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TOKYO ELECTRON: the COMPETITIVE CONSOLIDATION AND ANTITRUST CHALLENGE[[1]](#endnote-1)

Wiboon Kittilaksanawong and Claire André wrote this case solely to provide material for class discussion. The authors do not intend to illustrate either effective or ineffective handling of a managerial situation. The authors may have disguised certain names and other identifying information to protect confidentiality.

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I’m not convinced but the conclusion has been made. I have no choice but to accept it. It’s a regrettable outcome. I feel that it’s a real shame.[[2]](#endnote-2)

Tetsuro Higashi, CEO of Tokyo Electron Limited

Tokyo Electron Limited (Tokyo Electron) announced a merger of equals with Applied Materials, Inc. (Applied Materials) on September 24, 2013. The deal would allow the combined entity to compete effectively in the highly competitive and consolidated global semiconductor manufacturing equipment (SME) industry. However, one and a half years later, after multiple delays in the approval from concerned governments in several countries, the deal was rejected due to antitrust issues, and both companies agreed to cancel the deal. Tokyo Electron probably suffered more from this failure, as Applied Materials had already sought new acquisitions or partnerships. Shortly after the cancellation, in October 2015, Lam Research Corporation (Lam Research) announced a merger with KLA-Tencor Corporation (KLA-Tencor). If this merger was approved, the SME market would be led only by Applied Materials, ASML Holding (ASML), and Lam Research/KLA-Tencor, while Tokyo Electron would be marginalized. Given the tremendous cost pressures from such consolidated competitors and powerful customers, should the company initiate another merger attempt? What kind of merger should be made? Were there other competitive options? Was its traditional Japanese style of business management an impediment to responding effectively to such a demanding and dynamic industry environment?

OVERVIEW OF the Semiconductor Manufacturing Equipment Industry

The SME industry referred to all the equipment and machinery used to produce semiconductor devices, including microprocessors and memory devices. Semiconductor equipment was classified into two main categories: front-end equipment and back-end equipment. The former included silicon wafers and wafer-processing equipment, while the latter included equipment for testing, assembling, and packaging. SME companies built machinery and equipment that the semiconductor industry would use to produce semiconductor devices. The SME industry itself did not directly produce semiconductor devices. The entire process for chip manufacturing took between six and eight weeks and was carried out in highly specialized locations, called fabs. These fabs were owned by semiconductor companies like Intel Corporation (Intel), an American multinational company, which had more than 12 fabs worldwide. There were four main stages of manufacturing, including wafer manufacturing, front-end production, wafer testing, and back-end production. Each stage involved process control and a yield management process.

Not only was this manufacturing process complex, it was also costly. The process costs varied from US$200,000[[3]](#endnote-3) to $50 million depending on the equipment.[[4]](#endnote-4) In the end, because of the numerous expensive devices that were required for it to function, a fab would usually cost around $3 billion to $5 billion.[[5]](#endnote-5) Samsung Electronics (Samsung) announced in May 2015 that it would build a new $14 billion fab in South Korea for 2017, the world’s most expensive fab at the time of the announcement.[[6]](#endnote-6) The costs of SME were expected to rise by 7 per cent to 10 per cent in the coming years, which would in turn increase the costs of building a new fab to $10 billion.[[7]](#endnote-7) Therefore, few companies would be able to build a new fab in the coming years, which also meant that semiconductor equipment companies would rarely be able to afford one.

The SME industry had always been characterized by its volatility because of technological change and intense competition. For example, in 2000, industry sales reached a new record of $47.7 billion but then plummeted to $28 billion the following year. The gap between the most profitable year (2000) and the least profitable year (2005) was greater than $35 billion (see Exhibit 1). Such high uncertainty was caused by the volatility of the consumer electronics market, which in turn had a large impact on the semiconductor industry. Therefore, the demand for SME was driven by the demand from the semiconductor industry, which itself depended on the consumer demand for electronic products (e.g., computers, tablets, and smartphones) that used semiconductors. Given that the life cycle for these products was rather short (e.g., 4.7 years for smartphones and 5.1 for tablets in 2014), it was necessary for SME players to constantly innovate to remain competitive in the market.

