

Semiconductor Industry Market Trends 2019-20

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The logo for TEHCET, featuring the word "TEHCET" in a bold, white, sans-serif font. The letters are set against a dark blue, pill-shaped background with a slight 3D effect and a light blue highlight on the right side.

Electronics Materials Information

READERS NOTE

This report represents the interpretation and analysis of information generally available to the public or released by responsible agencies or individuals. Data was obtained from sources considered reliable. However, accuracy or completeness is not guaranteed.

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1 Executive Market Reports Description

TEHCET Executive Market Reports (EMRs™) are short reports customized for the executive reader that is looking to get the straight facts without a lot of fluff. For that reason this entire report may be considered as an Exec. Summary. We aim to provide high quality, value information and appreciate your feedback. Send any questions or comments to info@techcet.com

2 Worldwide Economy

Consumption of consumer electronic goods, ranging from smartphones to automobiles, propels global semiconductor demand. As such, the strength of the global economy is the primary factor for semiconductor industry growth; with the strong semiconductor industry revenue growth in 2018 coinciding with an expanding global GDP (Table 1). Slower economic growth is forecasted for 2019, and the semiconductor revenue growth will decline by double-digits. (More discussion on the semiconductor industry growth outlook is covered in Section 3).

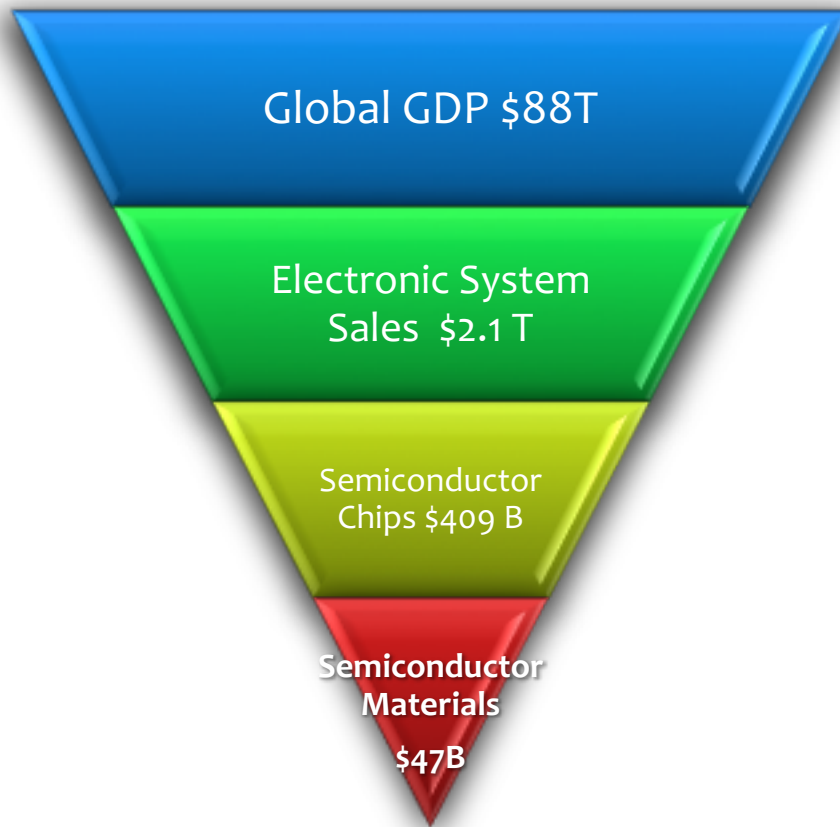
Table 1: Global GDP and Semiconductor Revenues

	2018	2019F	2020F
Global GDP	3.6%	3.0%	3.4%
Semiconductor Revenues (US\$B)	US\$468.8	US\$409.0	US\$433.0
% Semiconductor Revenue Growth	13.7%	-12.8%	5.9%

Source: IMF and WSTS

A simple pyramid, Figure 1, illustrates how demand for materials begins with the worldwide GDP, moves on to electronic goods, and then semiconductor devices. All segments along the pyramid experienced growth in 2018, with Electronic Systems sales increasing 5% for the year. While the global economy will grow in size for 2019, Electronic Equipment, Semiconductor Revenues, and Semiconductor Materials will contract.

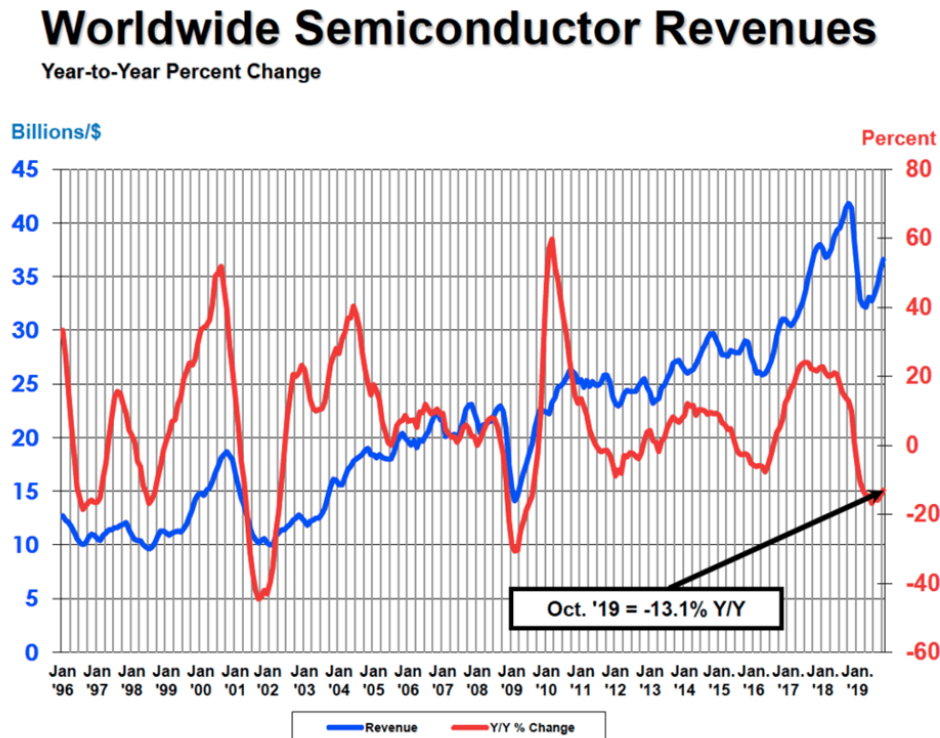
Figure 1: 2019 Global Economy and the Electronics Supply-Chain



Source: IMF, WSTS, VLSI Research, TECHCET

With the above stated, the global economy and, therefore, the global semiconductor industry encountered changing market conditions that slowed growth trends in the second half of 2018 and lowered expectations for growth in 2019. Figure 2 shows the 3-month average semiconductor sales through October 2019 as reported by the World Semiconductor Trade Statistics (WSTS) organization. Monthly sales have increased through 2016 and peaked in October 2018 before declining through much of 2019. Month-over-month growth has improved in 3Q with October sales up 2.9% versus September. October mark the fourth increase in month-to-month sales in a row, and the decline in year-over-year trends is shrinking.

