

Semiconductor winners

European companies with strong positions



Edison themes

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Trends in the relatively resilient semiconductor market are mostly global and dominated by US and Asian companies. Although Europe has limited exposure to logic microprocessors, high-end independent chip fabs (foundry) or memory chip makers, there are a number of themes the European focused investor can still play. We believe that technology plays such as high-end equipment manufacturers like ASML, wafer/substrate makers like IQE and automotive EV/ADAS-related specialists like Elmos are well positioned in the post COVID-19 world which, among other things, is seeing a significant change in consumer behaviour and work practices.

Post-COVID consumer behaviour determines trends

COVID-19 has had a profound impact on consumer behaviour. Working from home has become the new norm and this has had a profound impact on data traffic, laptop demand and games, and has absorbed recently added data centre capacity, to name a few areas of impact. At the same time, consumer confidence has deteriorated and unemployment increased rapidly, with a slump in new car sales being one example of an adverse economic effect of the pandemic. In this volatile environment, the global semiconductor market looks resilient with an expected increase of 3% (World Semiconductor Trade Statistics estimate) in market size to \$426bn this year.

Within the sector, however, differences are large: semiconductor markets in Japan and Europe are struggling, while the US and Asia are faring better. Markets for logic and foundry chips are breaking records, while automotive chip markets are falling from already low levels. Smartphone markets are sliding as well, while memory markets are starting to recover. Leading-edge semiconductor equipment companies continue to benefit from technology shifts, while capacity expansion is slowing. Meanwhile, the China/US trade and technology wars rage on, with mixed implications for different industry players in the short but negative longer term.

Main winners: 5G, EV/ADAS and equipment

Chip companies that are related to the home working trend (memory chips, microprocessors, graphics processors for games) and companies geared towards technology transitions are probably the main winners in the current economic environment. Within Europe, which is the scope of this report, we would highlight 5G technology players (both infrastructure and smartphones), logic/foundry as well as high-end substrate equipment suppliers, autonomous driving (ADAS) and electrical vehicles (EV) specialists and their supply chains as better positioned in the coming years.

Selected European sector plays

- Logic/foundry equipment manufacturers: Aixtron, ASML, ASMI, Besi and Suss MicroTec.
- High-end substrate (equipment) suppliers: IQE, Riber, PVA Tepla and Soitec.
- ADAS and EV chip manufacturers: Elmos, ams and, to a lesser extent, X-Fab.

From the street

'After a period of seven quarters of decline in the semiconductor sector, a new uptrend is becoming visible. We see the semiconductor sector as resilient to the COVID-19 crisis, as working at home and social distancing only strengthens demand for new technology.' Hilco Wiersma, Add Value Fund.

Edison themes

As one of the largest issuer-sponsored research firms, we are known for our bottom-up work on individual stocks. However, our thinking does not stop at the company level. Through our regular dialogue with management teams and investors, we consider the broad themes related to the companies we follow. Edison themes aims to identify the big issues likely to shape company strategy and portfolios in the years ahead.

Companies mentioned in this report

Aixtron (GR:AIXGn)	NXP (US:NXPI)
ams (SW:AMS)	PVA TePla (GR:TPE)
ASML (EU:ASML)	Riber* (EU:RIB)
ASMI (EU:ASM)	Samsung (KOR:005930)
Besi (EU:BESI)	Siltronic (GR:WAF)
Elmos (GR:ELG)	SK Hynix (KOR:000660)
Infineon (GR:IFX)	Soitec (EU:SOI)
Intel (US:INTC)	STMicroelectronics (EU:STM)
IQE* (LN:IQE)	Suss Micro (GR:SMHN)
Melexis (EU:MELE)	TSMC (TPE:2330)
Micron (US:MU)	X-Fab (EU:XFAB)
Nanoco* (LN:NANO1)	

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Semiconductors in an extremely dynamic world

Large underlying factors at play

The worldwide semiconductor market has been a rising market for several decades, growing to a market value of several hundred billion dollars. In 2019, according to Gartner the market declined 12% to \$418bn compared to 2018, and this year it looked to be heading for a small decrease (Gartner's latest estimate in April was -0.9%). However, market signals have been more positive in the last few months, despite COVID-19. In the latest estimate we have seen from World Semiconductor Trade Statistics (WSTS, from the Semiconductor Industry Association), an increase in sales of 3.3% in 2020 is expected, mostly driven by a rebound in memory chips. In the second quarter reporting season, we have seen a lot of confidence, but also uncertainty around the outlook for the second half of the year, especially regarding smartphone and memory markets.