Customers and Competitors

The SME market was dominated by buyers from the United States, South Korea, and Japan. Intel led the market with revenue of $51 billion in 2014 (a 6 per cent increase compared to 2013), followed by Samsung (South Korea) with revenue of $37 billion (an 8 per cent increase), and Taiwan Semiconductor Manufacturing Company (TSMC) with revenue of $25 billion (a 28 per cent increase). The combined revenue of these three industry leaders was higher than that of their next ten competitors.[[8]](#endnote-8) The top 10 leading companies held 59 per cent of the market, but this number would tend to increase as the industry became more consolidated, with 23 mergers and acquisitions deals completed in 2015.[[9]](#endnote-9) These buyers looked for equipment that would combine technical performance, value, and durability. Given their net increase in revenue of over three times the revenue of SME firms, these buyers could put significant pressure on SME firms (see Exhibit 2).

The SME market was highly concentrated, with 85 per cent of its worldwide sales held by manufacturers in Taiwan, South Korea, China, Japan, and North America (see Exhibit 3). Europe and the Middle East represented only 6 per cent of total sales. In 2013, $23 billion or 70 per cent out of a total of $33 billion of industry sales was made by 10 companies, and the remaining 30 per cent was made by the top two, Applied Materials and ASML.[[10]](#endnote-10) Due to the length and complexity of the manufacturing process, and the cost of developing new equipment, SME companies tended to specialize in one portion of the manufacturing process. For example, ASML specialized in the lithography system and thus occupied 82 per cent of the upper-end lithography market share.[[11]](#endnote-11)

KEY players in the industry

Applied Materials

Applied Materials was an American company headquartered in the Silicon Valley, United States. In 2015, the company was the industry leader, with $9.7 billion in revenue, $1.5 billion in investment in research and development (R&D), more than 10,200 patents, and 14,000 employees in 18 countries. It operated in four segments including silicon systems, applied global services, display, and energy and environmental solutions. In 2014, the company derived 66 per cent of its revenues from silicon systems.[[12]](#endnote-12) Its major customers were Taiwan Semiconductor Manufacturing Company, Limited (TSMC), Samsung, and Intel. In 2015, Asia-Pacific, the United States, and Europe represented 71 per cent, 22 per cent, and 7 per cent of revenues, respectively.[[13]](#endnote-13)

ASML

ASML was a Dutch company headquartered in Veldhoven, the Netherlands. In 2015, it was ranked number two in the industry, with $6.3 billion in revenue, $1.1 billion in investment in R&D, more than 10,000 patents, and 11,000 employees in 16 countries. ASML was the world leader in lithography equipment. Its major customers, too, were TSMC, Samsung, and Intel. It sold products in Asia, the United States, and Europe, representing 84 per cent, 14 per cent, and 2 per cent of sales revenues, respectively.[[14]](#endnote-14)

Lam Research

Lam Research was an American company headquartered in California. In 2015, the company was ranked number four in the industry, with $5.9 billion in revenue, around 10,000 patents, and more than 6,300 employees in 16 countries. Lam Research’s revenues were derived largely from etching (conductor, dielectric, and silicon) and electrochemical deposition. Its main customers were located in Asia-Pacific and the United States, and the largest customers were Samsung and TSMC. The company sold its products in Asia, the United States, and Europe, representing 76 per cent, 18 per cent, and 6 per cent of sales revenues, respectively.[[15]](#endnote-15) In October 2015, Lam Research announced that it had bought KLA-Tencor, a U.S. semiconductor equipment company, for $10.6 billion. The deal was supposed to be completed in the summer of 2016. This merger would have a significant impact on the competition in the industry, as KLA-Tencor specialized in process control and yield management, which was a major part of semiconductor manufacturing.

KLA-Tencor

KLA-Tencor was an American company also headquartered in California. In 2015, the company was the fifth-largest player in the industry, with $2.8 billion in revenue, $500 million in investment in R&D, and 5,800 employees. KLA-Tencor’s revenue was largely based on process control and yield management, with three customers—Intel, Samsung, and TSMC—accounting for more than 10 per cent of total revenues. The company sold its products in Asia, the United States, and Europe, representing 60 per cent, 27 per cent, and 13 per cent of its sales revenues, respectively.[[16]](#endnote-16)

These four companies were considered to be the major players in this industry because they each had a market share of greater than 5 per cent (see Exhibit 4).