Figure 2: Worldwide Semiconductor Sales



Source: WSTS

Slowing semiconductor industry conditions are tied to uncertainty in the global economy, which is generally attributed to the on-going trade disagreement between China and the U.S; slowing of the Chinese economy; sluggishness with Germany's manufacturing sector; and debt concerns globally. Figure 3 shows the Global Purchasing Managers Index (PMI), and it has trended downwards since early 2018 pointing to growing uncertainty in the economic outlook, though in 1Q 2019 the PMI remained in expansion before dipping into the contraction range by 2Q. The Global PMI in September remained slightly below the growth/contraction line though improved slightly from the August PMI.

The PMI is an indicator of economic health for manufacturing and service sectors. The purpose of the PMI is to provide information about current business conditions and survey areas cover new orders, inventory levels, production, supplier deliveries and employment. An expanding economy will have a PMI above 50, and a contracting

economy will have a PMI below 50.

Figure 3: Global Purchasing Managers Index



Source: Custer Consulting and Markit Economics

At the start of 2019, both the International Monetary Fund (IMF) and the World Bank have reduced their respective economic forecasts in light of a number of issues:

- “The global expansion is weakening and at a rate that is somewhat faster than expected.” (IMF, January 21, 2019)
- “At the beginning of 2018 the global economy was firing on all cylinders, but it lost speed during the year and the ride could get even bumpier in the year ahead,” said World Bank Chief Executive Officer Kristalina Georgieva. (World Bank, 1/2019)

Both the IMF and World Bank have forecasted a decelerating global GDP for 2019. Table 2 summarizes the GDP growth outlook from the IMF. The IMF forecasts an improved outlook for 2020.

Table 2: IMF GDP Forecast

	2018	2019f	2020f
US	2.9	2.4 (2.5)	1.7 (1.7)
Euro Area	1.9	1.2 (1.6)	1.4 (1.5)
Japan	0.8	0.9 (0.9)	0.5 (0.5)
Emerging Market	4.5	3.9 (4.3)	4.6 (4.6)
China	6.6	6.1 (6.2)	6.0 (6.2)
World	3.6	3.0 (3.2)	3.4 (3.5)

Numbers in brackets “()” indicate prior forecast from January 2019, indicating market uncertainty. Source: IMF, October 2019

For 2019, the IMF *World Economic Outlook* noted “the global expansion is weakening and at a rate that is somewhat faster than expected.” The IMF revised down its forecast for advanced economies, specifically noting a weaker auto sector in Germany and sovereign and financial risks in Italy. It also notes that its downward revision from the Fall 2018 is modest; “however, we believe the risks to more significant downward corrections are rising.” Other key points of note include:

- Trade and investment have slowed: “higher trade uncertainty will further dampen investment and disrupt global supply chains.”
- Industrial production outside the United States has decelerated
- Purchasing managers’ indices have weakened, flagging softening momentum
- China’s growth slowdown could be faster than expected especially if trade tensions continue.

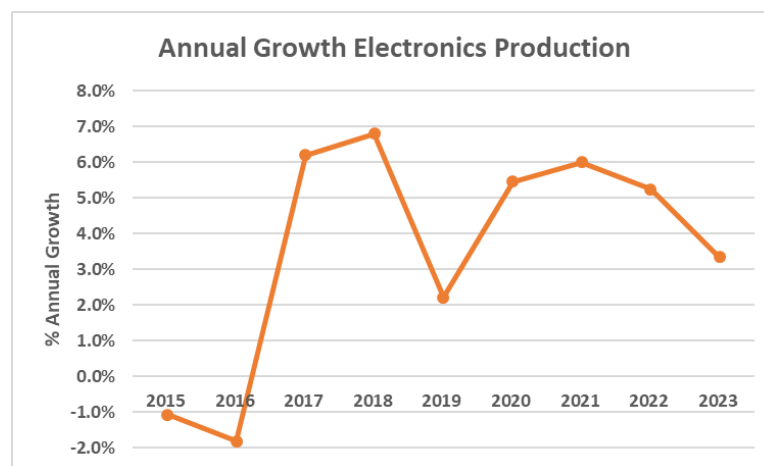
As noted by economists, a slowing economy in China will affect its trading partners and global commodity prices. As an example of the latter, the China / U.S. trade dispute and concerns with a slowing China economy resulted in a nearly 20% decline in the London Metal Exchange (LME) price for copper by July. Both the IMF and World Bank forecast slowing of the Chinese economy in 2019.

Actions by the Japanese government to put in place restrictions to key semiconductor materials exported to South Korea added another dimension to the global trade tensions.

3 Electronic Goods Market

Consumption of electronics goods market provides insight into the health and direction of the overall semiconductor industry. Per VLSI Research, electronic sales (global electronics production, with automotive related, storage, and servers) reached \$2,206 billion in 2018; 2018-2023 CAGR is estimated to be 4+% (Figure 4).

