ticker	Rating	Analyst	Pricing currency	PX (LCY)	TP (LCY)	Upside (%)	Market cap (US\$m)	EV (US\$m)	LTM PX move (%)	LTM ADTV (USDmn)	EPS growth			Trading P/E			Trading P/B			ROE			Div Yield			
												2020E	2021E	2022E	2020E	2021E	2022E	2020E	2021E	2022E	2020E	2021E	2022E	2020E	2021E	2022E	
Silicon wafer																											
Local																											
NSIG	688126.SS	Buy	Jin Guo	CNY	48.1	60	25%	17,059	17,237	1,138	431	NM	NM	319%	NM	NM	380.7	16.0	15.9	15.2	-1%	1%	4%	0.0%	0.0%	0.0%	
Zhonghuan Semi	002129.SZ	NC	NC	CNY	25.8	NA	NA	10,262	13,449	181	212	64%	33%	23%	48.5	36.4	29.6	4.5	4.0	3.6	9%	11%	12%	0.2%	0.2%	0.3%	
Yixin	Private	NC	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA		
Guosheng	Private	NC	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA		
Li-On Micro	Private	NC	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA		
Grimm	Private	NC	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA		
Poshing	Private	NC	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA		
Advanced Silicon Tech	Private	NC	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA		
Global																											
Global Wafer	6488.T	Buy	Thurston Lee	TWD	423.0	480	13%	6,259	5,588	36	66	-6%	16%	12%	14.3	12.3	11.1	3.9	3.6	3.3	28%	30%	31%	5.6%	6.4%	7.2%	
Shin Etsu	4053.T	Buy*	Shuhei Nakamura	JPY	12,410.0	14,000	13%	48,366	39,120	91	135	4%	12%	8%	16.3	14.6	13.5	1.9	1.8	1.6	12%	12%	12%	1.9%	2.0%	2.2%	
Wafer Works	6182.TWO	NC	NC	TWD	35.6	NA	NA	615	799	1	10	-31%	6%	NA	21.4	20.1	NA	2.1	2.0	NA	5%	7%	NA	3.7%	2.7%	NA	
Soltec	SOIT.PA	NC	NC	EUR	105.6	NA	NA	3,971	3,129	13	12	12%	-25%	63%	32.8	44.0	27.1	6.5	5.1	4.6	23%	16%	18%	0.0%	0.0%	0.0%	
Siltronic	WAF.Gn.DE	NC	NC	EUR	91.9	NA	NA	3,116	2,597	57	18	-36%	33%	20%	19.2	14.5	12.1	2.7	2.3	1.9	15%	18%	17%	2.1%	2.8%	3.2%	
SUNCO	3436.T	CS	NA	JPY	1,620.0	NA	NA	4,412	5,570	27	146	15%	26%	NA	13.8	10.9	NA	1.4	1.3	NA	10%	12%	NA	2.3%	2.8%	2.0%	
Average											185	128	3%	14%	74%	23.8	21.8	79.0	4.9	4.5	5.0	13%	13%	16%	2.0%	2.1%	2.1%
Median											33	100	4%	16%	21%	19.2	14.6	20.3	3.3	3.0	3.4	11%	12%	15%	2.0%	2.4%	2.0%

Prices as of July 10, 2020; NC = Not Covered; CS=Coverage suspended; *denotes for stocks in our AEJ conviction list

Source: Bloomberg, Goldman Sachs Global Investment Research, Gao Hua Securities Research