INDUSTRY Trends

Several important industry trends appeared to have a major impact on the industry; the first was an expected increase of 1.4 per cent in global sales for Semiconductor Equipment and Materials International (SEMI), a global trade association. SEMI also expected wafer fabrication equipment shipments to rise by 2.5 per cent in 2016.[[17]](#endnote-17) The most important factor that explained the SEMI forecast was the fact that demand for consumer electronics, which required semiconductors, was on an upswing. In the domain of the Internet of Things, the expected compound annual growth rate between 2014 and 2019 was 23 per cent, while it was 9 per cent for industrial applications and 10 per cent for the automotive industry.[[18]](#endnote-18) In 2020, there would be more than 50 billion of these devices on the market, accounting for more than six devices per person (see Exhibit 5).

However, an American research and advisory company, Gartner, Inc. (Gartner), expected that wafer fabrication equipment shipments would drop by 2.5 per cent in 2016 before following a growth trajectory in 2017.[[19]](#endnote-19) The discrepancy in the forecasts between the two was that SEMI expected that SME sales in Europe would increase by 63.1 per cent and increase in China by 9.1 per cent, as both regions were seeing an increase in investments from semiconductor companies. However, both SEMI and Gartner expected a decrease in equipment sales in Taiwan and South Korea, which were two key semiconductor manufacturing countries, accounting for 60 per cent of global SME sales in 2015.[[20]](#endnote-20) To summarize, if the Chinese market failed to perform and growth slackened in Taiwan and South Korea, then Gartner’s forecasts would most likely be right.

Finally, the consolidation of SME customers in 2015 and the coming years would likely lead to stronger buyer power, as these consumers would consolidate their revenues and margins. Obviously, this consolidation would lead to fierce competition. Because the forecasts were uncertain and the consumers were consolidating, the SME companies were advised to look toward mergers and acquisitions to consolidate and strengthen their competitive positions. Moreover, because of the industry’s high volatility, semiconductor companies were expected to compete in an increasingly complicated and difficult market.

Tokyo electron overview

History

Tokyo Electron was a Japanese company headquartered in Tokyo, Japan. The company was created in 1963 under the name Tokyo Electron Laboratories with a capitalization of ¥5 million.[[21]](#endnote-21) The company originally only imported and sold diffusion furnaces from Thermo Products Corp, a U.S.-based semiconductor manufacturer, but in 1968 both companies made a joint venture under the name TEL-Thermo and started to produce those same furnaces in Japan. Thus, from a trading company it became a manufacturing company. In the 1980s, the company was renamed Tokyo Electron Limited and started to expand its manufacturing with the production of in-circuit board testers, etch systems, and coater/developers. In 1990, it made a full-scale entry into the liquid-crystal display production equipment market.

Tokyo Electron made several acquisitions in the semiconductor equipment industry. The first acquisition was Timbre Technologies in 2001, an American company that specialized in the development of advanced software solutions for the semiconductor industry. Thanks to the acquired technologies and skills, the company could integrate the most advanced process controls and yield management technologies, which enabled it to develop next-generation wafer-processing equipment. The second acquisition was NEXX Systems in 2012, which specialized in the development of electrochemical deposition and physical vapour deposition systems. Both technologies were a key differentiating technology for wafer-level packaging, which was vital for the semiconductor industry as it allowed for the final chip to become significantly smaller. This technology was imperative for the continuously thinner and lighter smartphones that were predominant in the market.