Figure 4: Global Electronics Production Annual Growth

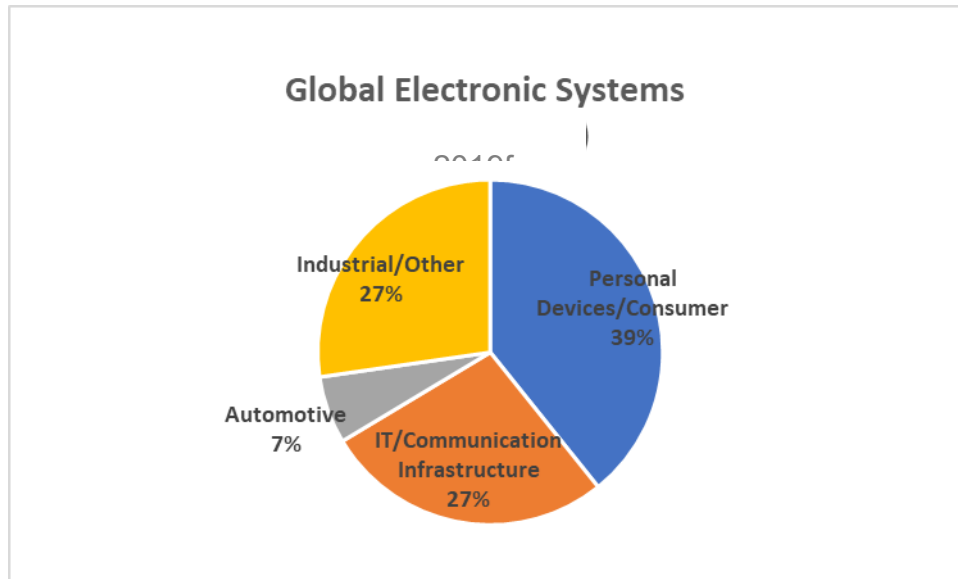


Source: Various public sources and TECHCET

IT / Data Systems

IT/Communication Infrastructure represented 27 percent of the \$2.2 trillion global electronics systems in 2018 (Figure 5). Worldwide IT Spending is estimated to grow by 3.2% overall in 2019 (and 2.8% in 2020), and growth in Data Center Systems and Devices of 4.2% and 1.6%, respectively for 2019. In its forecast, Gartner states that “spending will move from saturated segments such as mobile phones, PCs and on-premises data center infrastructure to cloud services and Internet of Things (IoT) devices”.

Figure 5: Global Electronics Production Annual Growth



Source: VLSI Research

Smart Phone Market

Once a major driver of both semiconductor industry growth, as well as new device technology, the smartphone market has slowed down considerably and is expected to grow < 3% in 2019. Different analyst firms note the mobile phone unit growth declined in 2018, including the higher-end smart phone segment. Several factors have been cited for this shipment decline: extended consumer upgrade cycle; increased smartphone market penetration; current economic uncertainty; and "growing consumer frustration" around rising smartphone prices. IDC commented that China, the world's largest market for smartphones, experienced a -10% decline in shipments in 4Q 2018 (Table 3).

Table 3: Smartphone Vendor Shipments (Millions of Units)

Company	2018 Shipment Volumes	2018 Market Share	2017 Shipment Volumes	2017 Market Share	% Y-o-Y Change
1. Samsung	292.3	20.8%	317.7	21.7%	-8.0%
2. Apple	208.8	14.9%	215.8	14.7%	-3.2%
3. Huawei	206	14.7%	154.2	10.5%	33.6%
4. Xiaomi	122.6	8.7%	92.7	6.3%	32.2%
5. OPPO	113.1	8.1%	111.7	7.6%	1.3%
Others	462	32.9%	573.4	39.1%	-19.4%
Total	1,404.9	100%	1465.5	100%	-4.1%

Source: IDC Quarterly Mobile Phone Tracker, January 30, 2019

Various news and reports cite 1Q 2019 will be a down quarter for mobile phone shipments, which has impacted the semiconductor industry outlook for the supply chain. However, a slight unit increase in mobile phone shipments for 2019 is forecasted.

While smartphone unit growth has declined and looks to be sluggish in 2019, newer models will include high-resolution displays and cameras, and further integration of biometric sensors and high-density memory. This will create demand for display drivers, different sensors, and memory devices spanning the range of 200 mm and 300 mm device fabrication. With the investment and the expected ramp in 5G networks targeted to begin in 2019, demand for newer broadband devices, RF technologies, and low-latency processors will increase in production to build out this emerging communication infrastructure.

PC Computers

The PC computer market is growing even slower than mobile phones. In an early January 2019 press release, Gartner released preliminary data for PC shipments and it has 2018 units declining to 259.4 million, or -1.3% below 2017 shipments; marking 2018 as the seventh consecutive year of decline in worldwide PC shipments. (Gartner did not issue a 2019 PC shipment forecast in its press release.) IHS Markit forecasts a -0.6% decline in PC notebook shipments in 2019 and -8.8% shipment decline in PC tablets. Beyond 2019, IHS Markit forecast PC notebook shipments to recovery in 2020 and remain stable through 2022. For the PC tablets, the forecast shows continued shipment decline through 2022.

Growth in the PC market can drive demand for MPU, GPU, and high-density memory devices, which directs manufacturing demand towards leading-edge fabs and foundries fabricating such devices. Driver devices will be needed for display and other computer peripherals, and many of these products are fabricated on 200mm wafers.

