

22 July 2022

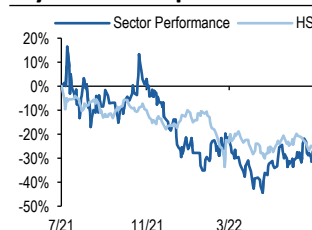
Technology Sector Insights

Sector Rating
Outperform

China SPE makers: from nobody to somebody

- ⊕ **Favor Chinese suppliers of semiconductor production equipment (SPE):** In the near term, we believe the US export ban will cut off China's access to chip manufacturing equipment, and slow down its progress toward advanced chips. In the longer term, however, the ban will induce China to accelerate domestic supply chain build-up. In 2017-21, domestic players have been outgrowing global peers in the China market (CAGR: 48% vs. 23%). We thus hold a long-term upbeat outlook on China's semiconductor production equipment (SPE) industry.
- ⊕ **Limited impact from global semiconductor downturn:** In response to market concerns about weakening demand and oversupply of fab capacities in 2023E, we expect equipment makers to survive the global semiconductor (semis) downturn as: (1) industry capex should overcome cyclicalities in the next few years with governments worldwide ramping up investment in domestic semiconductor manufacturing amid de-globalization; (2) structural shortage provides Chinese players more opportunities under global supply bottleneck; and (3) China's domestic equipment market has historically outperformed in both up- and down-cycles of semiconductors.
- ⊕ **To become somebody:** The vast downstream market, from smartphones to industrials and auto, is China's unique advantage. The Chinese government also plays a vital role in industry development via policy and fund support to encourage investments. This has brought a valuation premium for A-share-listed companies and, in turn, allows them to raise more funds for expansion. Although some believe China is 3-4 generations behind cutting-edge semiconductors, we still see plenty of upside for Chinese fabs and equipment makers, as less-advanced chips take 50%+ share in all applications.
- ⊕ **SPE players to watch:** We compare eight major A-share-listed Chinese semiconductor equipment companies by different indicators. Investors may follow stocks of key Chinese SPE suppliers, including Piotech (688072 CH/NR), AMEC (688012 CH/NR) and NAURA (002371 CH/NR).

1-year sector performance



Source: FactSet

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Valuation summary

Company name	Stock code	Rating	TP (local ccy)	CP (local ccy)	-----EPS-----		-----P/E-----		-----P/B-----		Yield FY22E
					FY22E (rpt ccy)	FY23E (rpt ccy)	FY22E (x)	FY23E (x)	FY22E (x)	FY23E (x)	
NAURA	002371 CH	NR	NA	280.57	3.290	4.640	85.3	60.5	7.96	7.07	0.1
AMEC	688012 CH	NR	NA	121.20	1.760	2.230	68.9	54.3	4.97	4.55	0.0
Piotech	688072 CH	NR	NA	201.00	0.938	1.651	214.3	121.7	7.33	6.89	0.0
Average							122.8	78.9	6.76	6.17	0.0

Source: FactSet (consensus for NR stocks)

Analyst certifications, disclosures and disclaimer at the back forms part of this report and must be read.

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Equipment Ban + Semis Downturn a Blessing in Disguise?

China has made its best efforts to catch up on semiconductors. However, the country's semiconductor industry remains vulnerable as it heavily relies on equipment imports. The US export ban could choke off China's access to the chip manufacturing equipment, thus impeding China's progress toward advanced chips. However, the ban will also induce China to accelerate the build-up of a self-reliant semiconductor supply chain, as it is now stepping up efforts in domestic equipment substitutes.

We see a rosy outlook on the Chinese suppliers of semiconductor production equipment (SPE) in the long run.

Limited impact from global semiconductor downturn

According to SEMI, global sales of SPE in 2021 surged 44% YoY to an all-time record of US\$102.6bn, driven by a dramatic increase in the industry's capex. Semiconductor makers spent US\$152bn on fabs and production expansion in 2021, growing by the fastest rate since 2018 at 41% YoY.

Nonetheless, the market has concerns about weakening demand and oversupply of fab capacities going into 2023E. In our view, the equipment market can survive the global semiconductor downturn for the following three reasons.

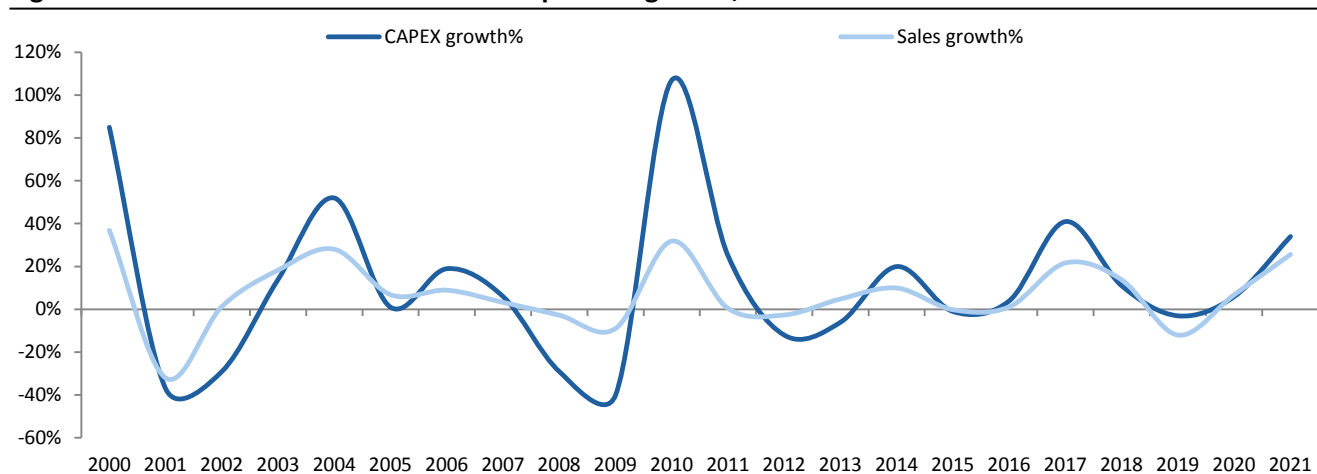
(1) Trend of de-globalization

The exogenous factors arising over the past few years, including the COVID pandemic and geopolitical tension, have disrupted the global semiconductor supply-chain structure and driven the industry further toward de-globalization. Semiconductors have become a national security issue. Major countries have announced government-backed investment plans in tandem to promote self-manufacturing of semiconductors:

- ⊖ **US:** The US House of Representatives passed in February this year the America Competes Act of 2022, which includes US\$52bn for semiconductor manufacturing, supply chain and R&D.
- ⊖ **EU:** The EU announced the European Chips Act also in February 2022, including a EUR43bn investment plan, which aims to boost the EU-made semiconductors.
- ⊖ **Japan:** The Japanese government in November 2021 approved funding of JPY774bn for domestic semiconductor investment, to be mostly invested in production capacity for both cutting-edge and legacy chips; the rest is for R&D.
- ⊖ **South Korea:** The Korean government announced in June 2022 a five-year plan to invest KRW1.02trn (~US\$794.8m) in R&D of cutting-edge AI semiconductor technology.
- ⊖ **India:** It is to spend US\$30bn to restructure its IT industry and build a semiconductor supply chain to avoid the constraints by foreign suppliers.

Therefore, even though the market has warned of weakening semiconductor demand in 2023E, major chip makers continue to expand production capacity aggressively. Historically, the industry's capex followed the same pattern of semiconductor sales' (Figure 1). However, we believe the vision toward semiconductor self-sufficiency will prompt global governments to accelerate investment in semiconductors and thus lead the industry's capex to go beyond cyclical in the next few years. According to IC insights, a sample of 13 global chips companies are expected to raise their capex by 40%+ in 2022.

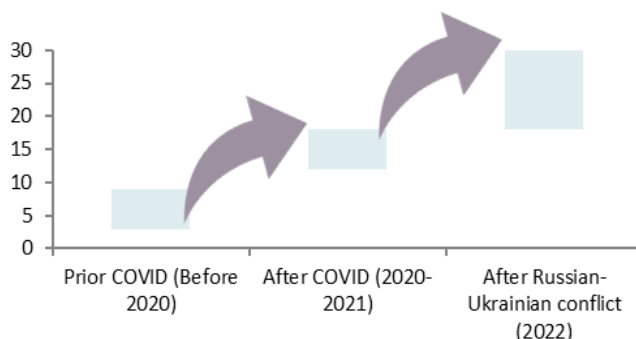
Figure 1: Global semiconductor sales and capex YoY growth, 2000-21



Source: WSTS, BOCOM Int'l

(2) Persistent supply chain shortage

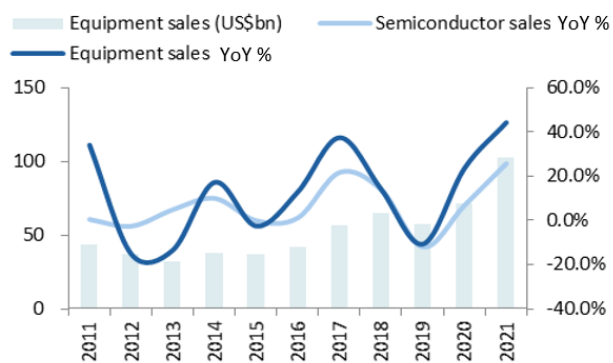
Although high inflationary pressure may depress global consumer demand, the semiconductor supply chain is still beset by the shortage of materials, equipment and components. According to TrendForce, the lead time of semiconductor equipment prior to COVID was approximately 3-6 months, but has now extended to 18-30 months (excl. EUV lithography) given the pandemic and geopolitical conflicts. *We expect the supply-chain shortage to last up to 2024E*, which may bless Chinese players with additional opportunities under the global supply constraints.

