



2016 Top Markets Report **Semiconductors and Semiconductor Manufacturing Equipment** Sector Snapshot

Semiconductor Manufacturing Equipment

The U.S. is the leader in the semiconductor manufacturing equipment industry with 47 percent of the world market. Along with Japan and the Netherlands, the top three countries control over 90 percent of the \$37 billion market. Although there was a slight downturn in the industry in 2015 when calculated in dollars, if exchange rates had remained constant and on a unit basis, this is not the case. In 2016, the market is expected to enter another cyclical upturn to continue into 2017. The majority (over 90 percent) of semiconductor manufacturing equipment sales take place in the five country case study areas (China, the EU, Japan, Korea (South) and Taiwan) plus the United States.

Industry Overview

There are two main sub-sectors for semiconductor manufacturing equipment: front end equipment (includes crystal pulling and bare wafer manufacturing, reticle and mask manufacturing, and auxiliary fab equipment and accessories as well as wafer processing equipment), and semiconductor final assembly/packaging and test equipment, sometimes known as back end equipment. Fab building is now mostly for new technology fabs in established product areas by established companies, but there may be some new fabs at the 200 mm wafer level for IoT devices. China is an exception. Its IC Industry Development plan funds and the growing market itself are leading to planned fab building and equipment upgrades by both Chinese and foreign companies.

Most sales will be upgrades, after-sale parts and service, or sales of accessories and parts to other semiconductor manufacturing equipment companies to assemble into their equipment (especially in sales

to the Netherlands) or directly to semiconductor fabs (semiconductor manufacturing/fabrication facilities) that are established customers. Therefore, it is important for U.S. semiconductor manufacturing equipment suppliers to establish long-term relationships with their customers. Trade shows for the industry, which provide an important opportunity to showcase U.S. semiconductor

Figure 1: Semiconductor Manufacturing Equipment Market Rankings (Top 20)

1. Taiwan
2. South Korea
3. China
4. Japan
5. Singapore
6. Germany
7. Netherlands
8. Ireland
9. Malaysia
10. Israel
11. France
12. Austria
13. Belgium
14. Italy
15. United Kingdom
16. Mexico
17. Philippines
18. Russia
19. Thailand
20. Vietnam

manufacturing equipment to potential buyers, include the SEMICON shows, notably SEMICON Japan, a 2016 Department of Commerce certified trade show.

U.S. Semiconductor Manufacturing Equipment Export Base

Overview of Global Export Opportunities

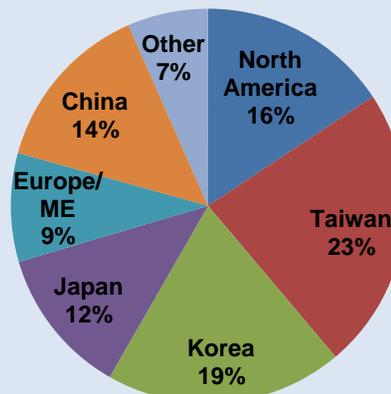
In 2016, 84 percent of worldwide sales of semiconductor manufacturing equipment are expected to be in five markets (Taiwan, Korea, China, Japan and the U.S./North America) creating a very concentrated market. Europe and the Middle East (primarily the EU and Israel) represent another 9 percent, and other markets (primarily Southeast Asia) account for the final 7 percent of the world market.¹ Worldwide sales in general track with U.S. exports, except in the case of Japan, a major competitor in semiconductor manufacturing equipment, and North America, which consists primarily of the United States market (which would be ranked fourth, after Taiwan, Korea and China). Mexico rounds out the top 10 when the EU is considered a single market, but to ITA's knowledge, the Mexico market is primarily for solar panel assembly equipment. There also is a subsidiary of Texas Instruments in Mexico dedicated to semiconductor final assembly/packaging and test.

