

Leading Players in the Supply Chain of Japan Semiconductor Industry (Part 1)

In the mid-1980s, Japanese companies such as Sony, NEC, Hitachi, Toshiba, Mitsubishi Electric Corporation and Fujitsu emerged as dominant players in the semiconductor industry, covering everything from chip design, chipmaking, semiconductor materials, chip manufacturing equipment, assembly, test and packaging. At that time, they surpassed US companies and came to control approximately 50% of the global semiconductor market.

However, Japan's rapid rise and dominance in the semiconductor market generated tensions with the U.S. government, forcing Japan to negotiate a semiconductor trade agreement to increase U.S. access to the Japanese semiconductor market and control Japanese exports to the United States.

The semiconductor agreement, coupled with the appreciation of the Japanese currency, the entry of new and cheaper competitors such as South Korea and Taiwan, and the slow adaptation of Japanese companies to changes in the global semiconductor production structure led Japan's global market share to drop from over 50% in 1988 to below 10% today. Yet, Japan managed to maintain its global leadership in the production of certain chips, semiconductor materials and equipment for chip manufacturing.

In this regard, the Center for International and Strategic Studies highlights that Japan continues to be one of the world's semiconductor leaders in memory chips, especially NAND, sensors such as complementary metal-oxide semiconductor (CMOS) image sensors, and power semiconductors. In addition, Japan accounts for 35 percent of global semiconductor manufacturing equipment and roughly half of the semiconductor materials supply, including wafer production and advanced immersion lithography, which is crucial to print the tiny circuits on wafer.

Let's take a closer look at the areas where Japan excels in the semiconductor supply chain and the leading companies in these areas.

Memory chips: Kioxia, former Toshiba Memory Corporation, is the world's third-largest manufacturer of NAND flash memory used for data storage. 56% of the company is owned by a special purpose company formed by Bain Capital (US) and SK Hynix (South Korea), while Toshiba has a 41% stake. NAND flash memory is used in a myriad of computing devices, including data centers, smartphones, tablets, computers, among others.

Power Semiconductors: Power semiconductors are crucial components used in the control and conversion of electrical power in a variety of applications, from consumer electronics to industrial automation, electric vehicles and renewable energy systems. These chips are designed to handle high voltages and currents, making them essential for efficient power management. In 2022, Mitsubishi Electric, Fuji Electric, Toshiba, Renesas Electronic Corp. and Rohm Semiconductor held a combined 21% of the global market share.

Image Sensors: The leading Japanese company producing Complementary Metal-Oxide-Semiconductor (CMOS) image sensors is Sony Group Corporation. Sony has a significant market

presence and has been consistently leading the global CMOS image sensor market. CMOS sensors convert light captured by camera lenses into electrical signals. As of 2023, Sony holds the largest share of the CMOS image sensor market, commanding approximately 51.6% of the market. Image sensors are used in a variety of devices and machines such as smartphones, cars, security and surveillance devices, medical devices, industrial inspection and automation for precise and reliable imaging.

Semiconductor Manufacturing Equipment

As for semiconductor manufacturing equipment, Japan holds around 35% of the global share, making it the second largest in the world, after the United States. This segment of the semiconductor industry refers to the machinery and tools used in the production of chips. This equipment is involved in various stages of semiconductor fabrication such as:

1. **Wafer Processing:** Equipment used for the initial stages of semiconductor manufacturing, where raw silicon wafers are prepared and processed.
2. **Photolithography:** Machines that transfer intricate circuit patterns onto the silicon wafer using light, masks, and photoresist materials. This is a critical step in defining the various layers of semiconductor devices.
3. **Deposition:** Equipment that deposits thin films of materials onto the wafer surface through processes like Chemical Vapor Deposition (CVD) and Physical Vapor Deposition (PVD).
4. **Etching:** Tools that remove selected portions of material from the wafer to create the desired pattern. This can be done using wet etching (chemical solutions) or dry etching (plasma).
5. **Chemical Mechanical Planarization (CMP):** Equipment that smooths and flattens the wafer surface by combining chemical and mechanical forces.
6. **Inspection and Metrology:** Tools used to inspect and measure the wafers and patterns to ensure precision and quality at various stages of the manufacturing process.
7. **Packaging and Testing:** Equipment used for assembling the final semiconductor devices into packages and testing their functionality and performance.