Figure 2: Semiconductor equipment lead time

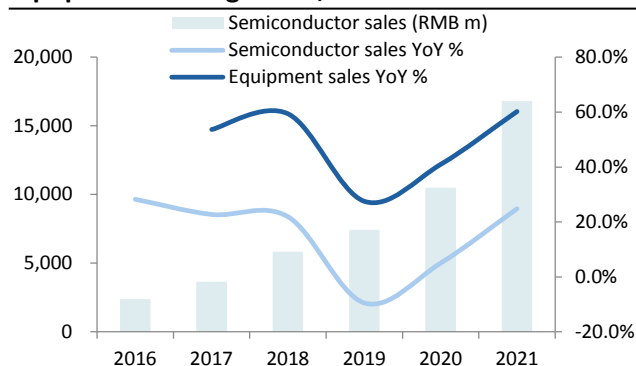
Source: TrendForce, BOCOM Int'l

(3) Chinese equipment players outperforming in both up- and down-cycles

Figures 3-4 show global and China's semiconductor capex vs. sales growth. It is clear that global SPE sales growth far outstripped semiconductor sales growth in an up-cycle, but shrank to a similar level in a down-cycle. Interestingly, Chinese semiconductor equipment companies appeared to outperform semiconductor sales through the cycles. We believe this is due to the fact that China's SPE industry is still evolving compared with the global peers. Thus, it is fair to expect Chinese equipment makers to continue to deliver strong sales growth in the next few years without too much concern on industry cyclicity.

Figure 3: Global semiconductor capex and equipment sales growth, 2011-21

Source: SEMI, BOCOM Int'l

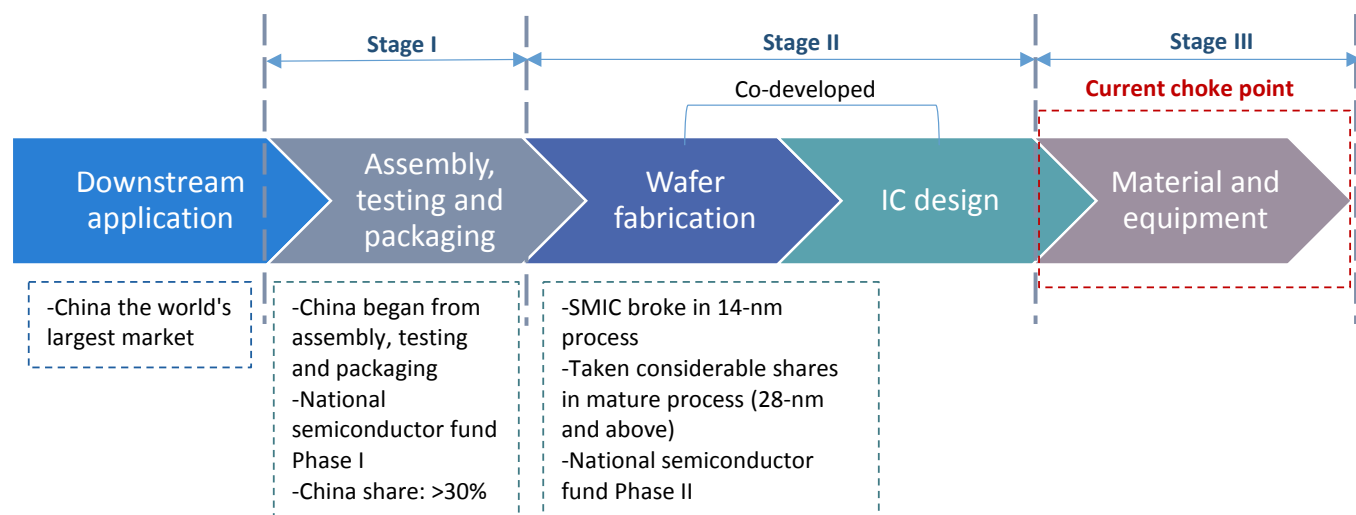
Figure 4: China semiconductor capex and equipment sales growth, 2016-21

Source: Counterpoint, BOCOM Int'l *China semiconductor sales were represented by revenue of AMEC, NAURA, Kingsemi, Piotech, ACM Research and Hwatsing

A pain point to be addressed

China is expediting strategic efforts to develop its semiconductor industry step by step (Figure 5), against the backdrop of China-US tensions. With equipment being the pain point, breakthrough in the area would catapult the country to the leading edge of the semiconductor industry.

Figure 5: China's semiconductor development pathway



Source: BOCOM Int'l

Stage I: Industry birth in back-end manufacturing segment

China incubated its semiconductor development by starting with the assembly, testing and packaging (ATP) industry, considering: (1) ATP is much easier to break into because the segment was closest to the downstream semiconductor markets where China held the largest shares (Figure 9), and (2) ATP is labor-intensive, so China can tap into its large pool of skilled and low-cost labor back then. After a decade of growth, China is now the global leader in ATP, holding a 38% share in 2020 (Figure 6).

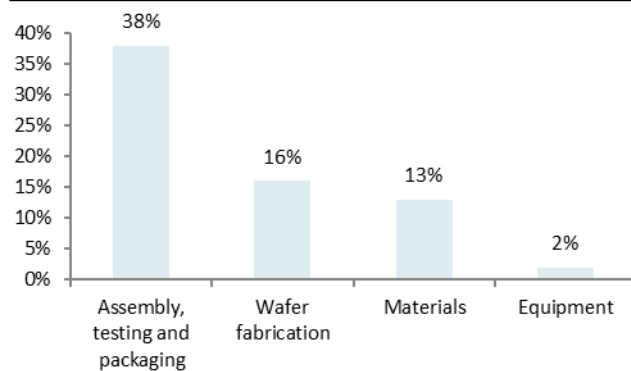
Stage II: Government-backed capital injected into front-end manufacturing

The government's effort in front-end manufacturing accelerated in 2014, when China released its National IC Promotion Guidelines and established the National IC Industry Development Investment Fund. Phase I National IC Fund primarily focused on design and manufacturing, driving a number of IDM and foundries (e.g. SMIC) to expand rapidly during the period with strong capital support. Chinese chip makers now have taken considerable shares in mature processes. Both SMIC and Hua Hong, China's leading chip makers, generate most income from mature process nodes. Other than that, SMIC reported 18.6% of its revenue from advanced 28nm/14nm FinFET processes in 4Q21, up from a mere 5% in 4Q20.

Stage III: Time for domestic equipment

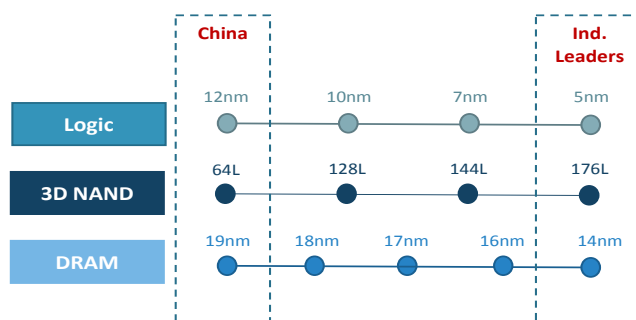
The US has initiated a series of trade restrictions on Chinese chip makers since 2018, in an apparent move to curb China's semiconductor development. The next possible sanction may be the Netherlands' ban on ASML's sale of DUV (deep ultraviolet) machines to Chinese firms, under the US' pressure. These machines are a generation behind cutting-edge but still widely used in less-advanced chip production – the segment where Chinese chip makers are seeking to expand capacity. Equipment has now become the most critical factor for Chinese companies to expand the capacity of mature process and approach cutting-edge process. This is also evident in *the shifting investment allocation of National IC Fund Phase II toward equipment and materials*.

Figure 6: China's share in global semiconductor supply chain in 2020 – equipment the weak link



Source: BCG, SIA Research, BOCOM Int'l

Figure 7: Process technology capacities: China vs. industry leaders



Source: SIA Research, BOCOM Int'l

Looking to the stars, feet on the ground

China is maneuvering its vast pool of capital and talents to focus on the SPE industry. Although its technology in most equipment is thought to lag market leaders, the massive downstream market and steadfast state support should underpin the industry with growing competitiveness, in our view.

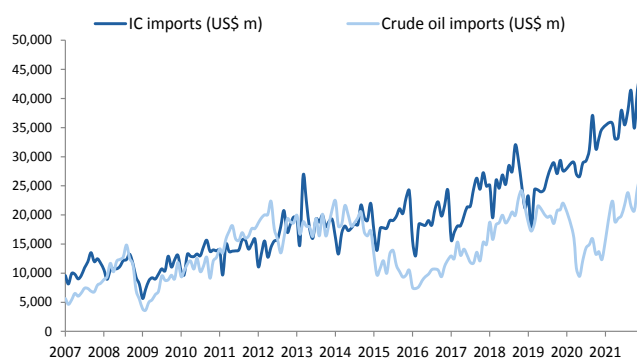
World's largest semiconductor market in the world

China is predominant in terms of regional semiconductor sales. Its integrated circuit (IC) import value has exceeded that of crude oil since 2014, and has now been China's largest import item. In 2021, China imported US\$432bn worth of semiconductors, far higher than its US\$257bn imports of crude oil (Figure 8). According to SIA data, China remained the largest market for semiconductors in 2021, with ~35% of global sales (Figure 9).