The top U.S. export markets for semiconductor manufacturing equipment (China, the European Union, Japan, Korea and Taiwan) are highlighted in the country case studies. Other key markets and an overview of the markets are covered below:

Europe and Middle East

Many countries in Europe, especially EU Member States, have at least one semiconductor fab, and the EU countries make up the bulk of sales of semiconductor manufacturing equipment in the Europe and Middle East region. The only major market for semiconductor manufacturing equipment in the Middle East is Israel. U.S. exports of semiconductor manufacturing equipment to Israel were \$93 million in 2015, but the value oscillates annually, depending on Intel's investment. Intel is the largest fab operator in Israel by far, but there are also other fabs in Israel - notably those of Israel's foundry TowerJazz. The U.S. and Japan trade places,

Figure 2: Key Markets for Semiconductor Manufacturing Equipment, 2015 Sales, \$Millions



Source: SEMI, including estimates for growth 2015-2016

depending on the year, as the top source of import by Israel, but on the average over the last eight years the exports from the U.S. are higher in value.

Southeast Asia

The majority of the "other" market is Southeast Asian countries. It is difficult to find information on the Southeast Asian markets for semiconductor manufacturing equipment; therefore, only a short synopsis is possible. Singapore is slightly different than the other SE Asian markets, with some fabs belonging to major U.S. semiconductor companies (Globalfoundries, Micron, Avago/Broadcom) and other foreign companies (ST Micro, NXP/TSMC, UMC). In addition, Singapore companies are leaders in OSAT (Outsourced Semiconductor Assembly and Test). U.S. exports to Singapore of semiconductor manufacturing equipment were \$925 million in 2015.

Malaysia's top electronics industry is semiconductor production; however, it is primarily OSAT.² There are also around a dozen fabs located in Malaysia, most foreign-owned.³ Imports of all ICT products into Singapore are already duty-free. Malaysia is a participant in the WTO Information Technology Agreement (ITA) and WTO ITA expansion.⁴ For more information on the WTO ITA expansion, see the endnote and Appendix 1. The Philippines is also a WTO ITA expansion participant, and its imports of semiconductor manufacturing equipment are mostly semiconductor assembly and test equipment. U.S. exports of semiconductor manufacturing equipment

to Malaysia and the Philippines were \$167 and \$120 million, respectively, in 2015.⁵

- 2017 Trade Show for Southeast Asia:
SEMICON SEAsia April 25-27 2017, Penang
Malaysia

Competition

U.S. companies have 47 percent share of the world market,⁶ followed by Japan with a 30 percent share.⁷ Sales by ASML and ASMI, the two largest semiconductor manufacturing equipment companies in the Netherlands, give that country at least 17 percent share. According to estimates based on sales of integrated circuit manufacturing equipment, other players, including South Korea and Germany, have less than 3 percent share each, and China, Taiwan, Singapore and a few other, mostly European, countries have 0.5 percent share or less each.⁸

U.S. companies are also leaders in most semiconductor manufacturing equipment subsectors, except lithography – where Dutch and Japanese manufacturers are the leading global suppliers – and cleaning and drying equipment. There are U.S. suppliers in these subsectors as well (such as U.S. lithography equipment company Ultratech).⁹ U.S. companies are also known suppliers of parts and accessories to ASML (the Netherlands), the top supplier of lithography equipment. Eighty-two percent of U.S. semiconductor manufacturing equipment exports to the Netherlands are accessories and parts – far exceeding the 22 percent share for accessories and parts for U.S. exports to the world. This contributes to the Netherlands' place among the top 10 export markets (and ranking as the second largest European market). The Netherlands also has some semiconductor fabs, most owned by NXP (formerly Philips Semiconductor).¹⁰

Despite last year's proposed Applied Materials and Tokyo Electron merger, the two companies abandoned their plans when the companies were unable to resolve competitive concerns raised by the U.S. Department of Justice.¹¹ Instead, the merger of the year was Lam Research and KLA Tencor, two U.S. companies, one on the fab equipment side (Lam) and the other on the OSAT (inspection equipment) side (KLA), with both sides having virtually no overlap in product coverage. According to Gartner