Underlying this seemingly flat market outlook, large dynamics are at play. In 2019, trade tensions between the US and China ramped up, with the semiconductor market stuck in the middle. Those tensions still resurface every now and then, especially with the current US administration. On top of that, the US mistrust of Huawei/ZTE chips has led to a ban on 5G equipment from these companies. Several other countries have followed suit, such as the UK and Australia.

Memory markets showed a large decrease in 2019, absorbing the oversupply arising from large investments that were made in the previous years, while automotive chip markets were in retreat due to lower global automotive production numbers.

COVID-19 has changed the game

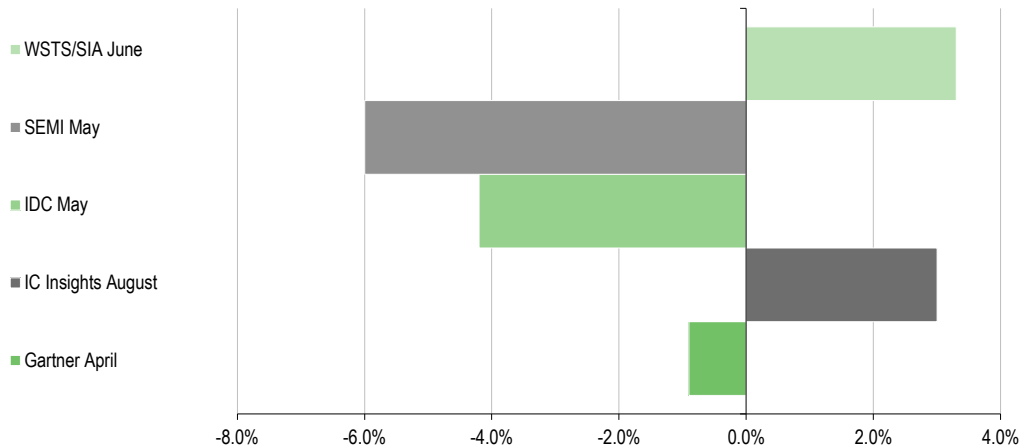
In 2020, COVID-19 had had an immediate impact on semiconductor stocks. With many countries going into lockdown, investors worried how semiconductor production capacity would be affected, or investment plans for that matter. Furthermore, there were worries about the supply chain, which is particularly complex and global.

On the other hand, with people stuck at home, digital requirements only increased, leading to growing demand for laptops and PCs and an increase in data centre traffic as video calls and meetings increased exponentially, starting a probably enduring trend. As well as driving demand for work-related technology, being stuck at home boosted demand for gaming and on-demand TV/film. Conversely, demand reduced for smartphones, new cars, industrial applications and public transport.

Against this market background, US/China trade issues are still flaring up now and again and more recently also the technology ban that the US wants to impose on Huawei. Furthermore, the US started government-subsidised plans to build up a semiconductor supply chain in the US and that resulted in TSMC's plans to build its first high-end fab in the US. These geopolitical tensions have mixed implications for different industry players in the short term and are more negative in the longer term.

All in all, up to May the semiconductor market was roughly flat (\$174bn sales, Semiconductor Industry Association) compared to last year, but expectations for the year (see Exhibit 1) are gradually becoming more positive, with the latest estimate from IC Insights (August) for an increase of 3.0% in 2020, mainly driven by a rebound in the memory market. Earlier market estimates were for a low- to mid-single-digit decrease.

Exhibit 1: Semiconductor market expectations for 2020



Source: SIA, SEMI, IDC, IC Insights, Gartner

Semiconductor stock prices decreased dramatically in March, with the bellwether PHLX Semiconductor Sector Index (SOX) dropping almost 35% from February (see Exhibit 2). With better sentiment around tech stocks in general, for a large part driven by the adjustment to the homeworking trend and the extra semiconductor content that requires, the SOX is now again at all-time record levels, especially driven by Nvidia, but also companies like Qualcomm and LAM Research.

