

# From drought to glut?

Where to position yourself in the chip value chain

**We believe 2022 will be a much more difficult year for investing in semiconductors than 2021's high tide that lifted almost all boats. Given the issues with supply that should be resolved in the next few months, more pandemic lockdowns and an economic slowdown in China, stock picking is key in the semiconductor sector. We believe automotive electric vehicles (EVs) and autonomous driving (ADAS) related specialists are best positioned, as well as semiconductor material specialists.**

## Record 2021 sales, 2022 looks up as well

The worldwide semiconductor market is expected to exceed the \$500bn mark for the first time in 2021, with year-on-year growth of 17–27%, according to sector organisations. Momentum is positive, as market estimates continue to creep up. Sector specialists forecast the semiconductor market to grow by 7.3% on average in 2022. Taking the FY22 sales estimates of the top 25 selling global semiconductor companies, analysts are forecasting 12.1% growth. However, given recent concerns about the Chinese economy casting a shadow over, for instance, new car and smartphone sales, this could prove too optimistic. China is a very important end-market for chips and this could affect growth expectations. Also, the new Omicron variant could pose a threat to semiconductor sales estimates.

## Supply chain issues and policymakers

COVID-19 has carved deep tracks into the supply chains of many sectors. Severe shortages of semiconductors have emerged and are affecting production capacity, not only for cars, but also for smartphones, TVs and graphic cards to name a few. The supply chain issues are expected to be resolved in 2022 and we tend to agree with that scenario, although we believe it will probably be earlier rather than later in the year, as inventories seem to be returning to normal levels. Supranational policymakers, including from the US, Europe, China and Japan, were concerned about the shortages and reacted with plans to add capacity in their regions. This could very well lead to a situation of overcapacity within a few years.

## Best positioned

We believe that the combination of policymakers interfering with current semiconductor supply chains by adding capacity, chip shortages coming to an end and economic pressures (eg from China or pandemic flare-ups) mean a selective approach to semiconductor investing is key in the coming year. This situation is the opposite to this year's share price increases, with the valuation multiples of many companies now at historically high levels. In Europe, we see chipmakers geared towards ADAS and EVs, and their supply chains, better positioned in the next year, as well as companies with a product portfolio that is still in very short supply.

## Selected European sector plays

- ADAS and EV chip manufacturers: X-Fab, Kalray and Elmos.
- Opto-electronic companies: ams, Dialog.
- High-end substrate (equipment) suppliers: [IQE](#), [Riber](#) and Soitec.
- Equipment makers: ASMI, ASML, Besi, Aixtron and Suss MicroTec.

17 December 2021

### 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)  
ams (SW:AMS)  
ASMI International (EU:ASM)  
ASML (EU:ASML)  
Besi (EU:BESI)  
Dialog (EU:DLG)  
Elmos Semiconductor (GR:ELG)  
Infineon Technologies (GR:IFX)  
Intel (US:INTC)  
IQE\* (LN:IQE)  
Kalray (EU:ALKAL)  
Melexis (EU:MELE)  
Micron Technology (US:MU)  
Nanoco\* (LN:NANO1)  
NXP Semiconductors (US:NXPI)  
PVA TePla (GR:TPE)  
Riber\* (EU:RIB)  
Samsung (KOR:005930)  
Siltronic (GR:WAF)  
SK Hynix (KOR:000660)  
Soitec (EU:SOI)  
STMicroelectronics (EU:STM)  
Suss MicroTec (GR:SMHN)  
TSMC (TPE:2330)  
X-Fab (EU:XFAB)