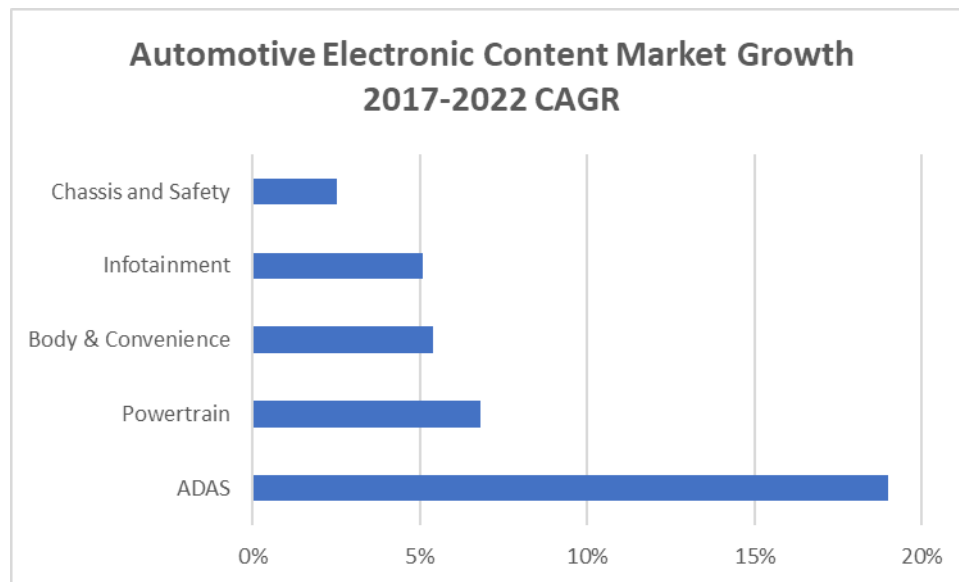
Automotive

The automotive segment has been a growing market for semiconductors as sales of hybrid and electric vehicles are increasing as well as the additional electronic content for safety, navigation, powertrain performance, and entertainment features increases in vehicles. Various industry reports note that vehicle production did slow in the 2H2018. The U.S. and China markets could experience a decline in vehicle sales in 2019. The National Automotive Dealers Association (www.nada.org) forecasts 16.8 million new cars and light trucks in 2019 for the U.S. market. This marks about 3 percent decline compared to 2018. NADA stated that “new vehicle sales totaled 17.3 million units in 2018, marking the fourth straight year of sales above 17 million units.”

While automotive production may decline some in 2019, both automotive electronic content and, therefore, chip growth remain positive going forward. Growth rates for various electronic systems consumed in vehicles are shown in Figure 6. Some

segments are forecasted to undergo growth rates of 5 percent or more even while global automotive production is expected to grow at low-single digit rates. These increases are driven by not only an increase in smart systems being integrated in traditional gas-powered vehicles but by an increase in demand for hybrid and electric powered vehicles.

Figure 6: Automotive Electronic Content Growth



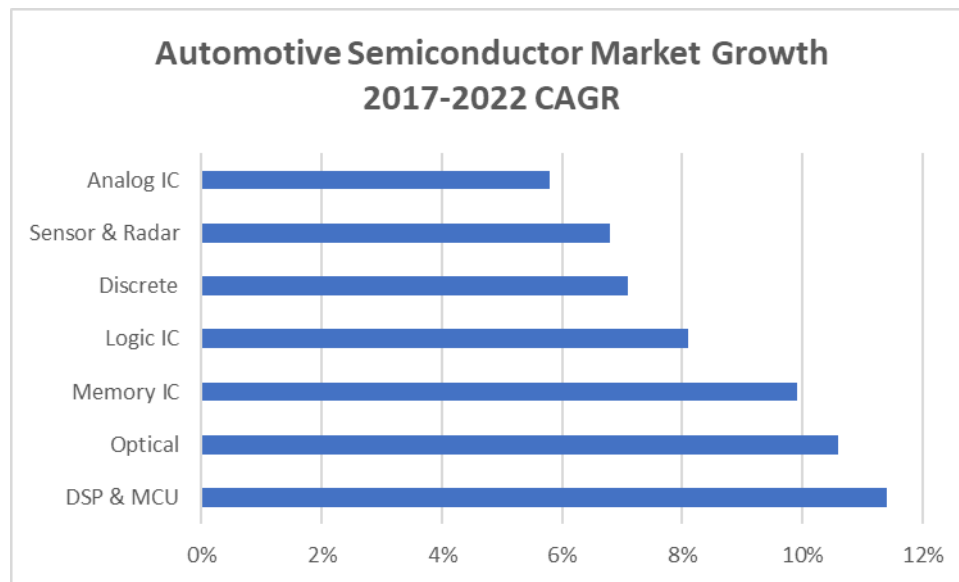
Source: IHS Markit (presented by JCET at Meptec Luncheon Seminar, February 2019)

While near-term vehicle sales are encountering growth challenges, the ramp and transition in hybrid vehicles and electric vehicles accelerates. Industry data show the automotive industry is ramping up L2+ types of vehicles (not fully autonomous), which drives demand for image sensor, radar, MCU and SoC. IHS Markit has ADAS unit shipments growing at a 15% to 20% CAGR range from 2017 to 2022. (ADAS unit shipments include radar, LIDAR, ECUs, cameras, and other devices.)

Automotive applications will require sensor devices for ADAS and other safety related applications; advanced processors and memory for increasing automated driving features and capabilities in vehicles; and new generation of power devices for energy efficiency and vehicle electrification. Figure 7 shows the forecasted growth rates for different semiconductor device segments for automotive applications. These device

applications run the gamut of technologies from devices fabricated in 150 nm to 300 nm fabs, and leading-edge device technologies run on 10 nm and below processes, as well as processes 65 nm and above. The mix of devices used in automotive applications is shown below:

Figure 7: Automotive Semiconductor Market Growth



Source: IHS (presented by JCET at Meptec Luncheon Seminar, February 2019)

Legacy devices, in particular, are receiving a boost from the automotive industry, as indicated below for RF, CIP and power devices. As indicated in the figure below, these chips are expected to growth 10% or more over the next several years.

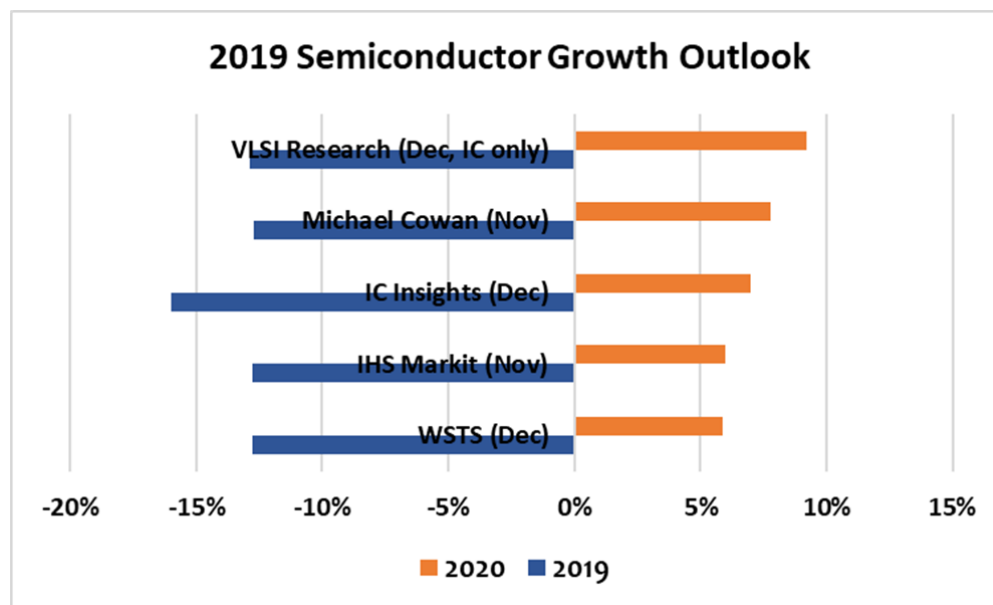
To summarize, while semiconductors for wireless (mobile) and consumer electronics applications will have the lowest growth in 2019, analysts forecasts the automotive and IT markets will undergo 4% to 5% growth over 2019. Analysts project devices for industrial, automotive, and computing & data storage applications to have CAGRs of 8% and higher beyond 2019.

