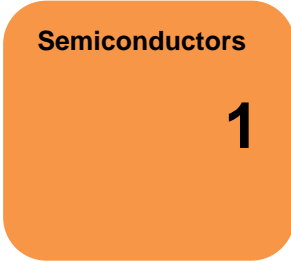




2016 Top Markets Report **Semiconductors and Semiconductor Manufacturing Equipment** Country Case Study

China

Over the past decade, China consistently ranks as one of the largest and fastest growing country markets for U.S. semiconductors and semiconductor manufacturing equipment and will continue to do so in the near-term. Global headwinds brought on by slowing global demand for ICT products, slowing transitions to smaller IC manufacturing nodes and a strong dollar, however, will be exacerbated by China’s opaque policies and unprecedented, state-led investment to develop an indigenous semiconductor industry. China’s policies create medium and long-term uncertainties for U.S. industry prospects in the Chinese market.



China remained the top market for semiconductors in 2015, representing the destination for \$98 billion or nearly one-third of total global shipments of semiconductors.¹ According to Semiconductor Equipment and Materials International (SEMI), in 2015, China’s semiconductor manufacturing equipment market traded places with Japan, causing China to drop one place to fourth in ITA’s country rankings for semiconductor manufacturing equipment, but it is expected to regain third place in 2016.²

Near-term prospects for China’s overall market seem favorable and stable for many sectors, including high-end ICT goods and services. Slowing economic growth, rising costs for U.S. companies operating in China, increasing Chinese domestic competition and market access barriers for foreign companies, however, have led to decreased U.S. company optimism about China’s market in the long-term.³ In 2015, turmoil in China’s stock market, deceleration of GDP growth and increasing capital flight were witnessed in what is likely the beginning of a broader

paradigm shift for China and its economy that will differ markedly from the last two decades of unprecedented expansion.

In response to its macro-economic challenges and in a broader effort to support national security, China has accelerated implementation of its strategy to develop a completely domestic information and communications technologies (ICT) supply chain (including semiconductors and related equipment). This ICT supply chain strategy also aligns with China’s aim to move from labor-intensive, low value-added production for export to higher margin, cleaner industries that produce goods made by China for China.⁴ This includes products used to manufacture ICT products in China that could eventually be exported, including semiconductors and semiconductor manufacturing equipment. China’s leadership strongly believes that this industrial development model (which it terms “indigenous innovation”) will lead to more sustainable and stable economic growth.

China is also utilizing various administrative and regulatory levers to support indigenous innovation by employing market access restrictions on foreign competition. This will increasingly affect what has consistently been the biggest and fastest growing ICT market for the last decade and a critical component in many multinationals' global supply chains. Despite these long-term hurdles, ITA expects there will be a continuation of strong, albeit slowing, growth in demand for semiconductors in China and a marked increase in demand in the semiconductor manufacturing equipment market in the near-term.

Overview of the Markets

Semiconductors

China ranks first in our study based on semiconductor demand for its electronics manufacturing industry. Demand is also increasing markedly from China's growing domestic market. China is the largest and fastest growing semiconductor market in the world, representing 29 percent (\$100 billion) of the \$335 billion global market in 2015⁵. In fact, China was the only growth region in sales for 2015, partially due to exchange rate fluctuations, with 7.7 percent growth from \$91.5 billion to \$98.6 billion.⁶

While growth in semiconductor exports to China has traditionally been propelled by consumer electronics assembled for export, China's domestic consumption represents an increasing share of China's semiconductor market. Domestic consumption is mainly being driven by data processing and communications applications sectors, with consumer electronics also being a significant contributor.⁷ Semiconductor demand growth is forecast to remain in the double digits for years to come. U.S. semiconductor companies have been successful in selling into the Chinese market, and 2015 was no exception. China's appetite for semiconductors is so great that domestic production only counts for 9 percent of consumption – leaving 91 percent of China's demand to be satisfied by imports,⁸ including 56.2 percent from the United States. Globally in 2015, U.S. companies represented 50 percent of total semiconductor sales, while Chinese companies only had 4 percent market share.⁹

Semiconductor Manufacturing Equipment

As mentioned above, China dropped from the third to fourth ranked market for U.S. semiconductor manufacturing equipment in 2015. ITA expects increased Chinese spending on semiconductor manufacturing equipment to equip and upgrade fabrication (fab) facilities. Total global sales of semiconductor manufacturing equipment in China reached \$4.9 billion in 2015 (13.4 percent of the \$36.5 billion world market), up 12 percent over 2014,¹⁰ and sales are forecast to grow another 8.5 percent in 2016.¹¹ Taiwan Semiconductor Manufacturing Corporation (TSMC), the largest foundry in the world, received approval from the Taiwanese government to build a fab in China.¹² Chinese chip-maker XMC is poised to start groundbreaking for a new NAND fab in Wuhan, and press reports indicate that Beijing NMC or Tsinghua Unigroup will build a memory fab in the Beijing area.