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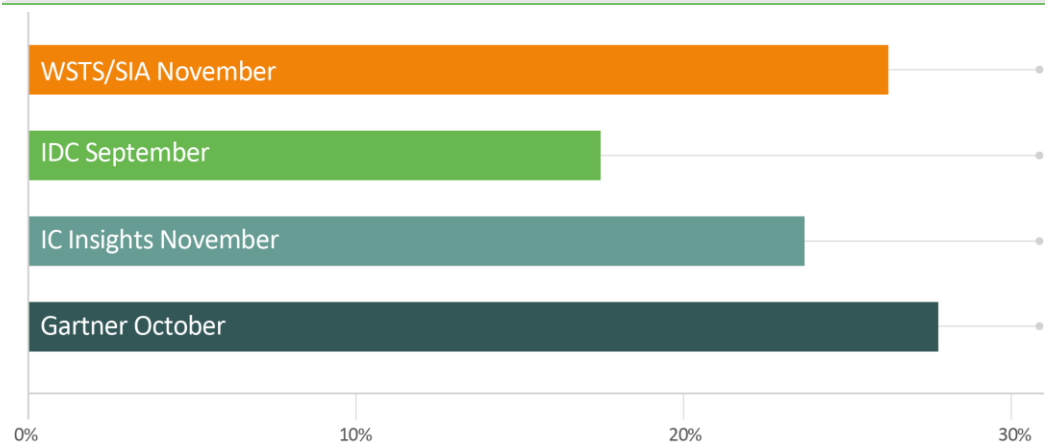
## 2021 will be a record year for semiconductors

The worldwide semiconductor market has been growing for several decades, reaching \$440bn by 2020 (WSTS, +6.8% compared to 2019) and expected to exceed the \$500bn mark for the first time this year, with growth of 17–27% according to sector organisations like WSTS and Gartner. Momentum has stayed positive during the year, as market estimates have continued to creep up.

Underlying the market outlook, more complex dynamics are at play. Next to the logic/foundry segments (eg processor chips) that benefit from new technology, the more volatile memory (storage of data) market is also showing increased momentum, with anticipated growth of 30% in 2021 (versus 10% in 2020) according to WSTS. The sensors and analog (for instance power chips) segments are also strong, with more than 20% increases. Opto-electronics and micro circuits are areas of lower expected growth.

In contrast to what we might expect given all the newsflow in the media, supply chain issues have not led to lower overall sales of semiconductors. Although there have been price increases, they do not explain the overall double-digit growth of the market. The recent Q3 results season made it clear that utilisation rates have been increasing as well as output. Without supply chain issues, semiconductor sales levels could have been even higher, as, for example, [Apple](#) and car makers have indicated.

**Exhibit 1: Semiconductor market expectations for 2021**



Source: SIA, IDC, IC Insights, Gartner, compiled by Edison Investment Research

The record year in semiconductor sales is a result of several very fast-moving dynamics. Logic and memory benefited from lockdowns, with people staying at home more, and analog and sensors benefited from higher automotive demand. Inventories are getting back to normal in many segments like PCs and most automotive chips, but still persist in others such as specific automotive chips like microcontrollers and gaming cards.

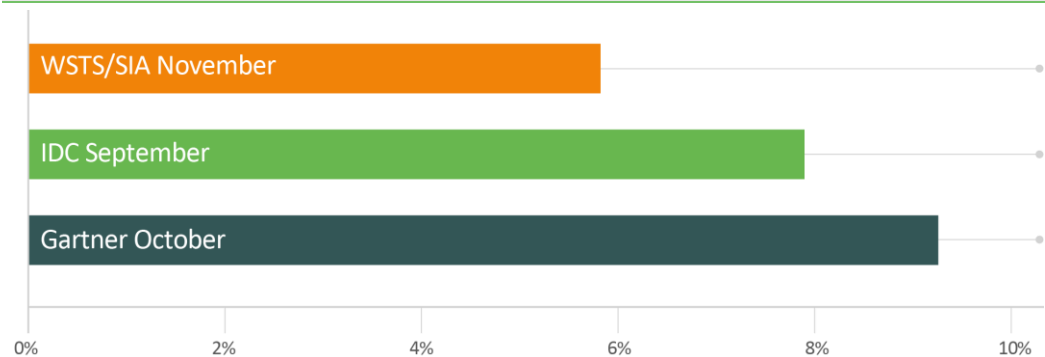
Looking at semiconductor equipment, there is a large difference between wafer processing (front end), which had a market size of \$61bn in 2020 (2019: \$56bn) and packaging/assembly (back end), which had a market size of \$4bn. This year, sector research organisation VLSI Research expects an increase in front-end of 33% (July estimate and Gartner at +28%) and an increase of 53% in back-end equipment spending (October, versus 42% in July). This is caused by a steep increase in demand driven by increases in capacity.

