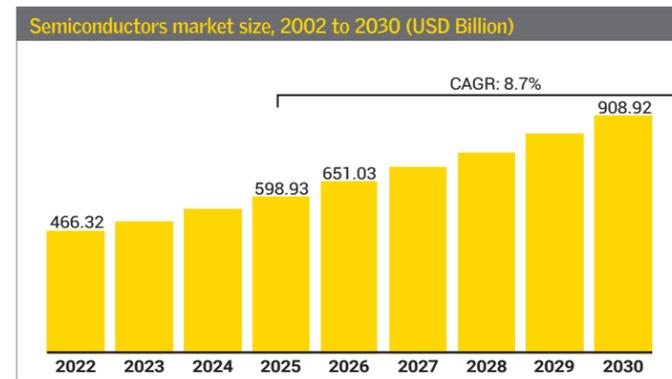


Japan's evolving role in semiconductors and electronics

As demands from the semiconductor and electronics industries become increasingly complex, Japan's equipment and material manufacturers are on hand to provide market-leading solutions.



Source: Vantage Market Research

With the emergence of new technologies such as AI, VR, Big Data, the Internet of Things, electric and autonomous vehicles, and 5G/6G internet, demand for semiconductors continues to grow at a rapid pace. Indeed, it is thanks to the rapid advancement of semiconductors, the building blocks of our digital world, that such technologies have been able to flourish. And as chips have become increasingly faster and smaller, the materials and techniques used to develop them must constantly evolve.

"This rapid advancement in semiconductor technology is driving various applications, including the rising popularity of generative AI, and the development of virtual reality and autonomous driving systems. Such innovations would not be possible without continuous improvements in the semiconductor industry, making it the driving force behind numerous technological breakthroughs," highlights Toshiki Kawai, Representative Director, President and CEO of Tokyo Electron (TEL).

While Japan is no longer the dominant player in global semiconductor production, Japanese companies still lead the world when it comes to the materials and manufacturing equipment used to make chips. As such, they are well placed to support the demand for ever-smaller and higher-performing semiconductors. One of Japan's leading players, TEL, which produces equipment for the production of cutting-edge semiconductor devices and flat panel displays, is doing just that, investing heavily in R&D to ensure its processing equipment is top of its field.

"The semiconductor market reached USD 574 billion in the 2022 fiscal year, and it is projected to skyrocket to over USD 1 trillion by 2030 (Source: 2022 (WSTS)/ 2030 (IBS, August 2023)), nearly doubling its size," says Mr. Kawai. "Global data traffic is expected to have an average compound annual growth rate (CAGR) of 26% (Source: Omdia (1990-2030)), growing tenfold in a decade. The future will also see an increase in bit-based computing, alongside quantum computing, and neural network-based computer processing is anticipated."

"While some argue that we have entered the Big Data era, we believe we are only on the cusp," he

adds. "Consequently, there will be a rising demand for advanced semiconductor technologies. Currently, Tokyo Electron holds about 22,000 patents for semiconductor production equipment, making us the industry leader. To strengthen our position further, we continue to invest significantly in R&D, having already invested JPY 600 billion between FY2018 and FY2022, with plans to invest over JPY 1 trillion between FY2023 and FY2027. These investments have resulted in groundbreaking achievements, such as etching process equipment capable of reaching a depth of 10 microns two and a half times faster than previous capabilities while consuming over 40% less power."

A leading manufacturer of materials, components and solutions for printed circuit boards (PCBs), FICT is also investing heavily in R&D to develop groundbreaking technologies. Having pioneered technologies such as Organic Flip-Chip BGA Substrate (FC-BGA), a global standard in semiconductor substrate packaging, and F-ALCS (F-All Layer Connection Structure), which maximizes the wiring capacity of printed wiring boards (over 60 layers) through paste filling and metal bonding, the company's R&D efforts today are focusing on the transition towards glass-made substrates.