Group, this will create the second-largest semiconductor manufacturing equipment company, after Applied Materials, giving the U.S. the top two slots based on sales (using 2015 and 2016 projections).¹² To ITA's knowledge, as of April 1, 2016, this deal is still undergoing regulatory review. ASML (the Netherlands), Tokyo Electron (Japan) and Screen Semiconductor (Japan, formerly Dai-Nippon Screen) are the third, fourth and fifth ranked semiconductor manufacturing equipment companies.¹³

The Semiconductor Equipment Export Opportunity in the Near Term

SEMICON Japan, for the third year in a row, will be a Department of Commerce certified trade show. Some SEMICON shows, including SEMICON Japan include an IoT (Internet of Things) pavilion featuring some semiconductor producers. See Japan case study for more information on this market.

The successful conclusion of the WTO ITA expansion negotiations represents increased opportunities for this industry, as the scope includes some semiconductor equipment and accessories that were not clearly included in the scope of the original WTO ITA.¹⁴ See endnote and Appendix 1 for more information.

Taiwan, Korea, the European Union, Japan and China will continue to be the principal export markets through 2016. Planned fab upgrades and new fab equipping will drive this growth. China has substantial plans for equipping fabs for 2016 through 2018. Europe and the Middle East are expected to have the fastest growth in 2016; see section on the EU for details. Intel is also expected to upgrade its fabs in Israel. Also, China is expected to pass Japan and become the third largest U.S. export market for semiconductor manufacturing equipment.

In the other market category, Singapore will continue to be the largest market, with sales continuing elsewhere in Southeast Asia as well. The Malaysian market is primarily semiconductor assembly and test equipment, as is Thailand's. Brazil's Six Semicondutores fab upgrade reported last year appears to have been equipped through the purchase of the former LFoundry Rousset fab (France), so that does not represent new sales opportunities.¹⁵

Up and coming Vietnam, currently representing only \$6 million in U.S. exports of semiconductor manufacturing equipment, is a participant in the original WTO ITA, so U.S. exports are duty free for most semiconductors and for most semiconductor manufacturing equipment. In Vietnam, preparation of the government-owned CNS/Saigon semiconductor fab proceeds, with groundbreaking expected in 2016. Equipment buys would occur in the next few years if preparations continue. There also is some OSAT business in Vietnam.¹⁶ Equipping the CNS fab would contribute to the expected jump in “other market” sales for 2016. This fab, however, will manufacture older technology semiconductors.

As a result, most of the purchases will be used equipment.¹⁷ Therefore, the best markets will continue to be the established ones – though there will be opportunities for some U.S. companies in Brazil and Vietnam.

Planning for the Long Term

Although two consortia-led fabs in India were mentioned in the previous year’s report, press reports in late April 2016 indicated that Indian partner Jaiprakash has dropped out of the Jaiprakash/IBM/Tower Semiconductors fab consortia,¹⁸ so the feasibility of that project is now uncertain. If the other consortia-owned fab (HSMC/STMicroelectronics/SilTerra) starts breaking ground, there may be sales of semiconductor manufacturing equipment in India in the future, but to ITA’s knowledge, site selection has not taken place, so the process is not proceeding in a timely fashion. This fab would start out with older technology, so there would not be new semiconductor manufacturing equipment sales at first. There are plans to upgrade in the future. A

third fab project was announced by U.S. startup Cricket Semiconductor to manufacture analog semiconductors in India, which appears likely to move forward.¹⁹ This project, however, probably will only require used, not new, semiconductor manufacturing equipment.