The whopping consumption is driven by the vital role that China plays in the world's manufacturing, including automobile, industrial and telecommunication products such as smartphones, PC, tablets, etc. Its superior manufacturing capabilities are supported by (1) massive consumer spending (population), (2) strong infrastructure and supplier base, and (3) relatively low labor cost. These unique advantages can hardly be found or

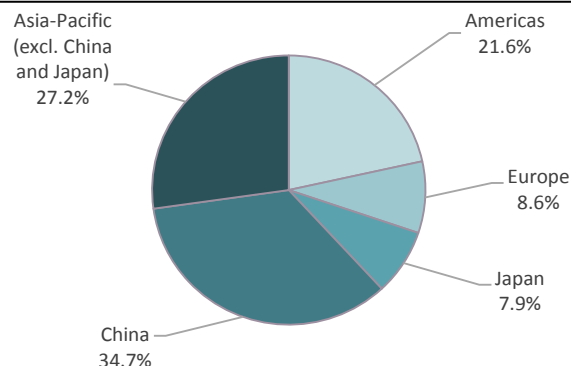
replicated in other countries. We believe its manufacturing superpower status is unshakable in the short to medium term.

Figure 8: China spends more on importing semiconductors than crude oil, 2007-21



Source: China Customs, BOCOM Int'l *monthly data above

Figure 9: China a firm leader in terms of semiconductor market sales, 2021

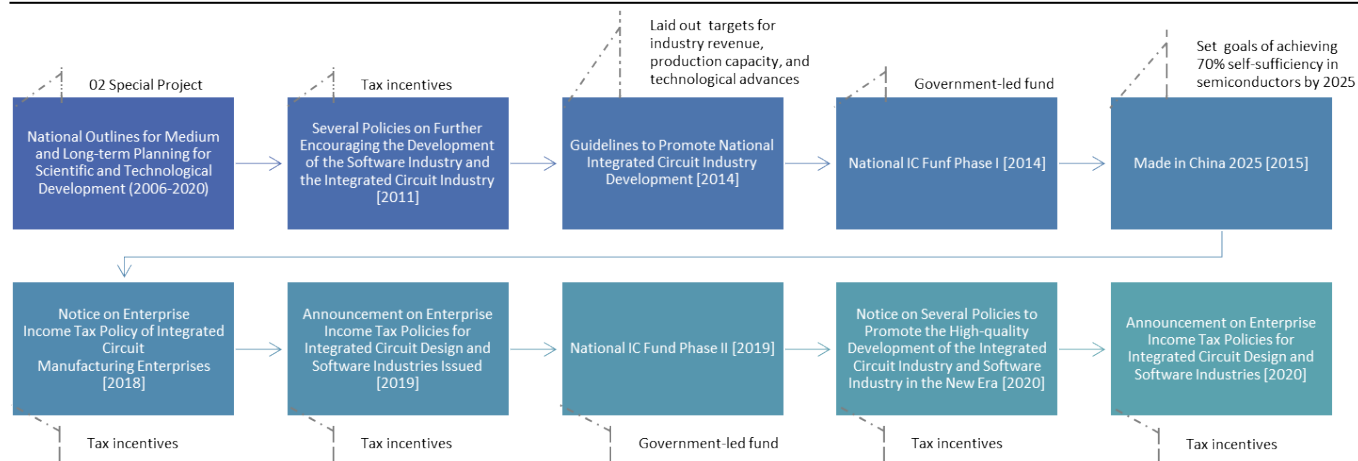


Source: SIA Research, BOCOM Int'l

Government support draws private capital, fab capacity expansion picks up pace

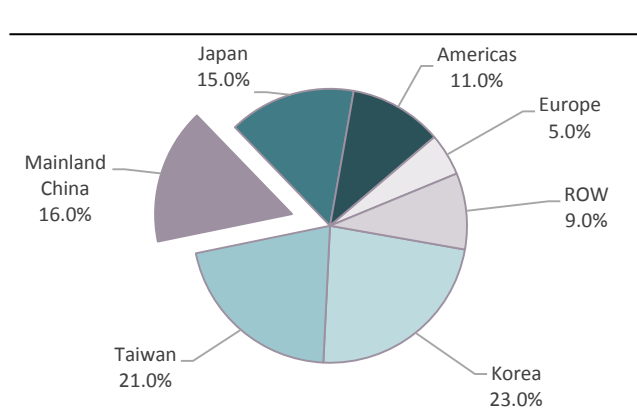
Geopolitical tensions have been intensifying between China and the US in the past few years. With the US leveraging its chip dominance to curb China's technological advances, the Chinese government has earmarked the semiconductor industry as a key strategic battlefield, releasing a slew of policies and measures, including tax incentives, subsidies, funding support, etc, to boost the country's chip autonomy.

Policies: In early 2000s, China issued 02 Special Project to focus on the extensive circuit integration and peripheral equipment manufacturing, along with other 15 National Special Projects published in the *"National Outlines for Medium and Long-term Planning for Scientific and Technological Development (2006-2020)"*. In 2014, the Chinese government published *"Guidelines to Promote National Integrated Circuit Industry Development"*, with the goal to meet 70% of China's semiconductor demand with domestic production by 2025E. The state-backed National IC Fund was launched in the same year. China also introduced tax incentives for domestic semiconductor players. For example, under the policy introduced by the State Council in 2020, qualified IC projects and enterprises that have operated for 15+ years will be exempted from corporate income tax for up to 10 years if they employ the 28nm process or more advanced nodes; projects from 28nm to 65nm will enjoy a five-year tax exemption and a 50% discount on the corporate tax rate for the subsequent five years.

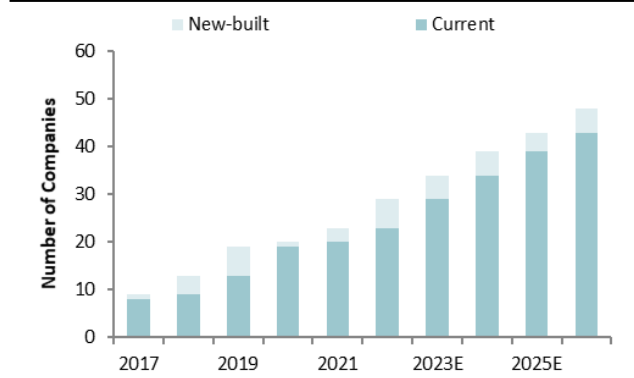
Figure 10: China's road to chip autonomy – summary of policies and initiatives since 2006

Source: BOCOM Int'l

Fund: It is worth highlighting the National IC Fund as a vital state support measure. The government-led investment started the engine for the capital-intensive semiconductor industry. The sector soon attracted more private capital seeking to ride on policy. Supported by the government and private investment, China semiconductor manufacturing capacity gradually expanded in the past few years. At the end of 2021, China had an estimated 3.5m wafers fab capacity, representing 16.2% of the global share (Figure 11), though half of them were foreign-owned. Presently, 23 12-inch fabs are operated in mainland China, processing 1.04m units of wafers per month, in which 15 fabs started operation in the past five years. Based on JW Insights estimate, mainland China will have another 25 new-built fabs in the coming five years (2022-26). By 2026, its 12-inch fabs could process up to 2.76m wafers per month, up 165.1% from now.

Figure 11: Global IC wafer capacity by region, 2021

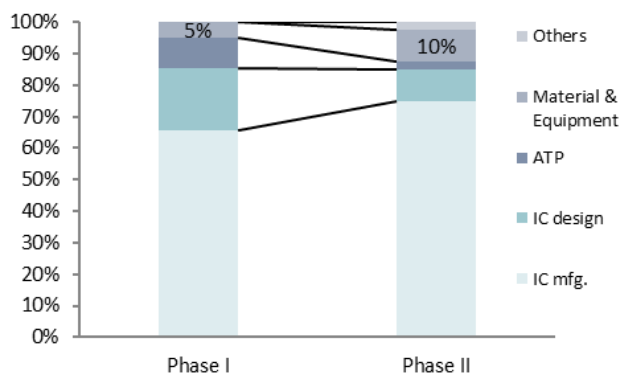
Source: Knometa Research, BOCOM Int'l

Figure 12: China has 25 new fabs on the way in 2022-26E

Source: JW Insights, BOCOM Int'l

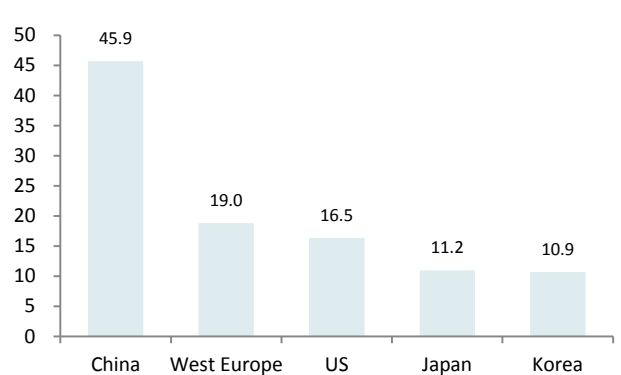
The National IC Fund was renewed in 2019 for a second round of state financing. As of 1Q22, Phase II invested RMB79bn. Of note, Phase II focuses more on material and equipment investments than Phase I (Figure 13).

Figure 13: Investment allocation of National IC Fund Phase I & II – shifting to material & equipment



Source: STCN, BOCOM Int'l

Figure 14: Semiconductor stock P/E (median) in different markets



Source: Bloomberg, BOCOM Int'l

Market: State government's dedicated support also shapes a favorable stock market for listed companies. The semiconductor stocks listed on the China market, A shares in particular, are generally given a higher valuation, indicating investors' upbeat outlook on the industry and also allowing the companies to raise more funds for business expansion. Comparing the median P/E of semiconductor stocks in different markets, China's is apparently the highest (Figure 14).