In 2012, Tokyo Electron spent $280 million to acquire Oerlikon Solar, a Swiss company that specialized in thin-film silicon photovoltaic panel technologies.[[22]](#endnote-22) These technologies provided superior energy conversion efficiency and manufacturing cost advantages. By combining such technologies with TEL’s advanced technologies in the SEM business, TEL would be able to develop world-leading, more competitive devices. The company also wanted to establish the photovoltaic panel production equipment business as its new core business. Oerlikon Solar became a wholly owned subsidiary of Tokyo Electron under the name TEL Solar AG. However, this business was less thriving than expected, with TEL Solar AG achieving revenue of only $810,412 in 2013, and Tokyo Electron decided to divest it in January 2014.[[23]](#endnote-23)

Competitive Position

Tokyo Electron was one of the leaders in the industry, with $5.1 billion in sales in 2015 and $593 million in investments in R&D (see Exhibit 6). The company had 10,844 employees worldwide, of which 66 per cent were located in Japan.[[24]](#endnote-24) More than 94 per cent of its sales came from semiconductor production equipment.[[25]](#endnote-25) Coater/developers, plasma etch systems, thermal processing systems, single wafer deposition systems, cleaning systems, and wafer probers were among the major products and services in this segment. In essence, Tokyo Electron dealt almost exclusively in front-end manufacturing equipment. The company’s most profitable market was coater/developers, which occupied over 89 per cent of the market share and had little competition.[[26]](#endnote-26)

In 2015, Japan, the United States, Europe, and Asia contributed 15.5 per cent, 22 per cent, 10.2 per cent, and 52 per cent of the total sales, respectively (see Exhibit 7). Tokyo Electron’s main customers, TSMC, Samsung, and Intel, were the same as those of its major rivals. On the occasion of its 50th anniversary in 2013, Tokyo Electron defined a new corporate philosophy that articulated the purpose of its existence and mission in society: “We strive to contribute to the development of a dream-inspiring society through our leading-edge technologies and reliable service and support.”[[27]](#endnote-27)

ANNOUNCEMENT OF MERGER BETWEEN Tokyo Electron and Applied Materials

On September 24, 2013, Applied Materials and Tokyo Electron announced a merger of equals between the two companies, with a combined market capitalization of $29 billion. This announcement was one of the most important strategic moves in the industry. “It’s like a merger of Google and Microsoft,”[[28]](#endnote-28) said Dan Hutcheson, a semiconductor market analyst at VLSI Research. The new entity would hold 25 per cent of the industry’s market share. This move came as a surprise in the industry, as Tokyo Electron had a strong financial position in 2013.[[29]](#endnote-29) While some employees could exhibit resistance toward this deal, especially considering the cultural differences, the merger was completely approved by the boards of directors of both companies.[[30]](#endnote-30)

Indeed, while the situations of both companies were positive in 2013, their core customers, which were the same, had been increasingly pressuring them to reduce costs and also to invest more in R&D so as to develop more complex and modern equipment.[[31]](#endnote-31) Moreover, while both companies seemed to sell similar types of products, they actually specialized in different stages in the semiconductor manufacturing process. In particular, Tokyo Electron specialized in thermal oxidation, lithography (photoresist), etching (oxide), and wafer testing. Applied Materials, however, specialized in depositions (physical vapour deposition and chemical vapour deposition), chemical mechanical planarization, and etching (metals) (see Exhibit 8).

This new merger would allow both companies to gain synergies from their operational activities and products, while leaving extra capital available for R&D investments.[[32]](#endnote-32) Facing cost pressures from customers, mergers were one of the growth strategies for a large electronic company like Applied Materials to increase its revenues more quickly, while preserving its profit margins. Developing new products was expensive in this industry (e.g., over $100 million for developing the product alone without selling it). So, it was simpler for a company to buy another one and integrate its existing technological know-how and products.

After the merger, Tetsuro Higashi, chief executive officer (CEO) of Tokyo Electron, and Gary Dickerson, CEO of Applied Materials, would become the chairman and the CEO, respectively, of the new entity. The new entity would be called Eteris and would be based in the Netherlands. The Netherlands was selected due to tax advantages (e.g., the tax rate during 2013 was 17 per cent versus 22 per cent in the United States), and also because it represented a middle ground for both companies. The CEOs of both companies expected that the deal would achieve $250 million in cost savings by the first fiscal year and a total of $500 million by the third fiscal year.[[33]](#endnote-33) Once the merger deal was announced, the shares of Tokyo Electron and Applied Materials rose by 14 per cent and 9.1 per cent, respectively.

While both companies acknowledged that the deal was a merger of equals, shareholders of Applied Materials would own 68 per cent of the total shares of the new company. Rather than a merger of equals, this deal could be seen as an acquisition of Tokyo Electron by Applied Materials. Hence, it was possible that some employees at Tokyo Electron were afraid of losing their autonomy and culture.