4 Semiconductor Device Outlook

The semiconductor market had another record revenue year in 2018 with 13.7% revenue growth for the year achieving \$469 billion in revenues, as cited by the World Semiconductor Trade Statistics (WSTS). As noted previously in the chapter, the monthly sales data show a slowing in the semiconductor monthly revenues since October 2018, with both month-to-month and year-to-year growth indicating the slowdown in early 2019.

The slowing semiconductor industry conditions coupled with the current economic uncertainty led industry analysts to forecast a decline in semiconductor revenues for 2019. Figure 8 highlights the semiconductor forecasts from five market research firms and organizations. All five analyst companies are forecasting a double-digit decline in semiconductor revenues for 2019, though these analysts are all positive for revenue growth in 2020.

Figure 8: 2019 and 2020 Semiconductor Revenue Growth Forecasts

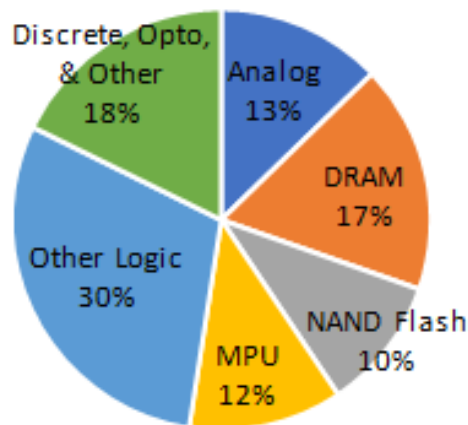


TECHCET October 2019

Predictions in early 2018 that the DRAM and NAND segments would be in oversupply due to the fab capacity brought on-line in from late 2017 and through 2018

proved portentous. These two segments combined represent about 27% of the semiconductor market in terms of revenues (Figure 9). As oversupply hit these markets, average selling prices declined for both NAND and DRAM devices, and memory makers experienced sharp declines in revenues during the fourth quarter of the calendar year and through early 2019. Both segments will experience sharp double-digit drop in revenues. While both the DRAM and NAND segments are expected to experience revenue declines in 2019, on a bit basis both segments will grow: by 15% to 20% for DRAM and 35% to 40% for NAND. The total revenue decline for all the non-memory segments will be -2.5% for 2019.

Figure 9: 2019 Semiconductor Market Size by Device Segment (as a % of total revenues)



Although there is not a 1:1 correlation between semiconductor revenues and MSI on material demand volumes, revenues trends are considered a good indicator of changes in material demand. Knowing that the memory market is currently undergoing an inventory correction, with ASPs likely to decline, one can deduce that unit sales of chips and MSI in 2019 will decline compared to 2018. In TECHCET's estimation, based on historical data and modeling, wafer starts are expected to decline, -2% to -4%, for 2019.

5 Equipment Spending and Fab and Capital Investments

Capital investment (Capex) in the semiconductor industry, a good growth indicator of chip manufacturing capacity is expected to decline in 2019. Semiconductor fabricator Capex has increased for three consecutive years from 2016 through 2018. Per SEMI, new semiconductor equipment spending reached an all-time high in 2017 at almost US\$57 billion and surpassed in 2018 with an estimated \$62 billion in spending. However, both SEMI and VLSI Research have forecasted equipment spending declines in 2019. Several semiconductor equipment companies in their respective quarterly financial calls provided a range of a -15% to -20% decline for the 2019 equipment market. The table below shows key chip fab plans for future capital investment. Important observations from these announcements are as follows:

- Currently, planned 300 mm related investments are directed towards technology transitions in memory and not capacity.
- For Logic and Foundry, 300 mm investments will focus on 10 nm, 7 nm, and 5 nm process technologies. Some 300 mm investment will be towards power and analog device fabrication.
- 200mm fab manufacturing remains important for MCU, PMIC, and IoT devices and remains a key area of investment in both technology and capacity.

Table 4: 2019 Investment Plans for Selected Device Companies

Company	2019 Capex and Fab Investment Initiatives
Intel	<p>Full year capital spending of US\$16 billion (includes spending for non-semiconductor manufacturing).</p> <p>Confirmed the third phase of D1X (in Hillsboro), which will apparently increase D1X's manufacturing space by about 50 percent.</p> <p>News reports state Intel will receive a US\$1 billion state grant from the Israel government for its Fab 28 (Kiryat Gat) investment plans, though reports in July state new fab construction has been delayed.</p> <p>New investments at Fab 11X Rio Rancho, NM</p>
Micron Technology	<p>FY2019 capex of US\$9.1 billion, currently guiding FY2020 capex of US\$7 billion to US\$8 billion</p> <p>Investments include new fabs, A3 and possible A5, in Taichung, Taiwan. in Taichung, Taiwan. A3 fab slated for completion in the fourth quarter of 2020.</p>
Samsung	<p>Spent KRW 8.8 trillion (~US\$7.6 billion) in 1H2019 on semiconductor capex.</p> <p>September media reports state that Samsung has started ordering semiconductor equipment for the new construction of fab at Pyeongtaek, Korea and Xian, China.</p> <p>5 nm is ready for risk production</p> <p>Samsung Foundry expanding 200 mm capacity: ramped to 250K wpm in 2018 and planned ramp to 277K wpm in 2019; will remain at 277K wpm in 2020; and then ramp to 300K by 2021</p>
SK hynix	<p>Reduce 2019 capex by at least 40% compared to 2018. Spent 17 trillion won (~US\$15 billion) in 2018.</p> <p>Analyst reports state SK hynix has slowed down investment and expansion plans for M15 fab in Cheongju, South Korea and M16 fab near Icheon, South Korea. Indications are SK hynix will reduce 2020 capex plans below 2019 spending.</p>
TSMC	<p>Raised full year 2019 CapEx by US\$4 billion to between US\$14 billion and US\$15 billion. About USD 1.5 billion of the USD 4 billion Capex increase is for 7-nanometer capacity and \$2.5 billion is for 5-nanometer capacity. This is in comparison to 2018 capex of US\$10.5 billion.</p> <p>2020 capex expected to be similar to the revised 2019 capex</p>