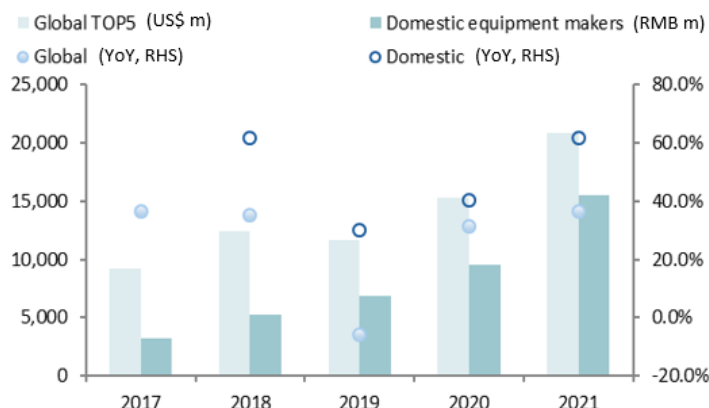
Rising domestic supplies; ramping up capacity from mature process

Due to the increasing restrictions on advanced equipment imports and fear of increased export controls, China is making a strong push to develop domestic supply chain capacities. Domestic equipment is seeing rising stakes in China's semiconductor industry. We take five Chinese semiconductor equipment makers (NAURA, AMEC, ACM Research, Kingsemi and Hwatsing) as the reference to compare their sales with global top 5's sales in the mainland China market (Figure 15). It is clear that the domestic players have grown much faster than global peers in the China market (2017-21 CAGR: 48% vs. 23%).

Moreover, we still see plenty of space up for grabs for Chinese fabs and equipment makers, even though some believe China is probably 3-4 generations behind cutting edge. Although the increasing needs for high computational applications raise the demand for leading-edge and advanced chips, the stakes of mature and legacy semiconductors cannot be ignored. In fact, below-advanced chips constitute the majority of demand in most applications. The vehicles produced by traditional OEMs are heavily reliant on mature and legacy semiconductors (75%); even the advanced battery electric vehicles (BEV) would take 50% less-advanced chips over total usage (Figure 16), according to Roland Berger. TSMC, Samsung and Intel are all moving toward more advanced process (Figure 18), so that their capacity would be re-prioritized for higher-margin process

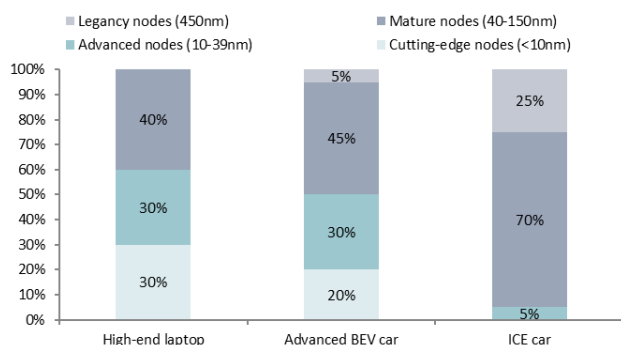
business. Chinese players have fostered capabilities in the mature process node and will be able to enjoy robust growth in this segment (Figure 17).

Figure 15: China market revenue growth: global top 5 vs. domestic players



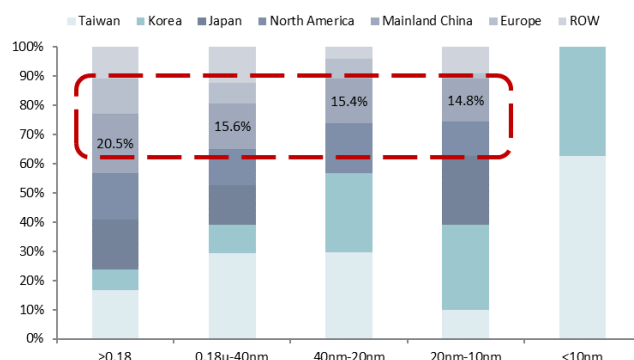
Source: Various companies, BOCOM Int'l *Most domestic players have made data public only since 2017

Figure 16: Semiconductor usage in selected OEM devices (by \$ of total 8" wafer eqv.)



Source: Roland Berger, BOCOM Int'l

Figure 17: Wafer fabrication installed capacity by geographic region as of Dec 2020



Source: IC Insights, BOCOM Int'l

Figure 18: Chipmakers' process roadmap

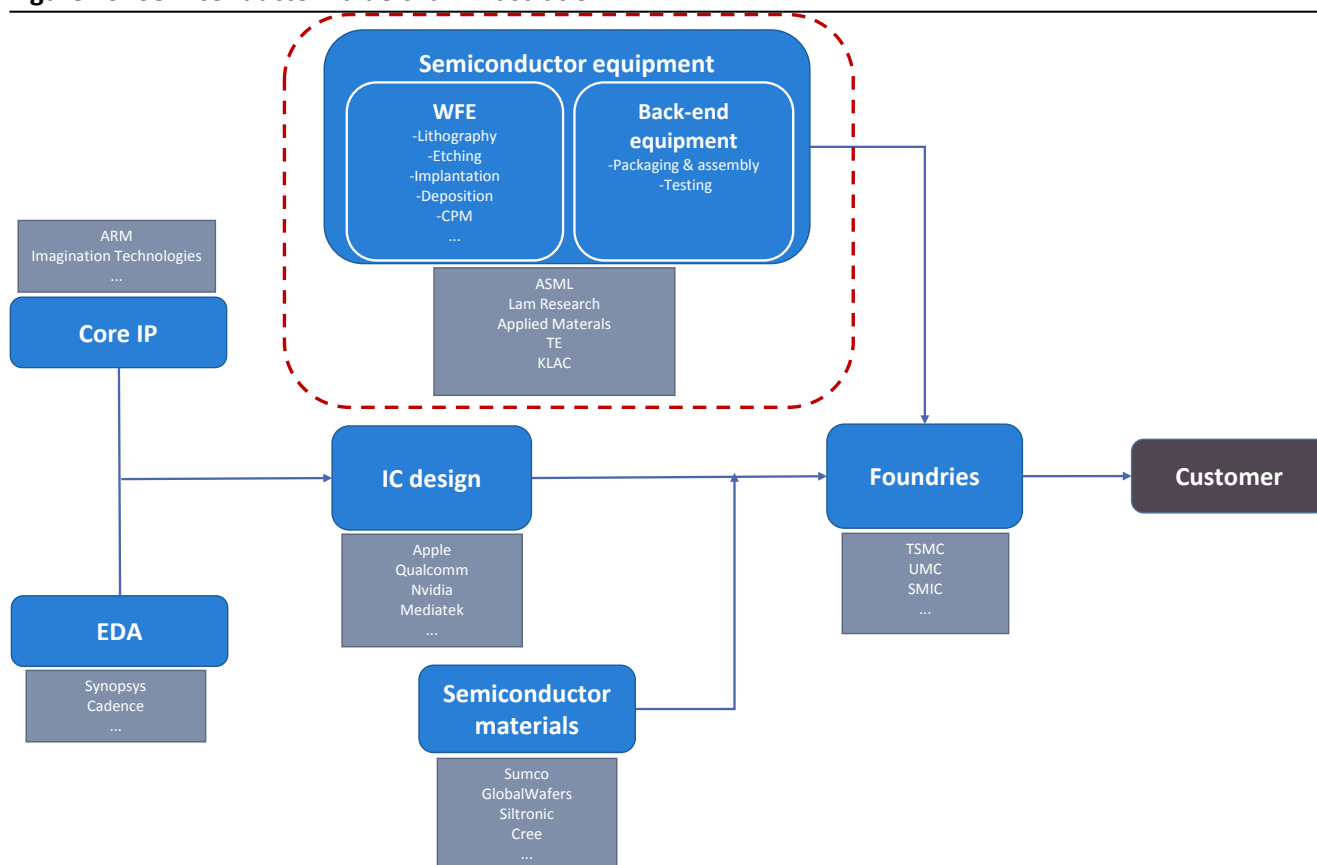
	2018	2019	2020	2021	2022E	2023E	2024E
TSMC	7nm (N7)	7nm (N7P)	7nm+	5nm	3nm	3nm+	2nm
Samsung	8nm	7nm	5nm		3nm	3nm+	2nm
Intel	14nm	10nm	i10	i7	i4	i3	20A 18A

Source: The Information Network, BOCOM Int'l

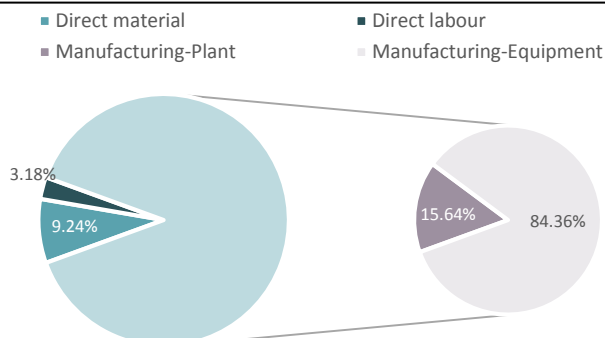
Equipment: Brain of Semiconductor Manufacturing

Equipment plays a critical role in chip manufacturing. Depreciation cost (of equipment) normally takes more than half of total production cost for the wafer fab. For example, SMIC reported 70%+ of its production cost coming from equipment depreciation (Figure 20). Equipment, according to the chip manufacturing flow, can be classified into wafer fabrication equipment (WFE) and back-end equipment. According to SEMI, WFE represented 85%+ of the semiconductor equipment market share in 2020.