## 2022 is shaping up, with some clouds on the horizon

For 2022, estimates are also largely positive, with expected growth rates of 4–10% (7.3% on average) according to semiconductorintelligence.com. WSTS, which gives an expectation per segment, expects the highest growth in the memory chip segment (18%) and a good year for logic chips (9%). Growth in analog and sensors is expected to slow down.

Recently, concerns about the Chinese economy and Chinese consumer behaviour have cast a shadow over, for example, new car and smartphone sales. As China is a very important end-market for chips, this could have repercussions on expectations for the development of demand in the coming period. The new Omicron variant could also pose a threat to semiconductor sales estimates.

**Exhibit 2: Semiconductor market expectations for 2022**



Source: SIA, IDC, IC, Gartner, compiled by Edison Investment Research

We have cross-referenced the estimates of sector organisations with average analyst estimates for 2021 and 2022 from Refinitiv (see Exhibit 3). If we take the sales estimates of the top 25 global semiconductor companies, the combined sales should be a large percentage of global sales as reported by the sector organisations. Note that we have adjusted for foundry revenues, to prevent double counting (fabless companies like Qualcomm outsource manufacturing to TSMC for instance). Our findings show that the top semiconductor companies reflect roughly 77–79% of global sales.

Looking at realised growth percentages, there are some smaller differences between the realised sales growth of the top 25 companies and the sector expectations total of -0.2–3.4%. For this year, the sector organisations are more positive compared to the broker average, while for 2022 the opposite is true, which could mean that broker estimates for 2022 are too optimistic. The difference for 2022 is 4.9pp growth; the sector organisations forecast 7.3% growth and analysts forecast 12.1%. The lowest growth is expected for analog companies like Texas Instruments and OnSemi, while the highest growth is expected for Analog Devices (M&A) and UMC. High-end companies like AMD, Nvidia and TSMC are expected to show close to 20% growth this year and double-digit growth in the next two years, while European companies like STMicroelectronics and Infineon are expected to show double-digit growth next year and single-digit growth in 2023.