	<p>2019 capex plan: about 80% of the capital budget will be allocated for other advanced process technologies, which includes 7 nm, 5 nm, and 3 nm. ~10% will be spent for advanced packaging and mask making, and ~10% spent for specialty technologies.</p> <p>New 3nm Pilot fab project planned in Hsinchu, has passed the initial environmental review earlier this month (June 2019). Expected to be the first of two technology & pilot production facilities for 3nm and below technology. Total investment could approach US\$6.5 billion.</p> <p>300mm Fab 12 Phase 9 to begin construction at the end of 2019 and could begin operation in 1H2021.</p> <p>New 200mm, Fab 6 Phase 3, fab in Tainan. Planned capacity of 100K wpm and an estimated investment of US\$1.4 billion. Fab shell to be completed by early 2020 and production is expected to commence mid-2020.</p>
Kioxia Holdings (Toshiba Memory)/Western Digital (WD)	<p>Toshiba is constructing its new Fab 7 in Kitakami. Began moving in equipment in June, construction phase to be completed in Fall of 2019.</p> <p>WD announced current fiscal year capex is for technology transition, not expanding wafer capacity. Long-term capital expenditure target of 6% to 8% of total revenue</p>
Infineon Technologies	2019 capex €1.5 billion
ST Microelectronics	<p>Plans US\$1.2 to US\$1.3 billion in capex.</p> <p>Spending includes three strategic initiatives: a new 300 mm fab in Agrate, expansion of silicon-carbide (SiC) capacity plus production ramp-up of gallium nitride (GaN) for RF devices, and next-generation image sensor technologies.</p> <p>New Agrate fab will produced BCD, IGBT, and power technology devices, with first equipment delivered in 2020 and volume production expected in 2021.</p> <p>New 200mm GaN pilot line in Tours, France under construction and production to begin in 2021.</p> <p>Planned new 150mm SiC fab in Singapore.</p>
UMC	<p>2019 capex revised to US\$700 million from previously announced US\$1.0 billion. 25% for 200mm investments and 75% for 300 mm</p> <p>200 mm spending will add up to 10K wpm capacity at the HeJian fab in Suzhou</p>

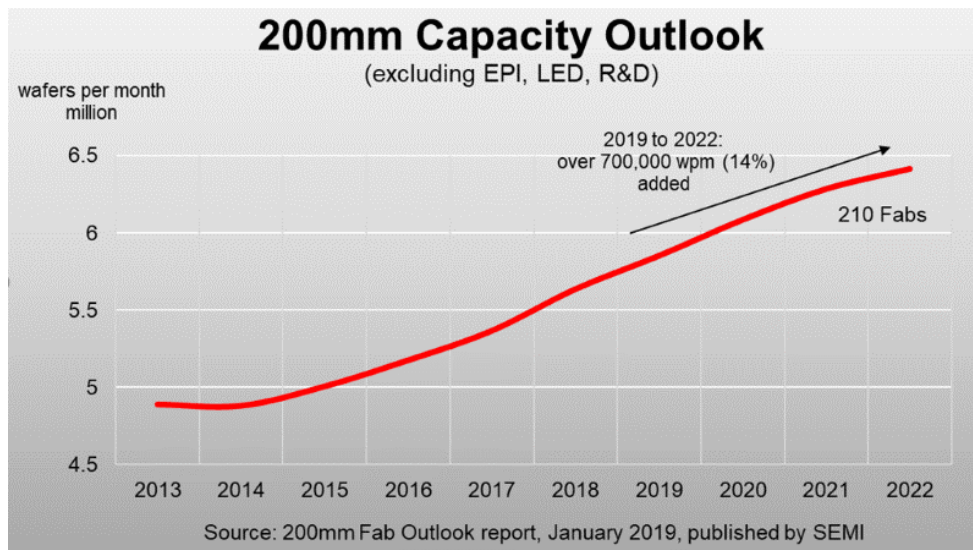
	At the end of September, UMC finalized full acquisition of the remaining 84.1% stake in Mie Fujitsu Semiconductor (MIFS) in Kuwana, prefecture Mie, Japan.
Vanguard Semiconductor	Vanguard to acquire GLOBALFOUNDRIES 200 mm Fab 3E in Singapore for US\$236 million. Fab 3E has an estimated capacity of 35K wpm. Will spend ~US\$116 million on new equipment in 2019 (vs. US\$65 million in 2018). Spending will be focused on Fab 3 in Taoyuan
Winbond Electronics	Stated plans for new 300 mm fab in Kaohsiung are on-track. NT\$355 billion (US\$11.3 billion) investment to build 300mm fab for 20nm technology. Construction began in October 2018 and fab to open in 2021. 2019 capex estimated at ~US\$600 million vs. ~US\$550 million in 2018
Cree	Announced US\$1 billion SiC fab at Marcy, NY site. NY State incentives to realize a net capital savings of about US\$280 million. Project will ramp through 2024.
Sony	To invest ¥120 billion (~US\$1 billion) to build a new fab for CMOS image sensors in Isahaya, Nagasaki Prefecture. Construction to begin at the end of 2019 and production expected to begin in 1H2019 Announced total investment ¥700 billion yen (~ US\$6.4 billion) through 2021 for CIS.