Antitrust Issues

Given that the merger deal would result in the new entity controlling 25 per cent of the global market share of the industry, there was a possibility that both merging parties could be exposed to antitrust issues.[[34]](#endnote-34) Jim Cramer, a financial analyst from the U.S. business and financial TV channel CNBC, stated: “It’s all about antitrust. This deal will not go through. It will absolutely not go through.”[[35]](#endnote-35) However, Ben Pang, an investment bank analyst at Northland Capital, thought that, “In each of the segments that they compete in, there is absolutely another competitor right now,”[[36]](#endnote-36) and thus there would be no reason for the antitrust regulations to forbid the deal. Therefore, at the time of the announcement, whether this deal would be rejected due to the antitrust was still inconclusive.

The antitrust concerns for this merger deal were valid for several reasons. First, some products of the two companies were indeed overlapping. The etching process would be the most problematic, as both companies had products made through this process but for different types of materials (e.g., oxide for Tokyo Electron and metals for Applied Materials). However, such an overlap would not create a monopoly in the etching process, as Lam Research would still be the number-one player, even after the merger between Tokyo Electron and Applied Materials.

Second, the U.S. antitrust regulator had a history of not approving large mergers. For example, in 2015, the U.S. Department of Justice refused the mergers between Comcast and Time Warner Cable,[[37]](#endnote-37) and between Sysco and US Foods.[[38]](#endnote-38) In all these cases, the U.S. Department of Justice invoked the protection of U.S. customers against the monopoly of companies in the merger deal. From the regulator’s perspective, there was also the risk that once the merger was done, the new company would decrease its innovation efforts, thereby developing fewer new products, as it would not have much pressure from the competition. In the end, both semiconductors companies and end customers would suffer from the lack of innovation. However, both Applied Materials and Tokyo Electron had rejected the likelihood of this innovation risk.[[39]](#endnote-39)

For the deal to be complete, both companies would have to gain regulatory approval from eight countries: the United States, Japan, China, South Korea, Germany, Taiwan, Singapore, and Israel. In December 2014, Tokyo Electron announced that the date for completion of the merger had to be postponed from December 30, 2014 to March 24, 2015.[[40]](#endnote-40) The date had already been delayed once from September 24, 2014 to December 30, 2014.[[41]](#endnote-41) As of the time of the announcement of March 24, 2015, only Israel and Singapore had approved the merger of the two companies.[[42]](#endnote-42) The antitrust regulations of several countries, such as China, Japan, and the United States, had been taking a longer time to review than expected.

At the time, both Tokyo Electron and Applied Materials had acknowledged that the main opposition came from the Japanese and U.S. antitrust regulators. They concurred that Tokyo Electron and Applied Materials had to divest a number of overlapping product lines. But, the most critical point in the regulators’ opinion was whether the divestitures that both companies were ready to pursue would be sufficient to tilt the balance in their favour. As of 2013, both companies had only been required to divest assets worth $600 million to secure antitrust approval.[[43]](#endnote-43)

Mark Ostrau, Fenwick & West LLP co-chairman, explained:

In such multiproduct situations, there’s often general consensus on the problem products and the safe products, but then there’s a gray area of products in the middle that the companies either have to convince the agencies are not a source of concern or have to dig deeper into the deal value and provide a fix to address [those] as well.[[44]](#endnote-44)

While both companies had not thought the antitrust issue would present a real threat, the international regulators might not think in the same way.