The top export markets rankings from 2015 and through 2018 in general are not expected to change, with the exception of China passing Japan again. Projections of sales of fab equipment show 13.2 percent growth in the world market from 2016 to 2017 (to an estimated \$42.8 billion), to be driven by equipment for foundries, and for memory (NAND flash and DRAM) and power semiconductor manufacturing.²⁰ China is expected to start or complete ten new fabs in 2016 to 2017, outstripping planned facilities in the U.S., Taiwan and Southeast Asia, with two new fabs each; and Japan, Korea, and Europe and the Middle East, with one each. All of these facilities, should construction proceed, will need equipping in the late 2016 to 2018 time-period.²¹

In the longer-term, Technavio predicts a CAGR of 4 percent for the industry until 2020²² (though the value will change from year to year). With the rise of IoT as an end application for semiconductors, there will be increased demand for legacy 200mm wafer equipment (300mm equipment will also remain in demand). It remains to be seen if the used equipment market can absorb this increased demand or if, contrary to previous years, new equipment for smaller wafers will need to be produced – and if it is needed, how it can be profitable. Innovative semiconductor packaging techniques for multilayer and small footprint ICs will also lead to sales of semiconductor final assembly/package and test equipment.

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- ¹ SEMI Worldwide Semiconductor Equipment Statistics, 2/2015 (subscription)
- ² Yearbook of World Electronics Data 2014, Volume 2 – America, Japan & Asia Pacific, [Reed Electronics Research](#)
- ³ World Fab Watch, SEMI 2/2016.
- ⁴ [WTO members conclude landmark \\$1.3 trillion IT trade deal](#) – Includes link to the parties’ national line schedules. [WTO](#), 12/16/2015. Also see Appendix 1.
- ⁵ Global Trade Atlas, Accessed 4/20/2016
- ⁶ SEMI Equipment Market Data Subscription 1/2015.
- ⁷ SEAJ – Semiconductor Equipment Association of Japan, Semiconductor Manufacturing Equipment book to bill 1/2015 Forecast. Yen to dollar rate from Federal Reserve System G.5A release
- ⁸ Based on VLSI Research, 12/2014
- ⁹ “Competitiveness of Semiconductor Equipment Industry by Country” source data KSIA. From “Promising Investment Opportunities – Semiconductors”, [Invest Korea](#), KOTRA 3/10/2014, Page 7
- ¹⁰ [World Fab Forecast](#), SEMI 11/2015.
- ¹¹ <https://www.justice.gov/opa/pr/applied-materials-inc-and-tokyo-electron-ltd-abandon-merger-plans-after-justice-departmen>
- ¹² “Lam Research, KLA-Tencor Merger Will Create New Equipment Market Giant”, [Gartner](#) 10/26/2015.
- ¹³ “The Semiconductor Equipment Market Will be Flat in 2015 – Maybe, Maybe Not” [Seeking Alpha](#) 11/16/2015.
- ¹⁴ [WTO members conclude landmark \\$1.3 trillion IT trade deal](#) – Includes link to the parties’ national line schedules. [WTO](#), 12/16/2015. Also see Appendix 1.
- ¹⁵ “Brazil Wins in LFoundryRousset Sell-off” [EETimes](#) 6/20/2014.
- ¹⁶ World Fab Watch, SEMI 2/2016.
- ¹⁷ SEMI World Fab Forecast Database
- ¹⁸ “Lead Partner Pulls Out of India Fab Plan” [EETimes](#) 4/21/2016.
- ¹⁹ “India’s First Analog Semiconductor Fab in Madhya Pradesh” [EE Hearld](#) 2/15/2015.
- ²⁰ “Highlights of the February 2016 Edition of the Fab Databases”, 3/16/2016.
- ²¹ “Equipment Spending Up: 19 New Fabs and Lines to Start Construction” [SEMI](#), 6/9/2016.
- ²² “Demand for Semiconductor ICs Fueling Global Wafer-level Manufacturing Equipment Market Through 2020”, [Solid-State Technology](#) 2/17/2016.