**Exhibit 3: Consensus estimates versus sector estimates**

Top semiconductor companies	2019	2020	2021e	2022e	2023e
Advanced Micro Devices	6,731	9,763	16,127	19,161	21,821
MediaTek	8,161	11,516	17,599	20,342	22,007
Nvidia	6,731	9,763	16,127	19,161	21,821
Qualcomm	19,398	21,654	33,467	39,543	42,583
SMIC	3,116	3,907	5,380	6,221	6,873
SK Hynix	21,189	28,543	36,247	41,744	47,618
Samsung	54,413	61,048	78,830	90,278	107,125
GlobalFoundries	0	0	6,541	7,762	8,678
Renesas	6,525	6,844	8,252	9,538	10,050
Micron	23,406	21,435	27,705	31,864	37,005
NXP	8,877	8,612	11,027	12,268	13,115
ON Semiconductor	5,518	5,255	6,681	7,115	7,409
UMC	4,799	6,209	7,589	10,800	10,974
Texas Instruments	14,383	14,461	17,923	18,702	19,822
TSMC	35,728	47,865	57,089	67,967	80,306
STMicroelectronics	9,556	10,219	12,585	13,862	14,715
Microchip Technology	5,476	5,274	5,438	6,745	7,294
Infineon	8,838	10,120	12,695	14,294	15,341
Analog Devices	5,991	5,603	7,318	10,664	11,357
Broadcom	22,597	23,888	27,412	29,435	30,788
Western Digital Corp	16,569	16,736	16,922	19,480	21,085
Intel	71,965	77,867	73,614	73,400	77,018
<b>Total</b>	<b>359,966</b>	<b>406,582</b>	<b>502,569</b>	<b>570,347</b>	<b>634,803</b>
Fabless companies to remove from total					
SMIC	3,116	3,907	5,380	6,221	6,873
GlobalFoundries	0	0	6,541	7,762	8,678
TSMC	35,728	47,865	57,089	67,967	80,306
UMC	4,799	6,209	7,589	10,800	10,974
<b>Total</b>	<b>43,642</b>	<b>57,981</b>	<b>76,599</b>	<b>92,750</b>	<b>106,832</b>
<b>Sector versus consensus estimates</b>					
Semiconductor sales top semi companies	316,324	348,601	425,970	477,596	527,971
Sales according to WSTS	412,307	440,389	550,876	606,482	
Top semiconductor companies % of total	77%	79%	77%	79%	
Sales growth top semiconductor companies	-12.3%	10.2%	22.2%	12.1%	10.5%
Average sector organisation estimate	-12.0%	6.8%	23.2%	7.3%	
Difference	-0.2%	3.4%	-1.0%	4.9%	

Source: Refinitiv, Edison Investment Research, WSTS, SIA, Gartner, IC Insights, IDC

## Driven by pandemic effects

Although the general chip market environment developed very favourably in the pandemic and the outlook continues to be supportive, COVID-19 has had a very large impact on semiconductor stocks and markets.

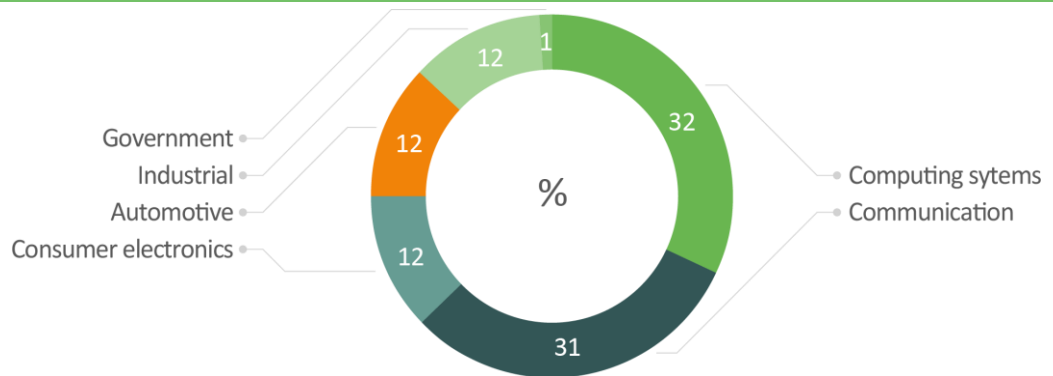
In early 2020, many countries went into lockdown and investors were concerned about how semiconductor production capacity would be affected, or investment plans for that matter. Furthermore, there were concerns about the supply chain, which is particularly complex and global. For instance, consumer demand for new cars decreased quickly in the early stages of the lockdowns and car manufacturers reacted by cutting their orders for semiconductors sharply in already very tight supply chains. In addition, demand from smartphones and industrial applications stalled. Furthermore, US/China trade issues were still flaring up now and again.

The picture began to change quickly, with people stuck at home and consumer confidence recovering, driven by government help programmes. Digital requirements increased, leading to growing demand for laptops and PCs, and an increase in data centre traffic as video calls and meetings increased exponentially, accelerating a more structural trend. This drove demand for work-related technology and home-bound consumers boosted demand for gaming and on-demand TV and film.