Exhibit 630: SPE peers comp table

	Ticker	Rating	Analyst	Pricing currency	PX (LCY)	TP (LCY)	Upside (%)	Market cap (US\$m)	EV (US\$m)	LTM PX move (%)	LTM ADTV (USDmn)	EPS growth			Trading P/E			Trading P/B			ROE			Div Yield			
												2020E	2021E	2022E	2020E	2021E	2022E	2020E	2021E	2022E	2020E	2021E	2022E	2020E	2021E	2022E	
Local	SPE																										
	Local																										
AMEC	688012.SS	Buy	Allen Chang, Jin Guo	CNY	269.2	382	42%	20,570	20,241	828	99	59%	97%	78%	458.8	233.1	130.9	35.4	30.7	24.9	8%	14%	21%	0.0%	0.0%	0.0%	
AccoTest	688200.SS	Buy	Jin Guo	CNY	317.1	469	48%	2,772	2,740	196	52	27%	52%	79%	109.7	72.3	40.3	8.5	8.8	7.7	13%	13%	20%	0.3%	0.5%	0.9%	
ACM Research	ACMR	Buy*	Jin Guo	USD	81.6	150	84%	1,465	1,485	385	15	9%	117%	57%	66.5	30.6	19.5	12.3	8.8	6.1	21%	33%	37%	0.0%	0.0%	0.0%	
Naura	002371.SZ	Buy	Jin Guo	CNY	221.3	307	39%	15,654	15,567	223	179	52%	108%	96%	216.5	104.2	53.1	17.4	15.1	12.0	8%	16%	25%	0.0%	0.1%	0.2%	
Kingsemi	688037.SS	NC	NA	CNY	144.2	NA	NA	1,731	1,652	435	69	25%	69%	53%	250.8	148.7	97.5	15.3	14.3	13.0	6%	10%	13%	NA	NA	NA	
Changchuan	300604.SZ	NC	NA	CNY	34.8	NA	NA	1,564	1,559	76	33	775%	16%	33%	99.5	66.0	64.5	10.2	9.2	8.2	7%	11%	13%	NA	NA	NA	
PNC	603690.SS	NC	NA	CNY	69.5	NA	NA	2,230	2,351	193	38	62%	45%	23%	82.2	56.5	46.0	10.5	9.1	6.6	15%	18%	15%	0.1%	0.1%	0.1%	
Jingsheng	300316.SZ	NC	NA	CNY	28.3	NA	NA	5,193	5,256	143	73	46%	25%	21%	38.7	31.0	25.5	6.8	5.8	4.9	17%	18%	18%	0.4%	0.7%	0.4%	
Wanye	600641.SS	NC	NA	CNY	25.6	NA	NA	2,946	2,350	134	43	5%	-8%	-26%	32.5	35.3	47.4	2.9	2.8	2.7	9%	8%	6%	1.0%	1.0%	NA	
Mallson	Private	NC	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA		
Hestling	Private	NC	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA		
Piotech	Private	NC	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA		
Raintree	Private	NC	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA		
Global																											
Applied Material	AMAT	Buy	Toshiya Hari	USD	62.6	69	10%	57,362	58,717	42	453	25%	-9%	46%	16.4	18.1	12.4	5.7	5.4	4.7	37%	31%	40%	1.4%	1.5%	1.6%	
ASML	ASML.AS	Buy	Alexander Duval	EUR	348.7	366	5%	167,723	167,448	91	328	10%	55%	20%	51.9	33.4	27.8	11.2	10.1	8.8	22%	32%	34%	0.7%	0.7%	0.9%	
Entegris	ENTG	Buy	Toshiya Hari	USD	59.1	65	10%	7,949	8,746	65	47	4%	2%	45%	29.4	28.9	20.0	6.2	6.2	5.9	17%	16%	25%	0.5%	0.6%	0.7%	
Lam Research	LRCX	Buy	Toshiya Hari	USD	340.0	330	-3%	49,352	49,220	88	506	3%	-6%	49%	22.6	24.1	16.2	9.9	9.2	8.2	46%	41%	54%	1.4%	1.4%	1.5%	
KEYight	KEYS	Neutral	Toshiya Hari	USD	97.6	93	-5%	18,262	18,371	10	167	-16%	16%	23%	27.1	23.3	19.0	5.6	5.1	4.7	22%	23%	26%	0.0%	0.0%	0.0%	
KLAC	KLAC	Neutral	Toshiya Hari	USD	202.3	193	-5%	31,360	33,283	73	243	22%	-2%	9%	19.5	20.0	18.3	13.4	12.8	13.0	65%	65%	69%	1.8%	2.0%	2.2%	
Teradyne	TER	Neutral	Toshiya Hari	USD	87.4	84	-4%	14,485	14,044	91	147	31%	0%	13%	23.6	23.6	21.0	7.4	6.7	6.4	37%	31%	32%	0.4%	0.5%	0.6%	
Tokyo Electron	8035.T	CS	NA	JPY	29,610.0	NA	NA	43,541	40,408	86	292	20%	19%	NA	22.5	18.9	NA	5.0	4.5	NA	23%	25%	NA	2.2%	2.6%	4.0%	
Advantest	6857.T	CS	NA	JPY	6,960.0	NA	NA	12,992	11,903	133	157	4%	26%	NA	27.3	21.6	NA	5.3	4.6	NA	20%	23%	NA	1.1%	1.4%	3.0%	
Screen Holdings	7735.T	CS	NA	JPY	5,270.0	NA	NA	2,504	2,762	9	53	103%	37%	NA	16.2	11.9	NA	1.3	1.2	NA	8%	10%	NA	1.5%	2.0%	3.0%	
Ulvac	6728.T	CS	NA	JPY	3,245.0	NA	NA	1,498	1,362	(7)	17	1%	38%	NA	16.4	11.8	NA	1.0	0.9	NA	6%	8%	NA	2.7%	3.1%	2.0%	
Nanometrics	ONTO	NC	NA	USD	35.4	NA	NA	1,720	1,452	6	10	NM	45%	33%	22.9	15.8	11.9	2.9	NA	NA	7%	10%	NA	NA	NA	NA	
Cohu	COHU	NC	NA	USD	16.8	NA	NA	702	920	20	5	NM	625%	49%	105.2	14.5	9.8	1.5	1.5	1.4	2%	12%	17%	0.4%	NA	NA	
Average											151	153	63%	62%	39%	72.8	45.3	57.6	8.7	8.2	8.2	15%	21%	27%	0.3%	1.6%	1.2%
Median											89	71	24%	32%	39%	30.9	26.5	23.2	7.1	6.7	6.6	16%	17%	25%	0.5%	0.7%	0.9%