"We believe that given the prevalent trend of wiring pattern (line/space) miniaturization, transitioning toward glass substrates becomes increasingly crucial," says FICT's former president Seiji Miyoshi. "Through our F-ALCS technology initiative, we aimed to pivot toward laminated glass technology. Unlike the conventional approach reliant on organic materials, our transition to glass empowers us to layer these components. A viable application lies in potential collaborations with LCD panel manufacturers. This collaboration could involve integrating a glass substrate into the semiconductor packaging with our G-ALCS (Glass All Layer Z-Connection Structure) technology, opening new avenues for advancement."

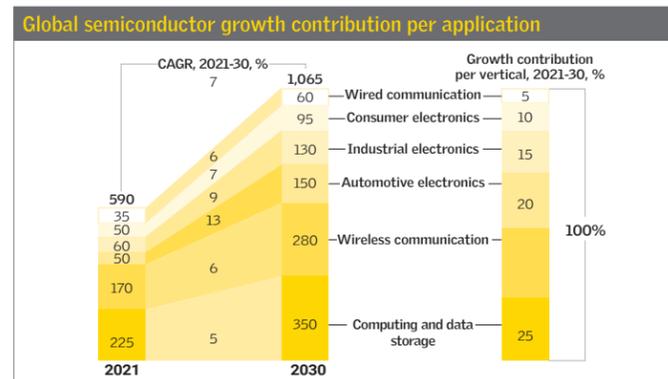
Amid the increasing demand for chips, there has been a revitalization of semiconductor production in both Japan and the United States. In Japan, TSMC is establishing a new semiconductor manufacturing facility in Kumamoto in

collaboration with Sony, while in the U.S., Intel is building two new fabs as the U.S. government has approved a package that will pump billions into stimulating the industry. Such developments bode well for Japanese firms, including Iwata and Co., Kanto Chemical, VALQUA and KEL.

With the revival of the industry in Japan, Dr. Takuya Iwata, President of Iwata & Co. – which provides high-purity chemicals and materials essential for semiconductor manufacturing processes – warns that enhancing the supply chain will be crucial. "The paramount concern regarding the semiconductor industry's further growth in Japan lies not only in investment but also in bolstering supply chain resilience. It is crucial for the Japanese government to extend support to local semiconductor manufacturers and the companies that play a pivotal role in sustaining the entire industry. By mirroring the domestic supply chain structure implemented by the automotive industry, we can fortify the semiconductor sector's stability and growth."

For its part, Iwata established a subsidiary in 2020, which is playing a crucial role in the rapidly expanding semiconductor industry in the Kyushu region. "These small-scale factories epitomize the essence of Japanese craftsmanship, and SMEs like ours possess and maintain advanced Japanese technology," adds Dr. Iwata. "Our subsidiary represents one of our core strengths, excelling in custom ordering production equipment and maintaining an efficient annual maintenance system. Their contributions are indispensable to the success of new semiconductor manufacturing brands and processes."

VALQUA Group is a pioneering company in the fields of seal engineering and resin-based materials for a wide range of industries, including semiconductors. Chairman and CEO, Toshikazu Takisawa, is optimistic about the company's potential for growth as a result of the expansion of the chip industry in Japan and the U.S. "We align with the U.S. and work with Western countries to re-establish the supply chain together. TSMC and Rapidus are investing and building factories in Japan once again. And apparently, we are regaining the attention of these companies. We



Source: McKinsey & Company

are their global supplier, so we will be able to cater to them domestically too, in Japan. Also, we are now about to build new factories in Japan, and we are relocating our manufacturing location from China to other countries in the Asian region. I am taking the U.S.-China decoupling rather positively because it may serve as a trigger to bring back *monozukuri* manufacturing probabilities to Japan. Moreover, it could be the start of another technical innovation expansion in Japan."