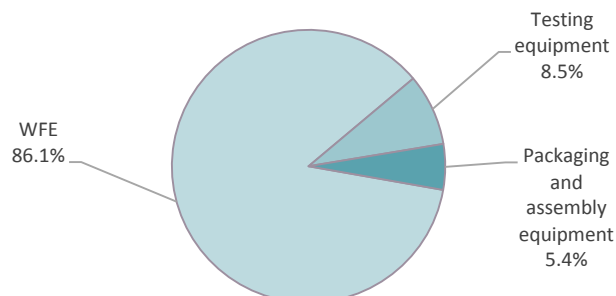
Figure 19: Semiconductor value chain illustration



Source: BOCOM Int'l

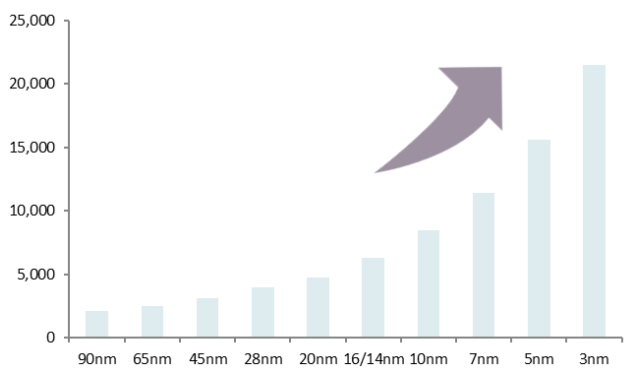
Figure 20: SMIC's cost breakdown

Source: SMIC, BOCOM Int'l

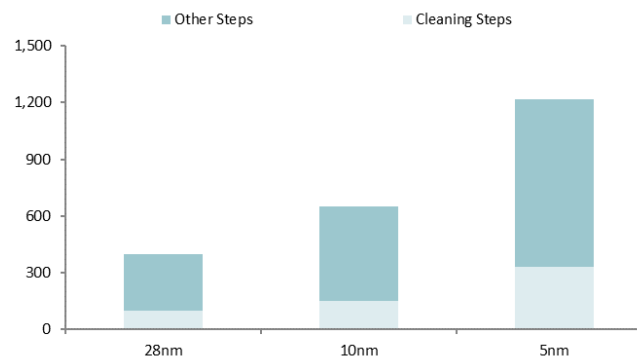
Figure 21: WFE accounts for >85% of equipment

Source: SEMI, BOCOM Int'l

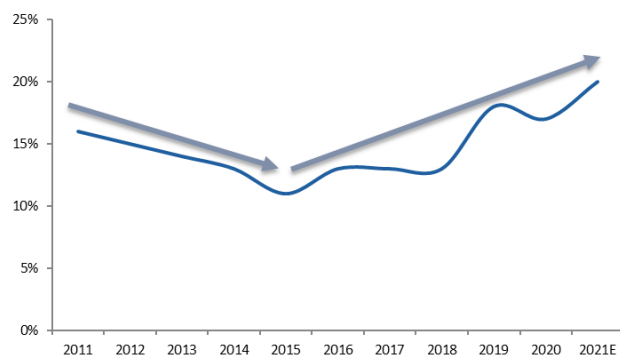
Wafer fabrication is an extremely sophisticated and intricate process in chip manufacturing. Thus, WFE is particularly important. In fact, the required WFE investment is growing with a rising level of technological difficulty (Figure 22) due to the increasing number of steps to make a chip (Figure 23). We actually see a flip around in 2015, where WFE intensity reversed the previous downswing to trend upward (Figure 24). The primary driver of intensity is not only the rising equipment cost, but also more wafer processing steps required to produce more complicated chips. Therefore, going forward, we may expect to see WFE growing faster than historical average.

Figure 22: Rising investment required with more advanced technology (US\$ m)

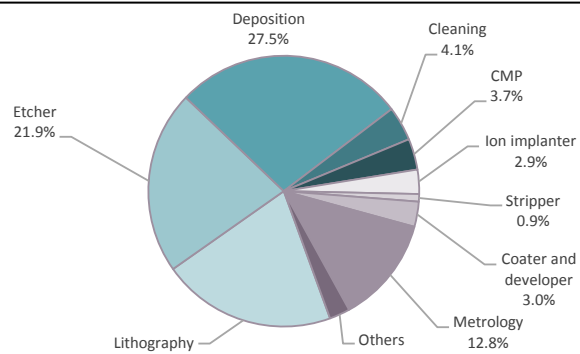
Source: IBS, BOCOM Int'l

Figure 23: Rising number of steps to make a chip

Source: Counterpoint, BOCOM Int'l

Figure 24: WFE intensity reversed course in 2015

Source: Counterpoint, BOCOM Int'l *WFE intensity refers to the proportion of semiconductor revenue invested in WFE to enable continued growth

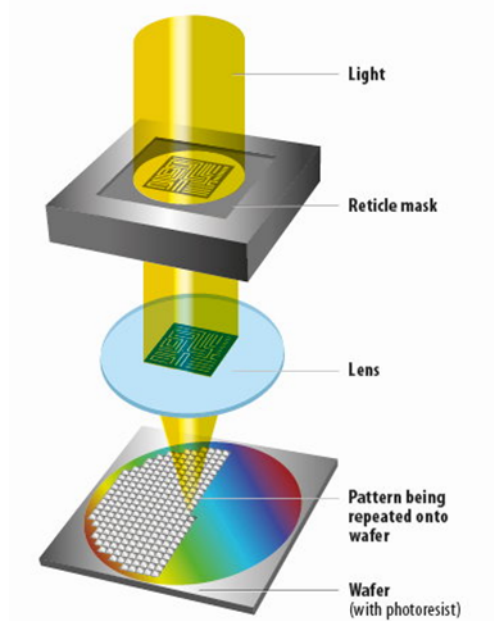
Figure 25: Market share of WFE by types

Source: SEMI, Gartner, BOCOM Int'l

In this report, we focus on the three most important wafer fabrication manufacturing equipment: lithography equipment, etcher and deposition equipment.

Lithography equipment

Lithography is the process of printing patterns of geometric shapes in a mask to a thin layer of radiation-sensitive material (photoresist), covering the surface of a wafer.

Figure 26: Lithographic process flow chart

Source: ASML, BOCOM Int'l

Smaller wavelength is the path to higher resolution. Extreme Ultraviolet Lithography (EUV), using a wavelength of just 13.5nm, is able to produce chips below 7nm. It is ASML's most advanced lithography equipment, and no other peers produce such equipment so far.

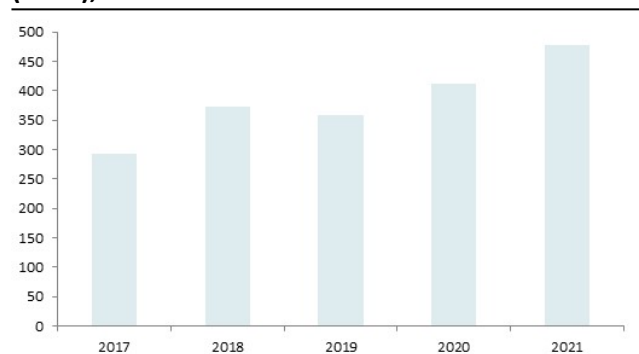
Figure 27: Lithography equipment roadmap

Light source	Wavelength	Process node	Lithography machine	Generation
EUV	13.5nm	7-3nm	Extreme ultraviolet lithography	V
DUV	ArF+immersion	193nm (eqv. 134nm)	DUV Immersion Scan/DUV step and scan	IV
	F2	157nm		
	ArF	193nm		
	KrF	248nm	DUV Scan	III
Mercy	i-line	365nm	Contact and proximity photolithography	II
	h-line	405nm		I
	g-line	436nm		

Source: ASML, BOCOM Int'l estimates

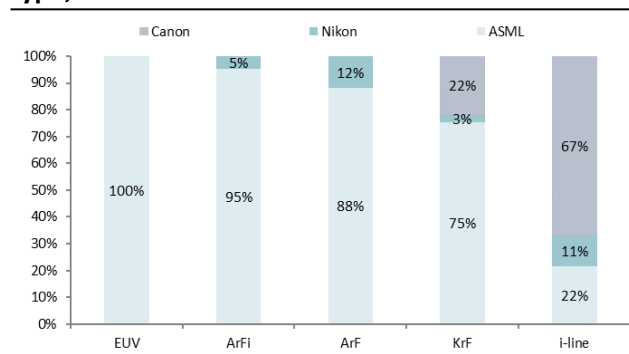
The global lithography equipment market is largely taken by ASML, Nikon and Canon, which in total recorded US\$24bn sales in 2021. ASML dominated with ~90% global market share by revenue given its high advanced lithography equipment market share. According to ChipInsights, all 42 EUV systems in 2021 were delivered by ASML. The company also sold 81 ArFi systems, giving it 95% global market share.

Figure 28: Global lithography equipment shipment (units), 2017-21



Source: Knometa Research, BOCOM Int'l

Figure 29: Lithography equipment market share by type, 2021



Source: ChipInsights, BOCOM Int'l

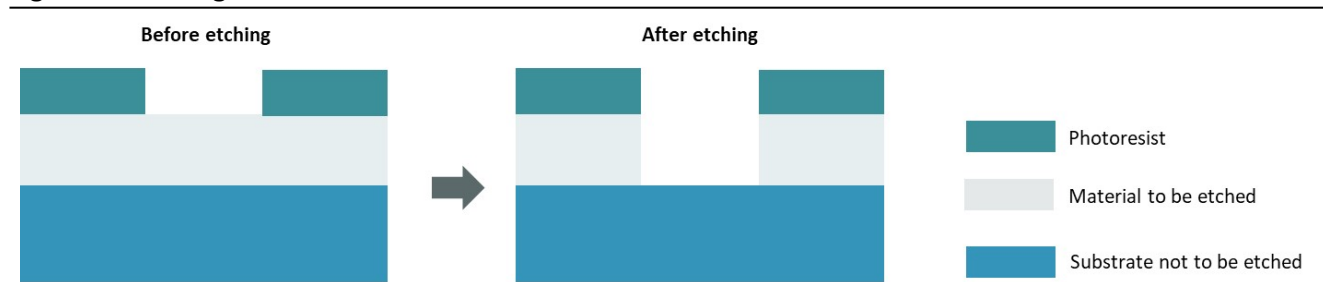
In China, Shanghai Micro Electronics Equipment (SMEE) is the “national champion” in lithography machines. SMEE's revenue largely comes from packaging lithography machines, part of the back-end process for chip making. It holds nearly 40% of the global share in back-end advanced packaging segment. However, SMEE is at a disadvantage when it comes to front-end machines. The company has made breakthrough in 90nm ArF lithography machine. But it has yet to deliver to customers in scale. SMEE is now at full steam to develop its second-generation DUV capable of 28nm resolution. Although it still

lag far behind ASML, SMEE is a hopeful candidate to produce made-in-China lithography equipment for advanced chips.