MEMS & Legacy Devices

Longer term, legacy device technologies, as well as MEMS and sensor devices, continue to have a positive growth outlook. 200mm fab capacity expansion is focused to increase by 14 percent from 2019 to 2022 (Figure 11 below); and this is driven by power, automotive, industrial, and IoT applications, in addition to the growth forecasted for MEMS and sensor are device application segments (ref. SEMI press release). Such growth will increase demand for 200mm wafers and process materials for 90nm and above technologies to such a degree that 200mm fab capacity growth could be constrained by the limited availability of secondary 200mm equipment. It should be noted that several device manufacturers are transitioning analog and power device

fabrication, devices manufactured at legacy nodes, to 300mm wafers. The latter is beginning to unfold as companies like Infineon and ST Microelectronics invest in 300mm capacity for power devices, and Texas Instruments invest in 300mm for analog. With that stated, 200mm manufacturing remains an attractive cost-effective solution for many device applications.

Figure 10: 200mm Fab Capacity Outlook to 2022



Source: SEMI

With investments focused on technology transition and not capacity addition, wafer start growth will grow, but more slowly for 2019. Investments in leading-edge memory, logic, and foundry will drive demand for advanced lithography chemicals and new deposition materials, and the increasing number of process steps will increase need for advanced cleaning chemistries. A reduced capex spend and slower wafer start growth will decrease the outlook for consumable parts.

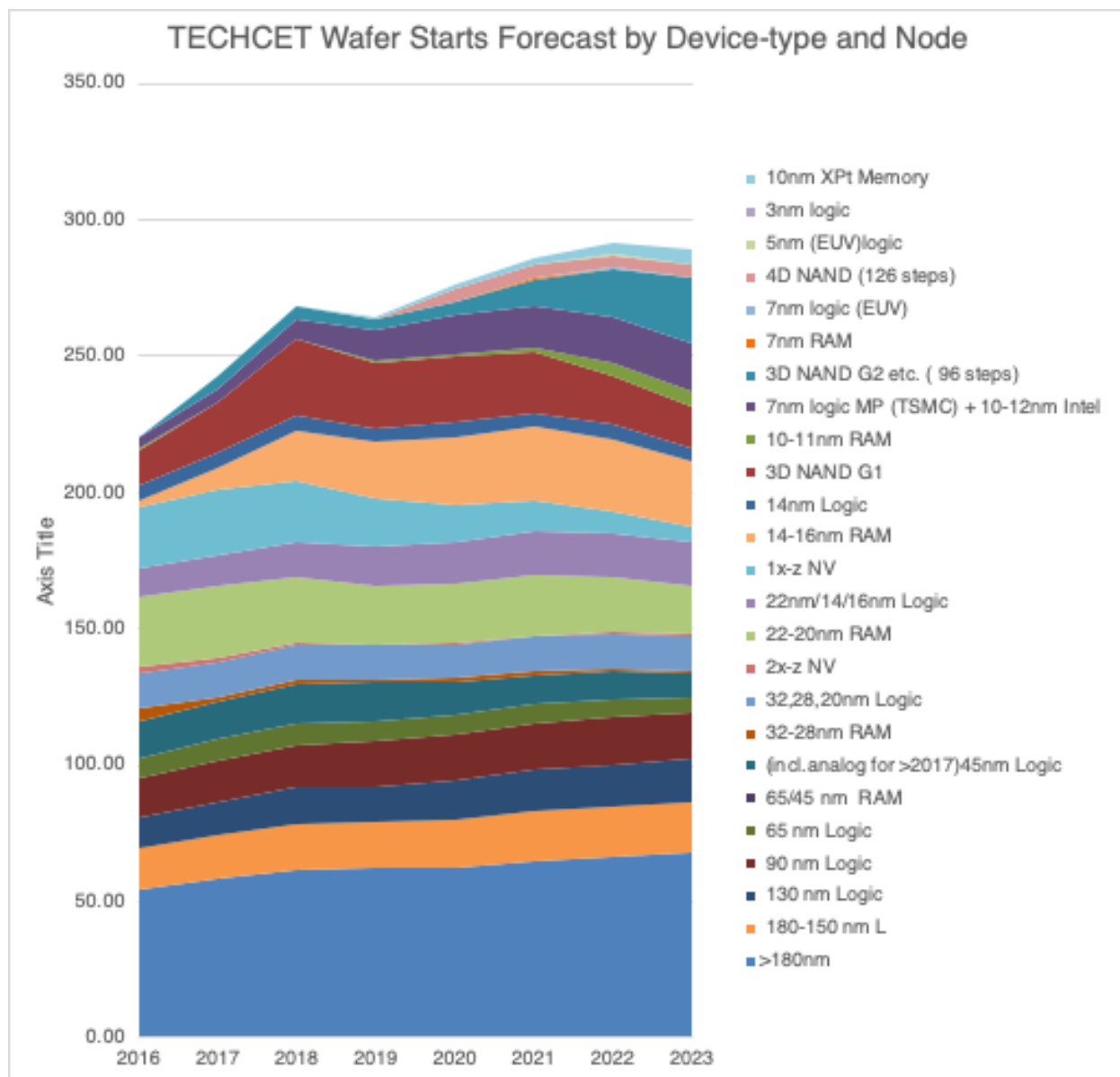
6 Wafer Start Forecast

TEHCET's wafer forecast shows overall decline in MSI (millions of square inches) of –2.5% for 2019, down from nearly 10% growth experienced in 2018. This is attributed to the market changes in memory, shifts in the electronic systems product mix, in addition to changes in global economies, as mentioned in the prior section.

As shown in the figure, below, for 2019, total RAM MSI and non-volatile memory MSI are expected to decline, while MPU/MCUs are expected to experience net positive growth. 2020 and beyond shows continued strength in the memory sector, attributed to growth in big data and continued need for increased memory storage in all applications.

CAGR for total wafer starts 2018-2023 is forecasted to be 3%. Growth rates vary depending on technology node and device type. Among the variety of devices, 3DNAND wafers starts will grow faster than most other device types ≥ 10 nm, with growth rates ranging 5% to 12%. The multiple layers required for 3DNAND stairsteps will continue driving volume demand for all materials. Leading edge devices, < 10 nm will also continue driving demand for materials, growing 50% CAGR through 2023. Note: total MSI for < 10 nm devices represent $< 20\%$ of all wafer starts.