Against that uncertain background and retracting orders from automotive producers, semiconductor producers had been quick to shift production towards the sectors with the greatest demand.

Capacity cuts were not necessary, as demand from the sectors that were performing well, for example PC/laptop and gaming, offset the loss of orders from automotive customers.

**Exhibit 4: Chip market segmentation by end-use, 2020**



Source: Statista

In fact, analog chips, the chips most widely used in automotive, showed stable development in 2020, with a small increase of 3.2% to \$55.7bn in total revenues. This year, global automotive demand recovered quickly as consumers avoided public transport. Chip content per car increased faster than usual as more premium EVs were produced and automotive tier one companies and OEMs rushed to get their orders to chipmakers to fulfil the vast needs of their depleted supply chains. However, as other sectors had secured as much production capacity as possible, microprocessor unit and storage controller and power management chip capacity at the chipmakers ran down. The chip industry was no longer able to fulfil orders, leading to the current shortage of these types of chips.

In addition, shortages started to evolve in other chips with exceptional demand, like graphic cards as well as components for high-end phones. To make matters worse, there were regional production glitches as a result of COVID-19 outbreaks (eg regional lockdowns in Malaysia), fire (Renesas in Japan), extreme cold (Infineon, NXP and Samsung in Texas) and a looming water shortage in Taiwan.

Car makers reacted by giving priority to the production of higher-margin premium models that also carry relatively higher chip content, which was a strong driver for automotive chip sales. Despite much lower global car production this year, automotive semiconductors are having a very good year, driven by a higher chip content in the cars produced and, we believe, inventory build-ups.

However, shortages also started to emerge in the supply chains that had secured supplies in the early lockdowns. Smartphone producers like Apple did not secure capacity for the next pandemic wave and consequently also experienced shortages, although this was partially offset by a slowing Chinese economy. Nevertheless, [Apple](#) stated that it could have sold millions more iPhone 13 models had there had been no supply chain issues.

## Chip shortages started a geopolitical run on fabs

The fact that powerful car OEMs were not able to produce cars as a result of chip shortages opened the eyes of policymakers around the globe. The United States had already realised that it was very dependent on China/Taiwan and South Korea for its cutting-edge chips and swiftly started government-subsidised plans to build up a semiconductor supply chain in the US. That resulted in both Samsung and TSMC building >\$10bn high-end fabs in the United States. Ford and General Motors also suggested starting their own chip production, but that would probably not work, as it takes time to build up knowledge, let alone cost-effective capacity. Japan also attracted a large investment from TSMC.

Policy makers throughout Europe also began to understand that the region lacked even basic chip production capacities. However, as Europe has leading car manufacturers in need of chips and Intel is seeking clients for its new foundry business as it looks to build up leading-edge chip manufacturing capacity (and of which Europe has knowledge), in our view collaboration between the two parties makes sense. Intel has a very aggressive capex plan (>\$80bn) in exchange for anticipated large subsidies (as Japan and the United States also provided for TSMC and Samsung).

Although they will not have a large impact on chip demand, these capacity expansions will lead to much more demand for equipment in the coming years and we would not be surprised if pockets of oversupply start to emerge.

## The high semiconductor tide lifted almost all boats

Semiconductor share prices decreased dramatically on stock markets in March 2020, with the bellwether PHLX Semiconductor Sector Index (SOX) dropping almost 35% from February (see Exhibit 5) last year to 1,287 points. Driven by higher sector growth estimates, better sentiment around for example homeworking, gaming, automotive and existing chip shortages, the SOX rose gradually >195% to 3,800 points plus levels in November 2021. All segments of the market benefited, from logic/memory to analog and from (fabless) chip makers to equipment.