Exhibit 2: Philadelphia Semiconductor Index



Source: Refinitiv

Positive for logic/foundry, less so for analogue/memory

To dig a little deeper, we examine what COVID-19 actually changed in terms of semiconductor end market demand. The games industry is benefiting, just as PC, notebook and data centre demand has been driven by working/staying at home trends. Automotive, smartphone and industrial applications have stalled, because of more macroeconomic issues, like collapsing consumer confidence, retail closures and travel restrictions, etc.

2020 was already destined to be a significant year for logic and foundry investments (logic and micro used for instance in microprocessors in PC's and Smartphones in Exhibit 3), which had 41% of the total chip market in 2019, as EUV¹ lithography moves to high volume manufacturing (HVM) for logic/foundry applications at the 7/6nm nodes of TSMC/Samsung, and Intel takes its first steps in EUV manufacturing. Concerns around the complex semiconductor supply chains used by the equipment makers proved unfounded in the high-tech end of the chain, as this part of the industry

¹ Extreme ultraviolet.

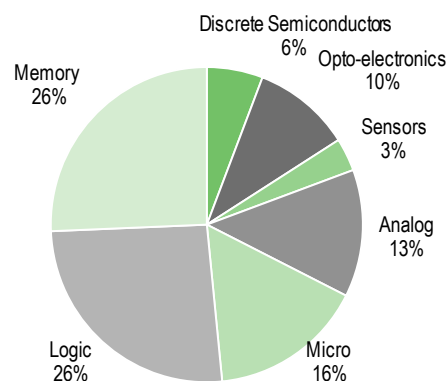
was deemed 'essential' in almost every country. In addition, the large foundries and OEMs were able to maintain production levels.

All in all, logic/foundry players are performing well, as can also be seen in the share price developments of TSMC, Nvidia and Qualcomm, but to a much lesser extent Intel, which has been struggling with its 10nm and now 7nm node processes.

Memory markets (memory chips are widely used in PC's/laptops, smartphones and data centres), 26% of the total chip market in 2019, were set to recover this year, as NAND and DRAM capacity capex from the years before was being absorbed. Initially there were concerns that COVID-19 would reverse this trend; however, data centre capacity was absorbed fairly quickly, driven by the working at home trend, at the same time as increasing demand for PC/notebook memory. However, smartphones could be in a more difficult spot this year, with Apple pushing back new model introductions and demand trends becoming less positive, as people cut down on non-essential spending. Overall, it appears that memory is still set for a recovery this year, but the picture is getting less certain. Share prices of memory manufacturers such as Micron and SK Hynix have recovered from the March trough, but to a lesser extent than the logic/foundry players.

The same goes for the discrete/mixed signal/analogue companies (22% of the chip market), such as Infineon, STMicroelectronics and Analog Devices. The automotive industry, traditionally the largest customer in this segment, fully hit the brakes as consumer confidence and end-market demand collapsed, while supply chains were interrupted in this field. Industrial demand also went down. Government stimulus of EVs, which are especially semiconductor loaded has had a partially offsetting impact.

Exhibit 3: Chip market segmentation 2019



Source: SIA

Where to invest in Europe to benefit from these market trends

Europe has a limited position in logic/foundry and memory chip design and manufacturing. However, there are ways for an investor in European stocks to take advantage of the trends mentioned above.

We have selected a number of angles to consider:

1. Although European companies do not make chips at the technologically most advanced levels, they do supply essential equipment, ranging from EUV lithography equipment and ALD² technology for logic, foundry and memory chips to equipment for high-end chip packaging.
2. European companies have a strong position in automotive and high-end laser/light applications, and semiconductor content in cars could grow to over \$2,000 per car, from \$389 per car on average now with the development of ADAS and EVs.

² Atomic layer deposition.

3. While European players such as Infineon, NXP and STMicroelectronics are small in the larger logic, foundry and memory markets, they are quite significant in the mixed signal/analogue/discrete segment, chips/sensors used in every product that converts analogue inputs into digital signals like light/radar/Lidar sensors, power amplifier- and radio chips

Semiconductor equipment and material suppliers

Looking at semiconductor equipment, there is a large difference between wafer processing (front end), which had a market size of US\$56bn in 2019, and packaging/assembly (back end), which had a market size of US\$3bn. This year sector research organisation VLSI expects a decrease in front-end equipment spending of 7% and for the back end an increase of 11%.