Prices as of July 10, 2020; NC = Not Covered; CS=Coverage suspended; *denotes for stocks in our AEJ conviction list

Source: Bloomberg, Goldman Sachs Global Investment Research, Gao Hua Securities Research

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Reg AC

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China Software



Extended Reality



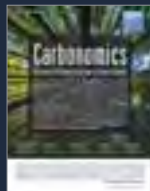
5G: From Lab to Launchpad



Climate Change



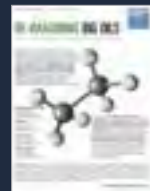
Carbonomics



The End of Non-OPEC Growth



Reimagining Big Oils



The Rise of Renewables



Shale Scale to Shale Tail



IMO 2020



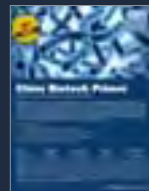
The Genome Revolution



Digital Health



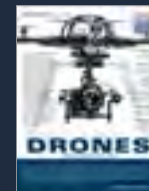
China Biotech Primer



Future of Work



Drones



Space



Factory of the Future



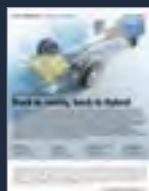
eSports: From Wild West to Mainstream



Music in the Air



EVs: Back to Reality



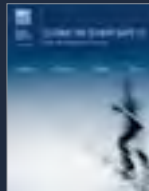
Venture Capital Horizons



ESG Rising



Womenomics



China Cosmetics



The Chinese Consumer



Feeding China's Changing Appetite



New China, Old China



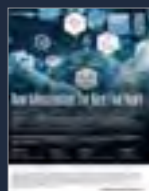
China A Shares in Anatomy



China's Credit Conundrum



New China Infrastructure



What the Market Pays For



What Matters for IPOs



Top of Mind



...and more