Etching

In semiconductor device fabrication, etching refers to selectively removing materials from the surface of a wafer (Figure 30). When it comes to the two major etching procedures, dry etching is a plasma-based etching process, whereas wet etching is a liquid-based process. Dry etching is currently much more used as it offers more control and is much safer. Inductively and capacitively coupled plasma are the two methods widely used in semiconductor fabrication for various etching processes. ICPs are typically used for metal and conductor etching, while CCPs are typically used for dielectric etching.

Figure 30: Etching mechanism

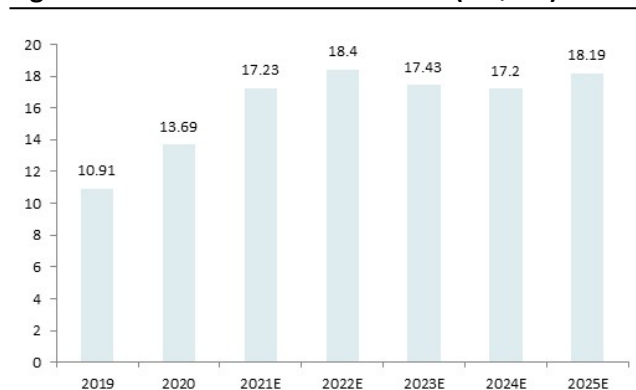


Source: Gases & Instrumentation, BOCOM Int'l

The global semiconductor etching equipment market size was valued at US\$13.69bn in 2020, and is projected to be worth US\$18.19bn by 2025E, with a CAGR of 6% in 2020-25E.

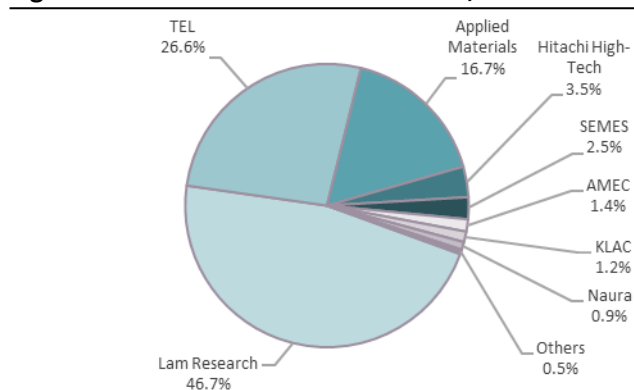
The global market is dominated by Lam Research, TEL and Applied Materials.

Figure 31: Global etcher market size (US\$ bn)



Source: Gartner, BOCOM Int'l

Figure 32: Global etcher market share, 2020



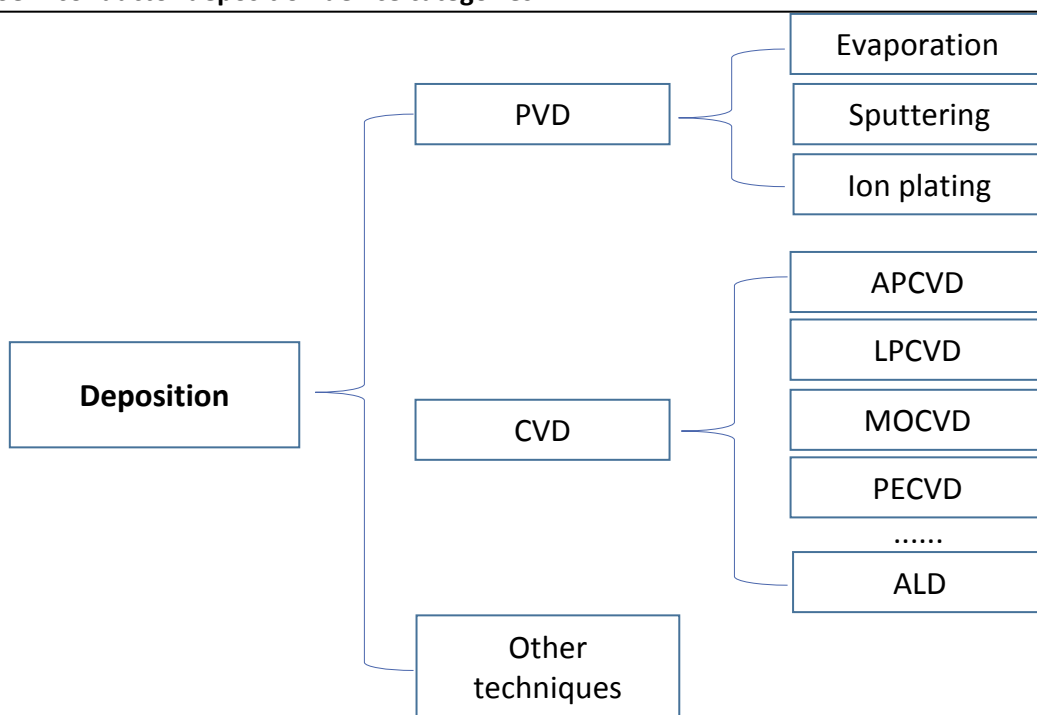
Source: Gartner, BOCOM Int'l

Chinese players Advanced Micro-Fabrication Equipment (AMEC) and NAURA Technology took only 1.4% and 0.9% shares of global market, respectively. However, etching equipment is one of the core semiconductor devices where China is most likely to break up the current monopoly. AMEC is China's etching equipment leader, whose etching equipment has been used in TSMC's 7nm and 5nm chip production lines. NAURA's ICP etching machine leads in the domestic market. Its 8-inch metal etching technology breaks the foreign monopoly, and 12-inch technology breaks into the process below 28nm. In December 2020, the delivery of NAURA's ICP etching machines exceeded 1,000 cavities, pointing to wide customer recognition of domestic etching machines.

Deposition

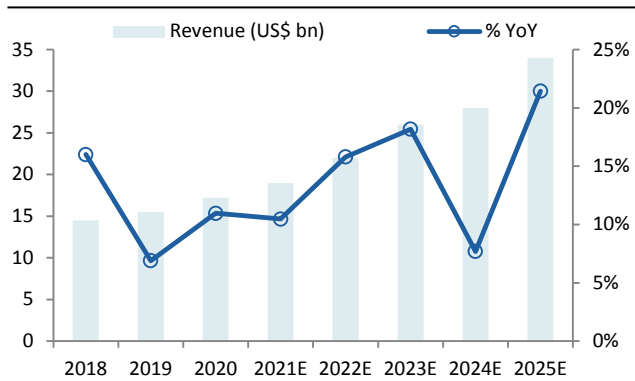
Deposition is a process that deposits a thin film onto a surface. Compared with etching, it is a process of "addition". It includes physical vapor deposition (PVD), chemical vapor deposition (CVD), and others. Each type can be further classified.

Figure 33: Semiconductor deposition device categories

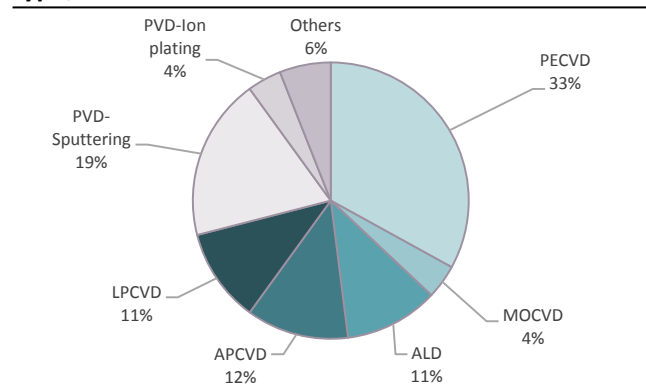


Source: BOCOM Int'l

The global semiconductor deposition device market was valued at US\$17.2bn in 2020 and is projected to reach US\$34bn in 2025, with a CAGR of 15% in 2020-25E. Looking into the market share by equipment type, CVD took 60% and PECVD was the largest among all sub-segments with 33% share. Sputtering PVD made up 19%.