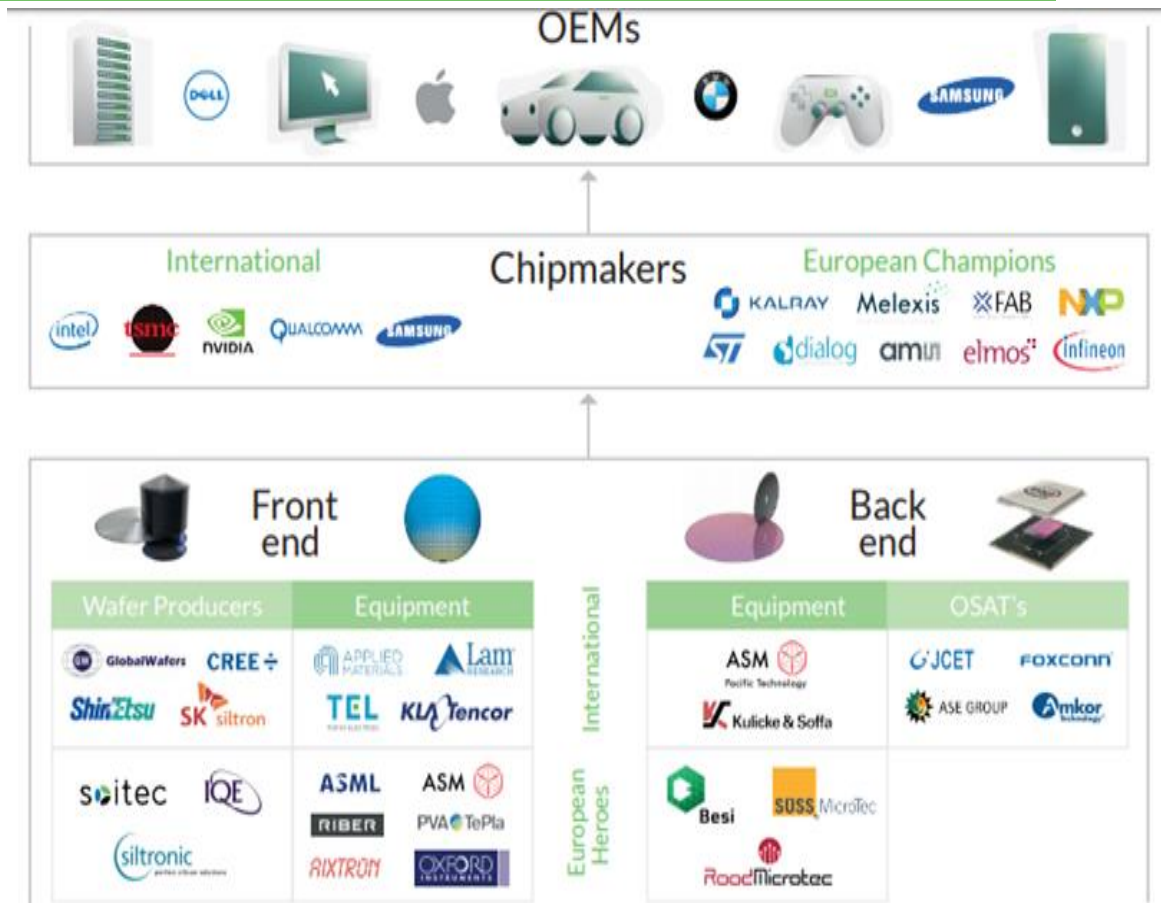
The largest semiconductor-related stock in Europe by far is not Infineon or STMicroelectronics, but ASML with a market cap of well over €100bn. Near monopolist ASML's lithographic equipment (in terms of market size the largest segment within the front end) is essential in realising shrink by enabling ever smaller patterns in the front-end process (wafer processing), fitting more transistors on a square inch of wafer surface, increasing the capacity of chips. This is essentially the enabler of Moore's Law, which tells us that die (chip) capacity doubles more or less every 1.5 years.