On April 27, 2015, over 18 months after the merger was first announced, Applied Materials eventually admitted that the deal had not gone through because of regulatory concerns. In particular, the U.S. Department of Justice had declared that the companies’ proposals and divestiture attempts were not sufficient to supersede the antitrust concerns.[[45]](#endnote-45) However, the merger between the two companies might be executed, but the new entity of Eteris would not be able to sell its products on U.S. territory. This restriction was unimaginable, given that one of the firms’ biggest customers, Intel, was located in the United States. The merger deal was hence cancelled. In fact, the deal was cancelled likely not only due to the antitrust concerns per se, but also because semiconductor companies like Intel and Samsung opposed the deal and proposed reasons for the rejection to the U.S. Department of Justice.[[46]](#endnote-46)

For Tokyo Electron, this failed merger was a tough blow, as the company had invested more than ¥10 billion in this strategic move with a lot of hope. As CEO Higashi said, “I’m not convinced but the conclusion has been made. I have no choice but to accept it. It’s a regrettable outcome. I feel that it’s a real shame.”[[47]](#endnote-47)

Aftermath

Many analysts believed that between the two companies, Tokyo Electron probably suffered more from the cancellation of the deal as Applied Materials had already looked ahead and sought new acquisitions or partnerships. “Now Tokyo Electron has to find a way to go it alone. If it doesn’t, we can expect the shares to fall,” said Mitsushige Akino, executive officer of Ichiyoshi Asset Management Co., Ltd.[[48]](#endnote-48) To add to such a difficult situation, Tokyo Electron was facing increasingly high costs, because of customer demand for next-generation equipment.

In October 2015, Lam Research announced a merger with KLA-Tencor. If the merger was to go through, then the semiconductor equipment market would be led by three major companies: Applied Materials, ASML, and Lam Research/KLA-Tencor, with each company holding around a 15 per cent market share.[[49]](#endnote-49) Tokyo Electron would fall behind, with only a 9 per cent market share (see Exhibit 4). The company was likely to be left behind in the semiconductor industry, where consolidation was a key driver of competitiveness.

Importantly, the threat from customers was still strong as Intel, Samsung, and TSMC bought 60 per cent of chip-making equipment and thus had a lot of bargaining power over their suppliers.[[50]](#endnote-50) Such a threat was imminent as Intel announced in July 2015 that it intended to spend only $7.7 billion on equipment for the year 2015, 11.5 per cent less than $8.7 billion, which was announced in April 2015, and 23 per cent less than $10 billion, which was projected in January 2015.[[51]](#endnote-51) These numbers were unlikely to change in a positive direction due to the expected slowdown in personal computer sales in the coming years.[[52]](#endnote-52)

“We would like to make a fresh departure as a new Tokyo Electron,” said the Tokyo Electron CEO in June 2015.[[53]](#endnote-53) Indeed, the future was not all bad for the company, as its financial position was still strong in 2015. Sales had reached ¥613 billion in 2015 (a 23 per cent increase compared to 2013), and even the operating profit had increased by 173 per cent from 2014 so as to reach ¥88 billion. While sales had indeed decreased in Japan in 2015 (a downward trend since 2011), they were compensated for by an increase in both Europe and the United States (see Exhibit 6).

Tokyo Electron had some of the most reliable and efficient products available on the market. However, some of its customers had complained that the company was not sufficiently proactive toward them, contrary to Applied Materials, which was praised for its good customer service.[[54]](#endnote-54) Because of a traditional silo organization with a bureaucratic and long decision-making process—characteristics of most Japanese organizations—it was possible the company could lose its customers to more aggressive competitors. Losing one major customer might mean losing around 10 per cent of the total sales, and meanwhile the cost of production was expected to rise in the near future.[[55]](#endnote-55) In this volatile industry, to be sustainable, the company needed to maintain a profit margin at over 15 per cent.[[56]](#endnote-56) For Tokyo Electron, the most important thing seemed to be how the company could become a customer-oriented rather than a product-oriented company.

It was indeed a challenging situation for Tokyo Electron in the global semiconductor industry. Externally, there were not many strategies for surviving and growing besides consolidating with its competitors and competing fiercely based on costs and probably innovations. The company could try to initiate another merger deal, but again, it might not succeed due to the same antitrust reasons as in its first attempt. Tokyo Electron possibly had to look for a different strategy to successfully compete in this highly consolidated industry. Internally, the CEO would need to consider reorganizing the company in order to make it more customer-centric and more responsive to such a demanding and dynamic industry environment.

Exhibit 1: Semiconductor equipment billings (2000–2015)

Source: Created by the case authors based on “Semiconductor Equipment Back on Track,” SC-IQ: Semiconductor Intelligence, December 19, 2013, accessed December 3, 2016, www.semiconductorintelligence.com/semiconductor-equipment-back-on-track.