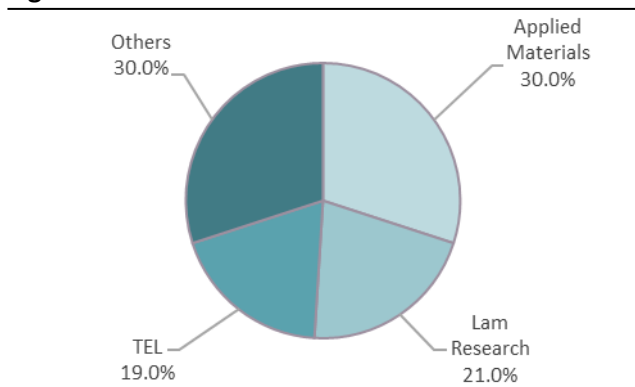
Figure 34: Global deposition device market size

Source: Maximize Market Research, BOCOM Int'l

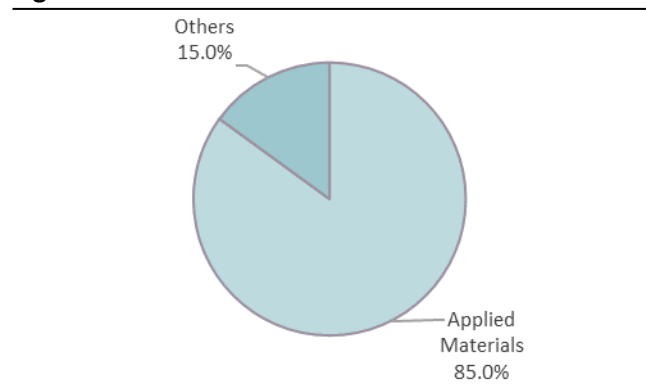
Figure 35: Global deposition device market share by type, 2020

Source: Gartner, BOCOM Int'l

Several methods of deposition involve varied techniques. Hence, each segment has a different market structure. Applied Materials, Lam Research and TEL combined for 70% of CVD market, while Applied Materials dominated PVD market with 85% share.

Figure 36: Global CVD market share

Source: Gartner, BOCOM Int'l

Figure 37: Global PVD market share

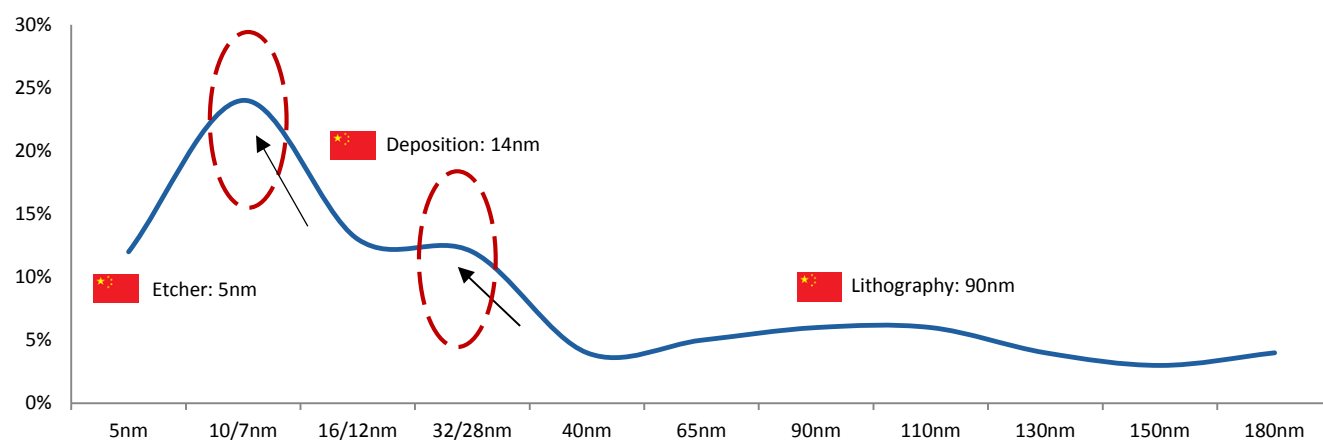
Source: Gartner, BOCOM Int'l

Piotech, NAURA and AMEC are three major Chinese deposition device suppliers. They each specialize in different segments. Piotech produces PECVD which is applied for 40-14nm node semiconductor technology (90% revenue in 2021 from sales of PECVD). NAURA focus more on PVD, supplied to customers like Yangtze Memory, Hua Hong, SMIC, etc. AMEC has developed a portfolio of MOCVD products, but mostly for LED application rather than integrated circuit.

Localization level

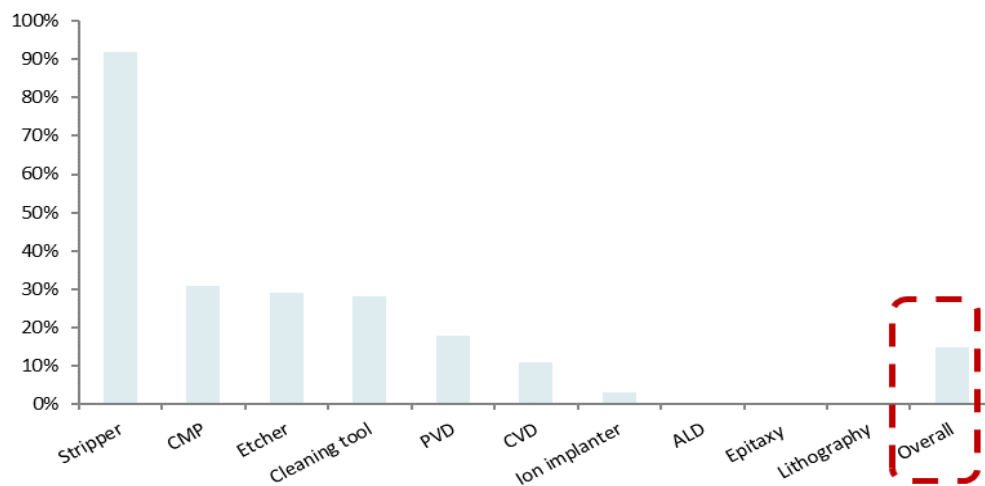
Figure 38 shows the market share of different process nodes. 32/28nm and 10/7nm are the two sweet spots set to drive a market boom. That is, the market size for Chinese players will jump when the core equipment self-sufficiency can be achieved for 28/32nm in the next step. Etcher and deposition devices are moving fast. Chinese equipment suppliers have made a technical breakthrough in deposition devices for 14nm node and in etchers for 5nm node. It is now waiting for the 28nm lithography machine to bring China's semiconductor industry a big step forward.

Figure 38: Aiming to reach next sweet spot: 32/28nm



Source: BOCOM Int'l *We use top 10 foundries' sales by node in 2021 to estimate the market share for each technology node

Lacking official statistics for all domestic fabs, we take Hua Hong's Wuxi fab as an example. The company closed the deal for 300+ equipment tenders in 5M22. The overall localization rate is around 15%. Among the different types of equipment, strippers are largely locally supplied. Localization rates of CMP, etchers and cleaning tools also approach 30%, but should still have large upside potential. On the other hand, lithography, ALD and epitaxy are still all imported.

Figure 39: Equipment localization rate for Hua Hong's Wuxi fab

Source: Chinabidding, BOCOM Int'l

China SPE Players Riding on Chip Autonomy

Among the major listed Chinese semiconductor equipment companies, AMEC and Piotech derive 80%+ of revenue from front-end equipment sales.

Figure 40: Company revenue and profit summary

	Market cap. (RMB m)	2021 revenue (RMB m)	(% YoY)	
NAURA	147,960	9,683	59.9	70% semiconductor equipment, including PVD, CVD, etcher, cleaning tool, etc
Jingsheng	87,300	5,961	56.4	83% silicon wafer equipment
AMEC	74,689	3,108	36.7	65% etcher, 16% deposition device
ACM Research (SH)	49,274	1,621	60.9	65% clean machine, 13% packaging machine
Hwatsing	30,144	805	108.6	100% polishing machine
Piotech	25,422	758	74.0	98% CVD
Huafeng Test	19,831	878	121.0	100% testing equipment
Kingsemi	14,788	829	152.0	76% semiconductor equipment, including coater/developer, wet etcher, scrubber, single-wafer cleaner, etc

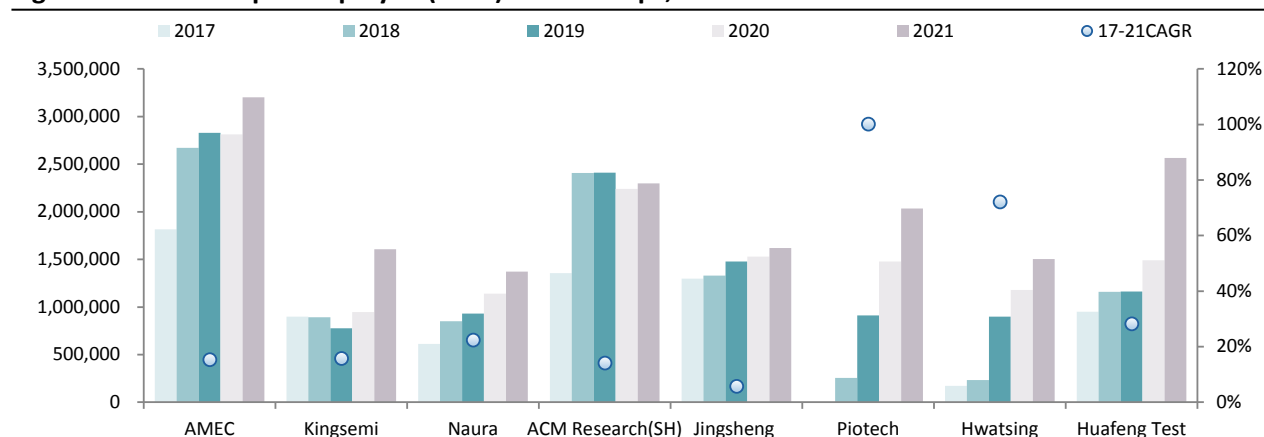
Source: Various companies, BOCOM Int'l *Market cap as of 21 July 2022

Unlike the capital-intensive fabs, semiconductor equipment companies are more talent-intensive, as the advanced machines are assembled and tested by engineers, rather than being simply produced on the automated production line. Thus, it is essential to examine the human-related indicators, as below.