Dutch ASML and German Aixtron make equipment for deposition, the third largest segment within the front-end equipment market after etching. Where ASML can deposit conformal layers of just one atom thick and is an increasingly important supplier to Intel, TSMC and Samsung (playing into the Logic/Foundry shrink trend), Aixtron's strength lies in providing metal organic chemical vapor deposition (MOCVD) tools to manufacture special materials like silicon carbide and gallium nitride which plays into the EV trend, but also has applications for 5G.

Also in silicon wafers and epitaxial wafers, Europe has a strong position with Siltronic as a flagship company, supplying the likes of Intel and TSMC with silicon wafers, but also companies like Soitec and IQE that are more geared towards wafers incorporating special materials, like silicon carbide (SiC), gallium nitride (GaN) and gallium arsenide (GaAs), which are deployed in EV applications, for instance, or 5G. In terms of equipment for these wafers, French company Riber makes molecular beam deposition systems that can be used for epitaxial layers of GaN and GaAs and PVA TePla produces the furnaces in which the silicon (carbide) ingots are made. Nanoco delivers nano materials (like quantum dots) for companies like STMicroelectronics.

In the back end, where the processed wafers from the front end are cut, connected and protected from the outer world, a process that is usually done in South-East Asia, Europe also has some technology leaders in terms of equipment. Besi is the technology leader in the back end and has many high-volume tools available playing into logic/foundry trends as well as 5G, while SUSS MicroTec is more R&D oriented with strong inroads into micro-optics equipment and lithography for the back end. The back-end process is increasing in importance now that form factor is a limiting factor for many applications. Technology is also enabling and requiring that more and more dies are assembled into one often very complex package.

Exhibit 4: Front- and back-end ecosystem



Source: Edison Investment Research

Semiconductor content in cars

Semiconductor content in cars is expected to grow significantly. While it already represented some \$389 per car (see Exhibit 5) in 2018, we believe it could be well over \$2,000 per fully autonomous driving (ADAS) electrical car (EV).

In Europe, there are several semiconductor companies fitting into this trend. While the larger companies (see below) are all also betting on trends like silicon carbide in power electronics (which makes the electrical/hybrid car ~10% more efficient) and ADAS through all kinds of sensors (ranging from camera, to ultrasound to Lidar), we believe there are better opportunities with niche companies such as Elmos, with its ultrasound sensors for parking, playing into the ADAS trend and an increasing number of ultrasound sensors per car, or PVA TePla with its SiC ingot furnaces, or IQE with its VCSEL epitaxy and Soitec with its SiC and GaAs wafers.

Providers of high-end light and proximity sensors include Dialog and ams. ams has acquired Osram, creating a much larger lighting/photronics powerhouse, with a speciality in automotive, on top of ams's speciality in VCSEL and 3D sensing for smartphones. Dialog, now part-owned by Apple, is more dependent on the smartphone market and one supplier, which makes it vulnerable, but when the high-end smartphone market is strong, Dialog is certainly a stock to watch.

Furthermore, there are niche companies like Kalray, playing into next-generation super computers with its 256 flexible programmable cores microprocessor (Coolidge) that has just entered the market. NXP has taken a stake in Kalray recently for its Automotive fusion chips products, that combine all the sensor inputs for Autonomous driving.

Exhibit 5: The automotive opportunity



Source: Edison Investment Research, Infineon, Statista

Mixed signal/analogue/discrete segment

US-listed but Holland-based NXP, STMicroelectronics, Infineon and non-listed Bosch have large market shares in the mixed signal/analogue/sensors world that are used in every product that converts analogue inputs into digital signals like light/radar/Lidar sensors, power amplifier- and radio chips. Bosch is especially strong in sensors, Infineon and NXP are well-positioned in automotive, with Infineon more focused on power electronics, while NXP is more geared towards in-car communication/MCU. As such, most have a large dependency on the automotive market, which is not very strong at the moment due to the low production car numbers and sales. The industrials sector, the second most important end market for these companies, is not performing well either.

Chip designer Melexis, fully geared towards automotive, offers a fabless alternative to these chip makers. Although Melexis has limited inroads into EV power and ADAS, it is particularly strong in the general electrification of the car and especially magnetic sensors.

X-Fab is Europe's only listed analogue/mixed signal foundry. Although recently hit by a cyber-attack that forced it to shut down production in all of its locations, it has some niche activity in SiC and 5G (filters).

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