Exhibit 2: Revenue comparison between Semiconductor Companies and Equipment and Material companies

Source: Created by the case authors based on Lara Chamness, “2011: A Look Back at the Semiconductor Equipment and Materials Market and Outlook,” Semiconductor Manufacturing & Design, accessed December 3, 2016, http://semimd.com/semi/2012/04/08/2011-a-look-back-at-the-semiconductor-equipment-and-materials-market-and-outlook.

Exhibit 3: Semiconductor equipment sales forecast by region (Us$ billions)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **2012** | **2013** | **2014** | **2015** | **2016F** |
| **China** | 2.50 | 3.38 | 4.37 | 4.88 | 5.32 |
| **Europe** | 5.55 | 1.92 | 2.38 | 2.07 | 3.37 |
| **Japan** | 3.42 | 3.38 | 4.18 | 5.55 | 4.58 |
| **Korea** | 8.67 | 5.22 | 6.84 | 8.08 | 7.36 |
| **North America** | 8.15 | 5.27 | 8.16 | 5.59 | 5.93 |
| **Taiwan** | 9.53 | 10.57 | 9.41 | 9.14 | 8.76 |
| **Rest of the World** | 2.10 | 2.08 | 2.15 | 1.99 | 2.50 |

Source: Created by the case authors based on “Semiconductor Equipment Sales Forecast: $37 Billion in 2015 and $38 Billion in 2016,” SEMI, December 15, 2015, accessed December 3, 2016, www.semi.org/en/node/60181.

Exhibit 4: Revenue of major SME players (US$ Millions)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Rank | Company | Company Specialization | 2013 Revenue (US$ Millions) | 2013 Market Share (%) | 2012–2013  Growth (%) |
| 1 | Applied Materials Inc. | Chemical mechanical planarization | 5,460.1 | 16.2 | −1.0 |
| 2 | ASML Holding | Lithography | 5,302.8 | 15.7 | 8.5 |
| 3 | Lam Research Corporation | Etching | 3,163.4 | 9.4 | 12.7 |
| 4 | Tokyo Electron Ltd. | Etching & thermal oxidation | 3,057.1 | 9.1 | −27.5 |
| 5 | KLA-Tencor Corporation | Process control & yield management | 2,163.4 | 6.4 | −12.2 |
| 6 | Dainippon Screen Manufacturing | Process control & yield management | 1,222.7 | 3.6 | −17.6 |
| 7 | Hitachi High-Technologies | Etching, process control, & yield management | 862.0 | 2.6 | −24.2 |
| 8 | Advantest Corporation | Process control & yield management | 844.8 | 2.5 | −40.6 |
| 9 | Teradyne | Process control & yield management | 822.0 | 2.4 | −10.4 |
| 10 | Nikon Corporation | Lithography | 636.3 | 1.9 | −36.8 |
|  | Others |  | 10,243.5 | 30.3 | −16.7 |
|  |  | Total market | 33,778.0 | 100.0 | −11.5 |

Source: Created by the case authors based on Gina Roos, “Semiconductor Spending Fell 12%,” EPS News, April 8, 2014, accessed December 3, 2016, https://epsnews.com/2014/04/08/semiconductor-equipment-spending-fell-12.

Exhibit 5: Expected forecast of the Internet of Things

Source: Created by the case authors based on Julianne Twining, “Behind the Numbers: Growth in the Internet of Things,” Platform: Technology, TV & the Future, March 20, 2015, accessed December 3, 2016, https://www.ncta.com/platform/broadband-internet/behind-the-numbers-growth-in-the-internet-of-things; Dave Evans, “The Internet of Things: How the Next Evolution of the Internet Is Changing Everything,” Cisco: White Paper, April 2011, accessed December 3, 2016, www.cisco.com/c/dam/en\_us/about/ac79/docs/innov/IoT\_IBSG\_0411FINAL.pdf.