All of this fab building and other upgrades/equipment purchases will result in a significant uptick in Chinese purchases of semiconductor manufacturing equipment from 2016 to 2018. Fab construction spending in China is expected to slow down in 2017,¹³ which may result in a pause in the increase of semiconductor equipment spending in 2018 to 2019, but the general trend will still be upward. China also buys a significant amount of machinery for outsourced semiconductor assembly and test (OSAT). China represents 27 percent of the world's floor space for OSAT.¹⁴

Challenges and Barriers to U.S. Semiconductor and Related Equipment Exports

Semiconductors –China's IC Industry Development Plan

China's leadership views China's reliance on foreign semiconductors as a major national security concern. Because semiconductors are foundational to information and communications technologies, China's leadership views the industry as a cornerstone of China's goal of securing its ICT ecosystem and technologies of the future through indigenization of the ICT supply chain while concurrently transforming and upgrading China's economy. The Chinese government has begun implementing ambitious policies aimed at

supporting domestic semiconductor design and manufacturing in order to develop a globally competitive semiconductor industry by 2030. Potentially discriminatory policies implemented to support its industry to become self-sufficient pose a real long-term threat to not only U.S. firms but the entire global semiconductor ecosystem.¹⁵

China's government is committed to investing upwards of \$150 billion into the industry over the next decade through what is dubbed the "National IC Fund," with additional funding encouraged at the sub-central level by provincial and municipal governments, to develop a globally competitive domestic industry.¹⁶ The initiative also has strong support from China's senior government leadership.

Since announcement of its semiconductor industry development policies in June 2014, China's objective has come into focus. China's government aims to replicate, to the furthest extent possible, the semiconductor value chain within China to reduce its reliance on foreign chips while simultaneously strengthening its economy and moving up the value-chain. To accomplish this, China is aggressively targeting memory ICs and IC design as the first step toward its IC industry ambitions. China is deploying its strategy along three main paths: mergers and acquisition (M&A), market power and regulation.

The flurry of M&A and foreign talent recruitment by Chinese companies is expected to continue in 2016 and beyond. It is important to note here the disparity between the unprecedented M&A activity that is taking place in the global industry and the M&A strategy being undertaken by China's government. In the latter case, the proposed deals are not between two commercial businesses looking to save costs and leverage synergies, rather the Chinese government appears to be driven by a desire to acquire know-how in all segments of the semiconductor supply chain.

China is also keenly aware that foreign chip companies need continuous access to the biggest market for semiconductors. U.S. industry contends that as China develops its industry, it tilts the playing-field further in favor of domestic firms by actions such as dictating indigenous standards and imposing local-content requirements. Industry has also raised concerns about potentially discriminatory enforcement of China's Anti-Monopoly Law.¹⁷

Semiconductors – Counterfeit ICs

According to the Semiconductor Industry Association (SIA), counterfeit semiconductors cost the U.S. semiconductor industry an estimated \$7.5 billion per year, which translates into nearly 11,000 lost American jobs.¹⁸ Counterfeit semiconductors pose serious risks to global supply chains, public health and safety, and civilian and military infrastructure. They are a growing problem for the United States and many other countries, despite gradual improvements in IPR enforcement around the world. Often harvested from electronic waste (e-waste), most counterfeit semiconductors are e-waste components re-marked to indicate that they are new or that they perform to a higher standard.

Semiconductor companies and their authorized distributors, resellers and aftermarket distributors/manufacturers have extensive, proven controls to ensure products are properly manufactured, tested, handled and stored to prevent failures. Counterfeiters have few, if any, such controls. In addition, crude methods are often used to extract used semiconductors from discarded boards. These used counterfeit semiconductors are assembled into supposedly new equipment. The result is that, unlike legitimate semiconductors from authorized sources, counterfeits and other semiconductors available from unauthorized sources often have low quality and poor reliability. Often the equipment containing the counterfeit semiconductors will function for a while but prematurely fail before the end of the equipment's expected life cycle or perform below specifications. This is especially dangerous in detection, testing or monitoring electronics and similar products, as the buyer may have no warning that the product is not functioning properly.