**Exhibit 5: PHLX Semiconductor Sector Index**



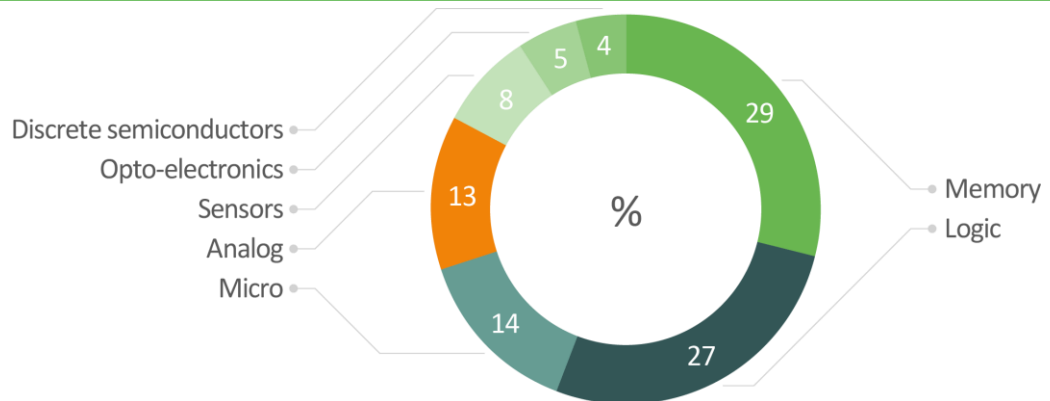
Source: Refinitiv

While [we argued in the autumn of 2020](#) that the logic and foundry segments (used for instance in microprocessors in PCs and smartphones in Exhibit 4) would benefit most, in late 2020/early 2021 the market also started to turn for analogue and memory. Share prices for analogue bellwethers like Infineon and STMicroelectronics have more than tripled compared to the lows recorded in March last year. This year, WSTS expects these two segments to show the highest growth.

We believe the largest beneficiaries of the sentiment around chips are equipment makers. On the one hand, they benefit from immediate capacity demand and, on the other, they should benefit from the investment spree that will occur when geographies start their own production hubs. This now seems inevitable with the \$50bn US CHIPS Act and a similar European initiative that is being considered.

ASML's share price went from a low of €186 in 2020 to a >€750 high in November this year, while ASMI's share price recovered from a low of €59 to more than €400 in the same time frame. Both are increasingly involved in the higher-technology nodes of the chip manufacturers and we believe this is also reflected in higher valuation multiples. The share prices of back-end equipment companies like Besi and Suss MicroTec and front-end company Aixtron more than tripled from their lows in March 2020 and now trade at valuation multiples clearly above their historical averages.

**Exhibit 6: Chip market segmentation 2021e**



Source: SIA

## Where to position yourself in Europe

The three things we can conclude on a global perspective are that chip demand is expected to stay solid, with the Chinese market as a question mark, that shortages persist in parts of the market and that investments will be made in adding chip making capacity. In light of these developments and taking into account the sharply re-rated valuation levels at, for instance, the equipment makers, we believe chipmakers that are most geared towards ADAS and EVs and their supply chains are the better plays in the next few years, as well as companies with a product portfolio that is still in very short supply. We believe automotive EV/ADAS-related specialists like X-Fab, ams and Elmos are well positioned, as well as material players like IQE.

### Not strong in logic/foundry

Europe has a very limited position in leading-edge logic/foundry and memory chip design and manufacturing. Intel has a relatively high-end fab in Ireland and in Germany GlobalFoundries has a <20nm fab (where TSMC already operates at 5nm). Other than that, there are highly regarded research institutes like IMEC in Belgium and CEA-Leti in France. Discussions are going on between Europe and Intel to invest up to €80bn in two high-end fabs in Europe between now and 2030, but it is going to want significant subsidies for this.

With respect to high-end chip manufacturing, suppliers to fab makers, like clean room makers and equipment builders, which should be well positioned in the coming years, are most relevant to investors in European equity. For example, companies like ASML, ASMI and, to a lesser extent, Besi and possibly Suss MicroTec should benefit, although share prices have risen to record levels. With the exception of ASML, which has a monopoly position, European equipment makers used to trade at a discount compared to US peers like Applied Materials, LAM Research and KLA-Tencor.