Exhibit 6: Tokyo Electron financial highlights

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Thousands of  U.S. Dollars | Millions of Japanese Yen | | |
|  | **2015** | **2015** | **2014** | **2013** |
| Net sales | 5,102,147 | 613,125 | 612,170 | 497,300 |
| Semiconductor production equipment | 4,795,223 | 576,242 | 478,842 | 392,027 |
| FPD production equipment | 272,198 | 32,710 | 28,317 | 20,077 |
| PV production equipment | 30,107 | 3,618 | 3,806 | 83 |
| Electronic components and computer networks |  |  | 100,726 | 84,665 |
| Other | 4,619 | 555 | 479 | 448 |
| Operating income (loss) | 733,236 | 88,113 | 32,205 | 12,549 |
| Income (loss) before income taxes and minority interests | 722,543 | 88,828 | −11,756 | 17,767 |
| Net income (loss) | 598,219 | 71,888 | −19,409 | 6,076 |
| Comprehensive income (loss) | 668,178 | 80,295 | −10,889 | 15,826 |
| Domestic sales | 790,930 | 95,046 | 161,631 | 118,504 |
| Overseas sales | 4,311,217 | 518,079 | 450,539 | 378,796 |
| Depreciation and amortization | 173,737 | 20,878 | 24,888 | 26,631 |
| Capital expenditures | 109,711 | 13,184 | 12,799 | 21,774 |
| R&D expenses | 593,742 | 71,350 | 78,664 | 73,249 |
| Total assets | 7,290,955 | 876,154 | 828,592 | 775,528 |
| Total net assets (total shareholders’ equity) | 5,335,456 | 641,163 | 590,614 | 605,127 |
| Number of employees |  | 10,844 | 12,304 | 12,201 |
| Number of shares outstanding (thousands) |  | 180,611 | 180,611 | 180,611 |
| Number of shareholders |  | 20,829 | 30,563 | 41,287 |
| Return on equity |  | 11.8 | −3.3 | 1.0 |
| Operating margin |  | 14.4 | 5.3 | 2.5 |
| Equity ratio |  | 73.0 | 69.8 | 76.5 |
| Asset turnover (times) |  | 0.72 | 0.76 | 0.64 |
| Net sales per employee | 470,500 | 56,540 | 49,754 | 40,759 |

Note: FPD = Flat Panel Display; PV = Photovoltaic Panel

Source: Created by the case authors based on Tokyo Electron, *2015: Factbook*, March. 31, 2015, accessed December 3, 2016, www.tel.com/ir/library/fb/document/fb2015.pdf.

Exhibit 7: Tokyo Electron consolidated sales by region

Note: JPY = Japanese Yen

Source: Created by the case authors based on Tokyo Electron, *2015: Factbook*, March 31, 2015, accessed December 3, 2016, [www.tel.com/ir/library/fb/document/fb2015.pdf](http://www.tel.com/ir/library/fb/document/fb2015.pdf).

Exhibit 8: Combined Portfolio of Applied Materials and Tokyo Electron

|  |  |  |  |
| --- | --- | --- | --- |
| High-Speed,  Low-Leakage  Transistors | Low-Resistance and Reliable Interconnect | 3D NAND  Memory | Low-Cost Scaling Enabled by Patterning |
| * AnnealT * CMPT * CVDT * EpiT * FurnaceA * ImplantT * PVDT * TrackA * Wet CleanA | * CMPT * CVDT * Dielectric EtchA * PVDT * Wet CleanA * Spin-on DielectricA | * ALDA * CMPT * Conductor EtchT * Dielectric EtchA * CVDT * FurnaceA * Selective MaterialRemovalT * Wet CleanA * Gas Chemical EtchA | * ALDA * BrightfieldT InspectionT * CVDT * Defect ReviewT * Dielectric EtchA * TrackA * Wet CleanA |

Note: T = Activities carried out by Tokyo Electron; A = Activities carried out by Applied Materials; CMP = chemical mechanical polish; CVD = chemical vapour deposition; PVD = physical vapour deposition; ALD = atomic layer deposition

Source: Created by the case authors based on Anne Shields, “Why Applied Materials Considered Acquisition of Tokyo Electron,” Market Realist, January 12, 2015, accessed January 26, 2017, [http://marketrealist.com/2015/01/applied-materials-considered-acquisition-tokyo-electron](http://marketrealist.com/2015/01/applied-materials-considered-acquisition-tokyo-electron/).

Endnotes

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