In one illustrative case, used and re-marked semiconductors were sold by a Chinese firm as new, and they were installed into the de-icing modules for new reconnaissance aircraft. The problem was detected during a test flight. Luckily, most of the 300 counterfeit semiconductors had not been installed into the planes yet. Counterfeit semiconductors have also caused fires in residential vacuum cleaners, have caused an overvoltage condition for Automated External Defibrillators (AEDS), and have caused a failure of a power supply used for airport landing lights. According to an estimate by SMT

Corp., used and remarked semiconductors sold as new accounted for 80 to 90 percent of counterfeit parts in circulation.¹⁹

Many of these counterfeit semiconductors originate from China. There are also reports that unscrupulous actors within China are upgrading counterfeit capabilities by setting up fabs to produce new counterfeit semiconductors, representing a worrying escalation of counterfeiting capabilities.

There are some notable developments in anti-counterfeiting. In 2015, the U.S. Trade Facilitation and Trade Enforcement Act of 2015, Pub. L. No. 114-125, was enacted and includes a key provision to combat counterfeit merchandise by authorizing the U.S. Customs and Border Protection to share information and suspect counterfeits with rights holders. This will facilitate expeditious identification of counterfeit semiconductors. In March 2016, the JEDEC published a new standard identifying the best commercial practices for mitigating and/or avoiding counterfeit products by all manufacturers of electronic parts. The new standard applies to monolithic circuits, hybrid circuits and discrete semiconductor products.²⁰ In another development, in June 2014, a U.S. citizen pleaded guilty to trafficking counterfeit semiconductors from China, including selling them to contractors that were supplying them to the U.S. military for use in nuclear submarines.²¹ In April 2016, three Chinese nationals pleaded guilty to conspiring to buy top-end, military-spec chips from a U.S. Navy base and replace them with counterfeit chips.²²

Semiconductor Manufacturing Equipment-IC Development Fund

China produces a nominal amount of semiconductor manufacturing equipment, less than a 0.5 percent share of the world market.²³ Although no less than 60 percent of IC development program funds are earmarked for IC manufacturing, the remaining funds are earmarked to develop indigenous Chinese semiconductor manufacturing equipment, semiconductor materials, OSAT and other semiconductor related industries.

China's IC industry development program goals call for Chinese semiconductor manufacturing equipment to achieve production application for 65 to 45 nanometer critical equipment by 2015 (this

goal was not reached); for Chinese critical equipment and materials to be included in the international procurement system by 2020; and for China to be acknowledged and accepted as a global leader in all segments of the equipment supply chain by 2030.²⁴

Imports of semiconductor manufacturing equipment, however, are expected to see continued near-term growth, as foreign firms continue to build capacity in China and also as funds from China's National IC Fund are used to build and upgrade Chinese company fabs in China. Increased purchases of semiconductor manufacturing equipment supported by loans and subsidies could cause over-capacity, as the expected volume of follow-up equipment sales may not occur, since building a fab does not guarantee increased IC sales, and also could lead to a glut of used semiconductor manufacturing equipment on the market.

Semiconductor Manufacturing Equipment – IP Issues

The U.S. semiconductor manufacturing equipment industry reports some concern over protection of IPR in China. There also are reports of pressure on U.S. manufacturers to transfer proprietary information about semiconductor manufacturing equipment designs, especially for parts.²⁵ U.S. exhibitors at semiconductor manufacturing equipment trade shows in China and selling in China should follow best practices in protecting their IPR.

Opportunities for U.S. Companies

WTO Information Technology Agreement (ITA)

China is a participant in the WTO Information Technology Agreement (WTO ITA) and the expansion that goes into effect on July 1, 2016. China has the least ambitious tariff reduction schedule among all of the participants in the WTO ITA expansion. All tariffs on items covered under the WTO ITA expansion will be reduced to zero within seven years and most within five. See Appendix 1 for details.

Semiconductors

China accounts for over 50 percent of the world's electronics production and represents nearly one-third of the global market for semiconductors. Not all of the buying decisions for semiconductors are

made in China, however. The foreign companies that contract out electronic goods production to China often make such decisions. The supply chain is global and semiconductors in different stages of completion are transshipped and re-exported from numerous markets.