GlobalFoundries, Bosch, STMicroelectronics and Infineon are also adding capacity in Europe, albeit in much less complex process nodes. These will be relatively minor expansions compared to the investments Intel is willing to make, probably in the single-digit billion-dollar range.

### A stronghold in automotive

The automotive industry is Europe's stronghold, with leading companies like Volkswagen, Renault, BMW and Daimler. Its tier one supply chain, with companies like Bosch, ZF, Valeo and Continental, is also largely still in Europe, as well as leading analog chip suppliers like NXP, Infineon, Melexis and STMicroelectronics.

As explained, supply chains for automotive chips are extremely tight and, as it is difficult to add capacity seamlessly, car manufacturers were forced to stop production in many cases. As this part of the chip market has had its share of pork cycle-like movements, it is very important to determine

whether current orders are the effect of over-ordering (as chip suppliers only deliver portions of orders), stock replenishment or real productions. Due to the specific COVID-19-related situation and very tight supplies, most companies in the supply chain have been more transparent and we expect that sector discipline is higher now and should prevent large swings in fab utilisation. All in all, we expect the situation to normalise early in 2022, faster than some market watchers, as we see some relaxation around Chinese end-market demand, as explained above (lower new car sales).

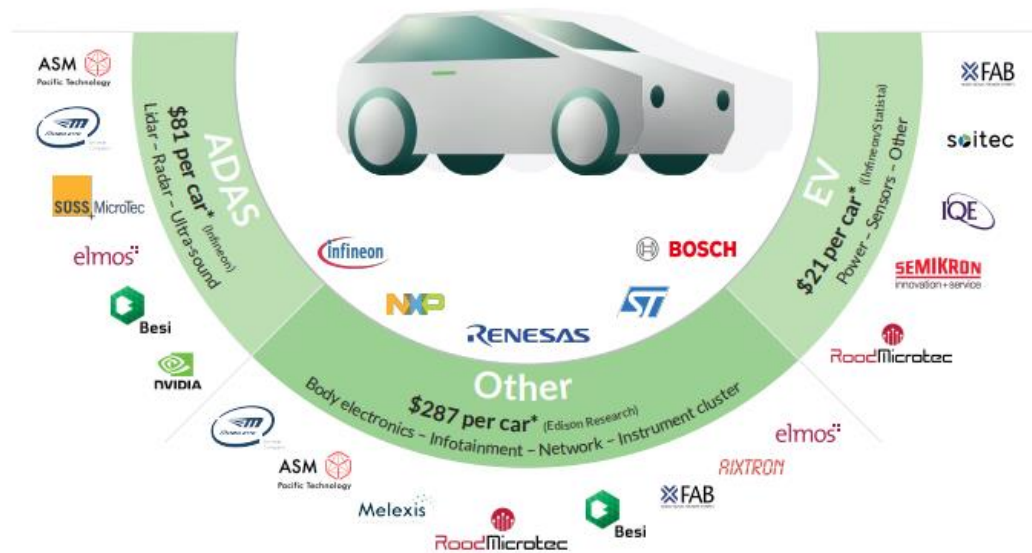
Demand for the chips that are now in high demand like micro controllers (market leaders NXP and Renesas) will probably continue for some time, until inventories are replenished. There are early signs from industry sources that inventories of several other chip types are getting back to normal levels already. With premium cars at higher production levels this year, we would expect that chips for premium applications could fall back next year.

### Semiconductor content in cars accelerates

Semiconductor content in cars is still expected to grow significantly and, given heightened global energy transition ambitions, we would expect it to grow at an accelerated pace. While semiconductor content already represented c \$389 per car in 2018, we believe it could be well over \$2,000 per ADAS EV in a few years. NXP stated with its Q3 results that average semiconductor content in an EV is about \$900 now, roughly double that of an equivalent internal combustion engine (ICE) vehicle.