Revenue per employee

Revenue per employee measures the company's productivity and efficiency. AMEC tops peers with RMB3.2m revenue per employee in 2021, followed by Huafeng Test's RMB2.5m, led by its strong sales that more than doubled YoY. Other high-potential companies include Piotech, which made significant progress in the past four years with a 100% 2018-21 CAGR to reach RMB2m revenue per employee in 2021. Hwatsing also delivered a >70% CAGR in 2017-21.

Figure 41: Revenue per employee (RMB) – AMEC tops; Piotech saw 100% CAGR

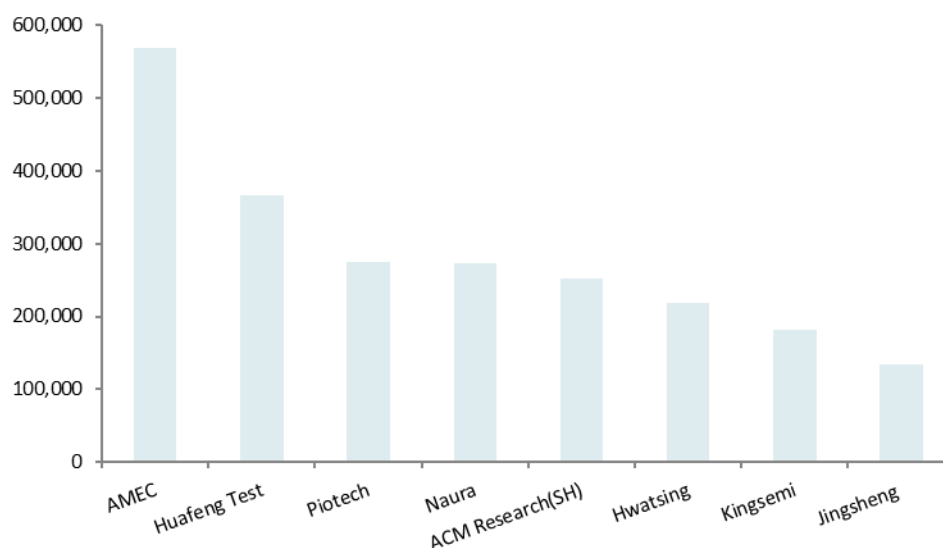


Source: Various companies, BOCOM Int'l *Piotech only has 2018-21 CAGR as 2017 financials were not released

Compensation per employee

AMEC again leads in the compensation per employee, which indicates the company's strong willingness and capability to attract talents. Even if we take out the six top management members who were paid higher than average, such compensation still surpasses RMB500k for AMEC. Huafeng Test/Piotech rank second/third, respectively.

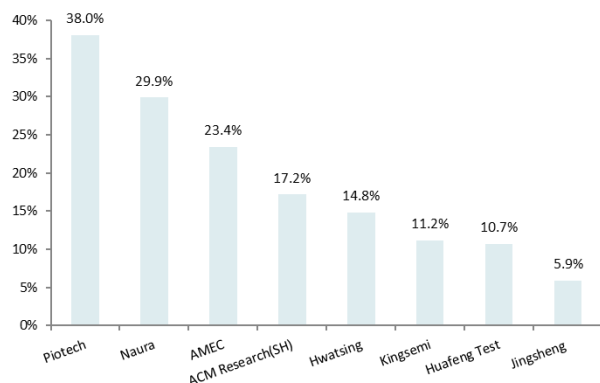
Figure 42: Compensation per employee, 2021 (RMB) – AMEC/Huafeng Test/Piotech highest



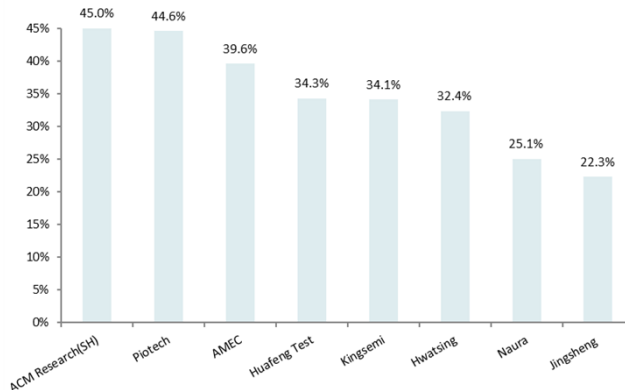
Source: Various companies, BOCOM Int'l

R&D input

R&D input is critical to high-tech companies. We compare the R&D expenditures of the eight Chinese semiconductor equipment companies in 2021. It is obvious Piotech is most willing to invest in R&D, spending 38% of its revenue on R&D in 2021. NAURA also places great emphasis on R&D, which accounts for as much as 30% of a high revenue base. In terms of R&D personnel, both Piotech and ACM Research (SH) had ~45% of staff from R&D departments in 2021.

Figure 43: R&D expenses as % of revenue, 2021

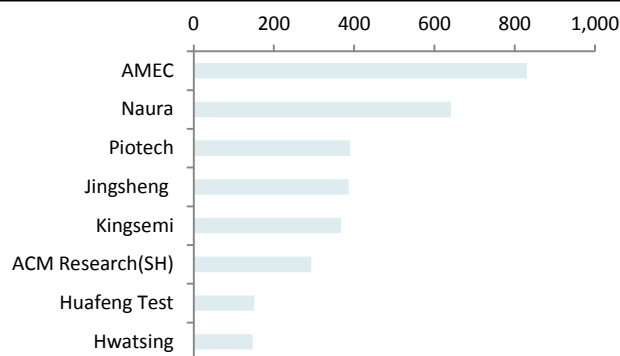
Source: Various companies, BOCOM Int'l

Figure 44: R&D personnel %, 2021

Source: Various companies, BOCOM Int'l

Patent

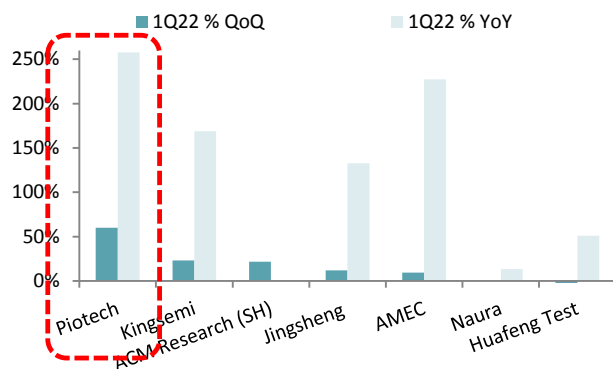
Semiconductors also entail intangible assets like intellectual property. The number of patents a company owns indicates its R&D capabilities. It is also important for the smaller players who may need patents to get a seat at the table when competing with the incumbents. According to CNIPA data, AMEC owns 830 patents and NAURA has 600+ patents. Piotech surprisingly ranks third despite a much smaller size than peers.

Figure 45: No. of patents (as of 30 June 2022)

Source: CNIPA, BOCOM Int'l

Contract liabilities

We also compare the contract liabilities of companies that are invoiced but have yet to deliver revenue. Most companies improved YoY significantly, reflecting generally strong industry demand. In particular, Piotech reported 60% QoQ growth of contract liabilities in 1Q22, far above peers.

Figure 46: Contract liabilities growth, QoQ and YoY

Source: Various companies, BOCOM Int'l *ACM Research did not release its 1Q21 contract liabilities

Key players: AMEC, Piotech and NAURA

Investors may follow AMEC, Piotech and NAURA. AMEC and Piotech rank top 3 in all our comparison analyses above. Etcher and deposition devices are the two largest sub-markets. Of note, Piotech is smaller in size, so earnings elasticity will likely be higher. NAURA stands out by size and product variety, and offers the highest visibility.

Risk Factors

- ⊖ **Capex slower-than-expected:** Although many countries are pressing ahead the domestic manufacturing of semiconductor chips, the global economic recession may drag the investment pace. Equipment sales are highly correlated to the capacity expansion of semiconductor fabrication plants.
- ⊖ **Domestic substitution missing forecasts:** In some of the most advanced equipment such as lithography, Chinese players still lag far behind global peers. It may take longer time for China-made equipment to be accepted by the manufacturers.
- ⊖ **Parts and components shortage:** Some equipment is heavily affected by the tight supply of parts and components, which could also affect Chinese equipment players. Delayed delivery in turn affects sales recognition.
- ⊖ **Talent risk:** Semiconductor equipment is a skill-intensive industry which requires many high-skilled R&D personnel and engineers. Talent shortage may slow down China's catch-up with global leaders. Indeed, Japanese electronics manufacturers recently warned that the country now faces a shortage of skilled engineers, which could threaten Japan's regaining its footing in semiconductor manufacturing.

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Buy: The stock's total return is expected to **exceed** that of the corresponding industry over the next 12 months.

Neutral: The stock's total return is expected to be **in line with** that of the corresponding industry over the next 12 months.

Sell: The stock's total return is expected to be **below** that of the corresponding industry over the next 12 months.

Not-Rated: The analyst **does not have conviction** regarding the outlook of the stock's total return relative to that of the corresponding industry over the next 12 months.

Analyst Industry Views:

Outperform: The analyst expects the industry coverage universe to be **attractive** relative to the relevant broad market benchmark over the next 12 months.

Market perform: The analyst expects the industry coverage universe to be **in line with** the relevant broad market benchmark over the next 12 months.

Underperform: The analyst expects the industry coverage universe to be **unattractive** relative to the relevant broad market benchmark over the next 12 months.

Broad market benchmark for Hong Kong is the **Hang Seng Composite Index**, for China A-shares is the **MSCI China A Index**, for US-listed Chinese companies is **S&P US Listed China 50 (USD) Index**.

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