Domestic demand from China will also be a growing source of revenue for U.S. semiconductor manufacturers over the next few years, despite China's policies. ITA thus encourages U.S. companies to continue targeting Chinese consumer electronics, data processing and communications companies manufacturing in China. Lenovo and Huawei, for example, are among the top 10 buyers of semiconductors globally, and other Chinese companies, including ZTE, Datang Telecomm, Xiaomi and Haier, are also major purchasers.

Semiconductor Manufacturing Equipment

As stated earlier, overall sales of equipment in China grew by 12.2 percent in 2015 to \$4.9 billion, and China is expected to surpass Japan in 2016 with sales reaching \$5.4 billion.²⁶ If even some of the fab

building and upgrade projects reach fruition, China will probably surpass Japan again in 2017 and 2018. The National IC Industry Development plan creates opportunities but the projects funded may spur artificial demand for semiconductor manufacturing equipment. In addition, there are some IPR issues. Overall, the U.S. semiconductor manufacturing equipment industry enjoys good access to the Chinese market, but this could change if the approach becomes similar to that for semiconductors. In the case of semiconductor manufacturing equipment, however, there is only a small specialized market; and there are few companies left that are easy to acquire that are not niche product or trailing technology, so an aggressive acquisition strategy is unlikely to lead to China's goals. Overall, the market is open, but IPR and oversupply issues should be carefully monitored when selling in the market.

2017 Trade Shows/Events in China

March 2017: SEMICON China 2017, Shanghai, China

¹ Semiconductor Industry Blue Book December 2015 Administered by WSTS, Inc., Feb 1, 2016.

² "SEMI's 2015 Year –End Semiconductor Equipment Forecast Report" SEMI December 2015. ITA's rankings remove the U.S. from the rankings as it is the domestic market.

³ "China Business Report 2016" AmCham Shanghai

⁴ "Chips on their shoulders" The Economist, January 23, 2016

⁵ World Semiconductor Trade Statistics

⁶ WSTS World Semiconductor Trade Statistics

⁷ "China's impact on the semiconductor industry: 2015 update" PWC, Gartner

⁸ China News Daily (USA edition), October 7, 2014.

⁹ "SIA 2016 Factbook", Semiconductor Industry Association, March 2016.

¹⁰ "WWSEMS Report December 2015", SEMI, March 2016

¹¹ "SEMI's 2015 Year-End Semiconductor Equipment Forecast Report," SEMI, 12/2015

¹² "TSMC Gets Green Light to Build 12-inch Fab in China" The China Post 4/4/2016.

¹³ "Highlights of the February 2016 Edition of the Fab Databases" SEMI 3/14/2016.

¹⁴ A Decade of Unprecedented Growth: China's Impact on the Semiconductor Industry 2014 Update Price Waterhouse Coopers

¹⁵ "SIA 2016 Factbook" Semiconductor Industry Association, March 2016.

¹⁶ "From Catching Up to Forging Ahead" Dieter Ernst, East-West Center

¹⁷ "Xi Visit Highlights" Dieter Ernst, East-West Center

¹⁸ Oral Testimony of SIA President Brian Toohey during the Senate Armed Services Committee Hearing on Counterfeit Electronic Parts in the Department of Defense's Supply Chain, November 8, 2011.

¹⁹ "Senate Committee Considers Risk of Counterfeits" SIA Blog 4/27/2016

²⁰ http://cdn2.hubspot.net/hubfs/409470/documents/JESD243.pdf?t=1458138794014&utm_campaign=Member+Update&utm_source=hs_email&utm_medium=email&utm_content=27351848&hsenc=p2ANqtz-ywUz6e4OXncDznHFPom_SuGFNhpVpGrsXz0ughfxRHiKvRv-gRfb2Y9hLU-3EBs7mMiPS_6E_OkTYbXCV9LyOX5kmRA&hsmi=27351848

²¹ <https://www.justice.gov/opa/pr/massachusetts-man-pleads-guilty-importing-and-selling-counterfeit-intergrated-circuits-china>

²² <https://www.justice.gov/usao-ct/pr/citizen-china-pleads-guilty-trafficking-counterfeit-computer-chips>

²³ A Decade of Unprecedented Growth: China's Impact on the Semiconductor Industry 2014 Update Price Waterhouse Coopers

²⁴ A Decade of unprecedented Growth: China's Impact on the Semiconductor Industry 2014 Update Price Waterhouse Coopers

²⁵ "IP Challenges for the Semiconductor Equipment and Materials Industries", SEMI, June 2012 (updated 10/12)

²⁶ "SEMI's 2015 Year –End Semiconductor Equipment Forecast Report" SEMI December 2015