Leading Companies in Semiconductor Manufacturing Equipment

Japan is home to several leading companies that specialize in the manufacture of semiconductor-making equipment. Here are some of the key Japanese companies in this field:

Tokyo Electron Limited (TEL)

Tokyo Electron Limited is the world's third-largest supplier of semiconductor manufacturing tools after Applied Materials (US) and ASML Holdings (Netherlands), and holds a substantial market share in various segments, including deposition, lithography, etching, cleaning, testing and bonding/debonding equipment. TEL is particularly dominant in the market for in-line

coaters/developers for extreme ultraviolet (EUV) lithography, holding nearly 100% of this niche market. It also controls roughly 90% of the market for tools which apply photoresist coating—a light-sensitive chemical applied to a semiconductor wafer in the manufacturing process.

Advantest Corporation

Advantest is a leading provider of automated test equipment (ATE) for the semiconductor industry, commanding a global market share of over 50%. Advantest's ATE includes the testing of integrated circuits (ICs), memory chips, logic devices, and system-on-chip (SoC) devices. The company is a major player in the global test equipment market, essential for ensuring the quality and performance of semiconductor devices.

Screen Holdings Co., Ltd.

Screen is the world's largest manufacturer of equipment used to clean silicon wafers. Screen Holdings is prominent in the semiconductor cleaning and resist processing equipment markets. They hold a significant share in these segments, providing critical tools for maintaining wafer cleanliness and precision during the fabrication process.

Lasertec Corporation

Lasertec is the world's only maker of semiconductor inspection equipment using extreme ultraviolet mask lithography technology. It holds a significant market share in the global market for semiconductor inspection equipment, which include photomask inspection systems, wafer inspection systems, and defect review systems. These tools are crucial for ensuring the quality and reliability of semiconductor devices. Its cutting-edge EUV mask inspection systems are essential for the production of advanced semiconductor nodes. The company's technology helps identify defects at very small scales, contributing to the overall improvement of semiconductor manufacturing processes.

Canon Inc.

Canon plays a significant role in the semiconductor equipment industry as it provides advanced photolithography equipment, particularly immersion lithography systems, using deep ultraviolet light (DUV), which are critical for creating fine patterns on silicon wafers. DUV is the second-most advanced system to create the minute circuitry of chips after extreme ultraviolet (EUV) machines. Canon holds the second place in global sales of lithography equipment with around 30% after the dutch company ASML. Canon has also developed a new generation of lithographic equipment called nanoimprint lithography (NIL), capable of producing 5 nanometers chips. Unlike traditional photolithography, which uses light to transfer and print patterns on wafers, NIL uses a physical mold to imprint patterns directly onto the material.

Nikon Corporation

In addition to optical products like cameras and microscopes, Nikon also manufactures semiconductor production equipment. A competitor of Canon, Nikon is also a leading producer of deep ultraviolet (DUV) lithography machines, holding a 7% share of the global market for this segment.

Disco Corporation

Disco Corporation specializes in the manufacturing of precision cutting and grinding tools used in semiconductor fabrication. These tools includes dicing saws, grinders, polishers, and laser saws, which are essential for wafer processing, including cutting and thinning wafers to the required dimensions. Disco is recognized for holding a dominant position in this segment, reflecting its critical role in the semiconductor manufacturing process.

Ebara Corporation

Ebara Corporation is a leading global supplier of Chemical Mechanical Polishing (CMP) systems and electroplating systems. CMP technology is crucial for planarizing semiconductor wafers during the manufacturing process while electroplating systems are essential for depositing metal layers on semiconductor wafers. These systems support the production of advanced semiconductor devices. Ebara is considered a top player alongside companies like Applied Materials and Lam Research.

This quick review shows that Japanese companies plays an essential role in the global semiconductor supply chain, enabling the production of advanced semiconductor devices used in various applications, from consumer electronics to high-performance computing.

The next instalment of the Japan semiconductor supply chain will review the main Japanese companies in the production of semiconductor materials.

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Note

My opinion articles are food for thought and are intended for family, friends, acquaintances, and citizens, with the aim of reflecting and stimulating discussion on current issues.

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