Looking in particular at the ADAS and EV trends in Europe, there are several semiconductor companies aligning. Key for the investor is to pick companies that are more geared toward products that are less exposed to inventory issues, and we believe those are the companies with relatively more exposure to ADAS and EVs.

**Exhibit 7: Semiconductor content in cars**



Source: Edison Investment Research

For larger companies like NXP, Infineon and STMicroelectronics, trends like silicon carbide (SiC) 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 light detection and ranging (Lidar)), are important, but part of a broader product offering. STMicroelectronics is an important supplier to Tesla for SiC and Infineon has also built a position in SiC. As such, they are partly active in attractive niches, but their share prices have more than tripled since March 2020, and 2022 is not



shaping up to be a very strong year for a diversified semiconductor company, as chip shortages are decreasing for most chips, demand trends are not all positive and given that capacity is being added.

Niche companies with a higher gearing towards automotive, like fabless Melexis (big in magnetic field sensors), closely related foundry X-Fab and automotive chipmaker Elmos, have a higher gearing towards automotive, and of these Elmos is the purest play on the ADAS trend with its ultrasound sensors for cars. On the other hand, Elmos and Melexis have no or hardly any exposure to SiC and a higher exposure to the premium segment, which does not seem particularly attractive at the moment given market dynamics.

On the other hand, X-Fab has a good position in SiC, although sales are still relatively low at €9.9m in Q321. Despite the chip shortages, X-Fab has not been able to step up production very fast, despite a significant amount of spare capacity in France, as switching between fabs is not that easy given design issues. German PVA TePla has a position with its SiC ingot furnaces, especially as a supplier to STMicroelectronics. Its share price has increased very quickly this year (+106%), compared to X-Fab's 83.5%.

Furthermore, there are scale-up niche companies like Kalray, which is playing into next-generation super computers with its 256 flexible programmable cores microprocessor (Coolidge) and acceleration cards, which entered the market in 2021. NXP has taken a stake in Kalray for its automotive fusion chip products, which combine all the sensor inputs for ADAS. Joint developments with server producer Wistron for datacentre chips and Viking and Scaleway were also announced.

Other niche players are the providers of high-end light and proximity sensors like 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 vertical cavity surface emitting lasers (VCSEL) and 3D sensing for smartphones. The integration process has not been seamless and these issues may have contributed to the underperformance of the shares relative to peers. Now that Apple seems to be developing its own fully ADAS/EV car, Lidar could be needed faster than the market now anticipates and ams has a position in this market.

Dialog, now part-owned by Apple, is more dependent on the smartphone market and one supplier, which makes it vulnerable. Dialog does have the ambition to expand in automotive.

German Aixtron, like Dutch ASMI, makes equipment for deposition. Its strength lies in providing metal organic chemical vapor deposition (MOCVD) tools to manufacture special materials like SiC and gallium nitride (GaN), which plays into the EV/lower energy consumption trend, but also has applications for 5G and micro-LEDs.

## Material suppliers

In silicon wafers and epitaxial wafers, Europe had a strong position with Siltronic as a flagship company, although it will be acquired by GlobalWafers. Siltronic supplies the likes of Intel and TSMC with silicon wafers.

In terms of materials, companies like Soitec and IQE are more geared towards wafers incorporating special materials, like SiC, GaN and gallium arsenide (GaAs), which are deployed in for example EV applications or 5G. Although the smartphone market has been weaker than expected, the advanced 5G infrastructure roll-out still is at an early stage and special material wafers should have a strong position given the tight supply situation. Because of its high exposure to high-end smartphones, IQE has suffered this year, while Soitec could benefit from its broader market position.

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. Nanoco delivers nano materials (like quantum dots) for companies like STMicroelectronics.

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