Figure 11: TECHCET Wafer Starts by Technology Node and Device Type – 11/2019



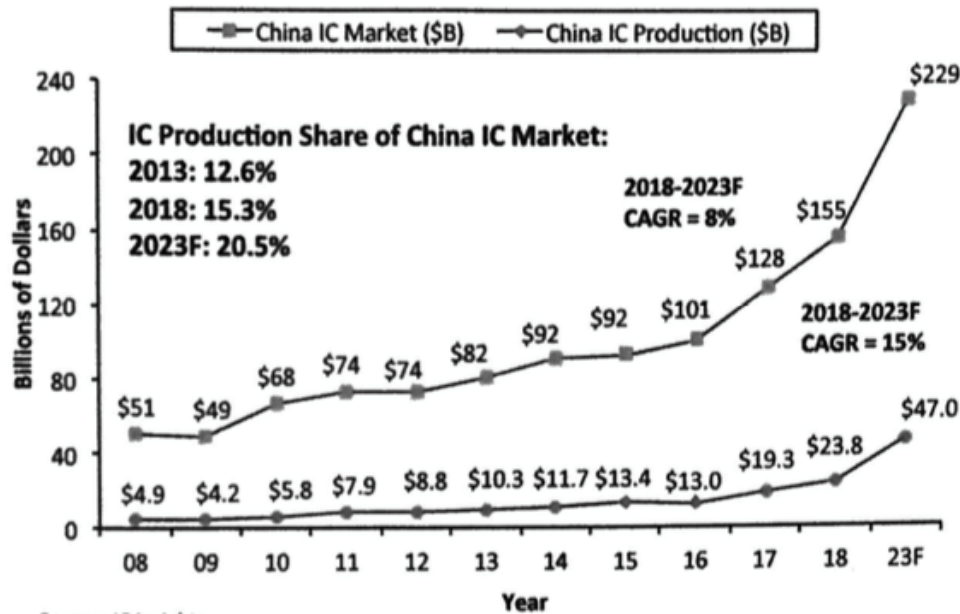
TEHCET's wafer forecast is a product of business and technology market intelligence. The model is generated quarterly using multiple sources of data including wafer capacity, device production, fab company announcements, and technical trend information. Historical cycles and vetting with electronic system forecasts, like equipment utilization, and test wafers, and other factors, are also taken into account.

TEHCET's wafer forecast model is used as a basis to model a variety of semiconductor process material forecasts. Not all materials are used in the same quantity per device type, for that matter, TEHCET uses internal knowledge of process steps by devices type and design rule (node) to calculate initial estimates of material demand. These numbers are then validated with industry surveys and interviews.

7 Overall China Market News and Trends

With its "Made in China 2025" initiative announced in 2015 and billions of dollars available for industry investments, the government and local companies have sought to revamp the semiconductor industry and its supply chain in China. The initiative is to move the country to be less dependent on foreign countries for semiconductor and related products. Their goal is to increase their ability to satisfy their own demand for semiconductor devices from 15%, 2017, to 40% in 2020 and 70% by 2025. The data indicates that China IC production captures just 15% of its consumption in 2018. For a deeper dive of information please see contact TEHCET at info@techcet.com

Figure 12: China IC Production Share and Consumption Trends



Source: IC Insights Publicly Released in 2019

The initiative includes a national funds along with provincial and local funds to boost China's capabilities in IC design, IC fabrication, packaging, equipment and materials production. Related to semiconductor manufacturing, the installed fab capacity in China, according to SEMI, is forecast to grow at a 12 percent CAGR from 2.3 million wafers per month (wpm) in 2015 to 4 million wpm in 2020. While multi-national companies play a key part in China's fab manufacturing, domestic companies are increasing capabilities as well:

- SMIC and Shanghai Huali are targeting 14nm manufacturing. (SMIC is targeting risk production in 2019).
- YMTC in Wuhan, China is in initial production with 32L 3D NAND and is targeting 64L designs in its next phases.
- ChangXin Memory is constructing a \$7+ billion fab in Hefei, China for DRAM fabrication and currently targets to begin production by the end of 2019. The company is reportedly targeting development for 17 nm DRAM.
- Foxconn announced a potential US\$9 billion fab project in Zhuhai, Guangdong Province, China for Display Driver and MCU. Construction to begin in 2019 with production expected to begin later in 2020. Sharp will be the technology partner.

- CanSemi Technology Inc. announced a 300mm fab in Guangzhou. Reportedly, 7RMB billion has been invested and the fab will target 0.13 μ m to 0.18 μ m process technologies for IoT and automotive applications.
- CR Microelectronics and its subsidiary SkySilicon announced plans for a new 300mm power semiconductor fab in Chongqing, Sichuan for power semiconductors (IGBT, MOSFET, and PMIC). Construction to begin in 2019.

There are other fab projects in China targeted toward MEMs and both SiC and GaN device fabrication. China investment initiatives include expanding the capabilities of China headquartered packaging subcontractors, process equipment companies, and semiconductor material suppliers, including silicon wafers, CMP materials, specialty chemical, gases, and other.

China's efforts to expand its semiconductor industry supply chain have faced several challenges. In the past several years, companies in the U.S. and Europe targeted for acquisition by Chinese companies have been blocked by regulatory authorities to prevent technology transfer. In the current trade-war environment, China semiconductor manufacturers may face restrictions in accessing semiconductor process equipment. For example, Fujian Jinhua Integrated Circuit Co. (JHICC) entry into the memory market is delayed as there are IP and legal issues involving its technology partner UMC and Micron Technology. As such, there are restrictions on fab equipment exports from the U.S. to JHICC.

Despite near-term challenges and uncertainty in the China market and with investments for new fabs there, the longer-term prospects remain positive. As a result, China will be a key market for electronic materials consumption, and this growth prospect is also driving the emergence of a domestic materials supply base for fab materials.

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In summary, overall semiconductor industry growth is tightly coupled to global economic expansion and especially demand growth for consumer electronics; thus, growing wafer starts drives electronic materials consumption. The market uncertainty for the industry at the start of 2019 points to lower wafer start growth compared to the previous two years for the industry. Memory investments will likely focus on technology improvements and not expanded capacity or wafer starts. Some slower growth could be expected for advanced materials consumed in memory, while continued investments in 7 nm and below, and in EUV lithography will spur ramp in consumption of newer materials for these leading-edge devices. Prospects for materials consumption remain positive in the longer term when economic uncertainty clears and new applications in 5G, high-performance computing, automotive, and other emerging applications grow and increase demand for new and advanced semiconductor devices.