Like Iwata, Kanto Chemical supplies high-purity chemicals to the semiconductor industry and already exports its products to the U.S., while the company has been exporting to countries such as Taiwan, Singapore, Malaysia, and China since the 1990s. "We are dedicated to strengthening our presence in these countries and regions by enhancing our factories and providing comprehensive support to our local customers in the semiconductor industry," says Manabu Nozawa, President and CEO of Kanto Chemical. "Currently, our priority market is the United States, which is experiencing a resurgence in the semiconductor sector. Given the discussions on economic security, we are actively pursuing opportunities to penetrate the U.S. market. Our efforts are centered in Japan, and we are collaborating with Kanto-PPC in Taiwan and Kanto Corporation in the U.S., along with our partner companies, to launch a robust sales promotion campaign within the U.S. market."

Turning attention back to Japan, Sean M. Stack, President and CEO of Proterial – which supplies high-quality, cutting-edge materials to several industries, including automotives and semiconductors – says that Japan offers an advantageous ecosystem for semiconductor development in two key areas.

"First is the equipment used to manufacture semiconductors, which is a big opportunity. We support both equipment manufacturers and chip makers by providing specialty steel, electric wires and cables, lead frame materials, and silicon carbide for the chip-making process. Our relationship with customers in this domain is strong, and we constantly evaluate investment opportunities every quarter to meet the increasing demand, reduce lead times, and secure the supply chain," he explains.

"The second advantage of operating in Japan is the close proximity and collaboration with Japanese equipment manufacturers and chip makers. This proximity enables efficient coordination and shorter lead times for securing equipment necessary for our materials production. Customers are coming to us probably earlier than expected because of the demand and the opportunities they see."

A company that provides state-of-the-art connectors essential for industrial, automotive, electronics and communication equipment, including 5G and 6G technologies, KEL sees ample potential for business growth with the prospective reboot of Japan's semiconductor industry domestically. "The more semiconductors are consumed and produced, the more connectors are used. For instance, when there is an increase in the usage of PCBs on which semiconductors are mounted, connectors that connect these PCBs see higher

demand," explains president Akira Kasuga. "If semiconductor development and engineering return to Japan, it would facilitate application development and provide more opportunities for us to focus on specifications. Previously, it was challenging for KEL to participate in such activities overseas. The return of production and development to Japan, especially for automotive applications, would benefit us since we have numerous automotive manufacturer clients."

With the trend towards miniaturization, semiconductors have become increasingly smaller, and removing the nano-sized particles that can impact their performance and quality is a crucial part of the manufacturing, transport and packaging processes. In the area of semiconductor cleaning equipment, Japanese companies like AICELLO and Miyatsu have and will continue to lead the charge.

"In semiconductor production, every step requires a particular chemical packed and transported with our containers. The size of semiconductor products is becoming smaller, thus, there is a higher chance for contamination or impurities during the process to cause defects to the end product," says Satoshi Morita, President and CEO of AICELLO Corporation. "To that end, because chemical manufacturers are required to keep their products as clean as possible, they also demand the cleanest packaging with high purity. We are the only company that can realize the needed quality for plastic-based bottles for the storage of semiconductor-related chemical products."

Miyatsu, meanwhile, has developed pioneering technology that is a vital part of the semiconductor process. The company's MG6500R, for example, is a batch-ashing device that removes impurities or organic matter from the wafer. Chiharu Miyata, Chairman and CEO of Miyatsu, explains: "At the heart of our MG Series lies the plasma emitter, a vital component that has been a cornerstone of our machinery for over two decades. Ashing, also known as plasma etching, serves as an entry process and may seem daunting to some, but in reality, it is not as difficult as perceived. Once the plasma emitter achieves stability, it efficiently cleans the wafer surfaces, making it a crucial element in maintaining clean and smooth surfaces. This equipment has been highly acclaimed by our customers due to its safety and user-friendly nature."

Moving beyond semiconductors to the wider electronics field, JNC develops high-performing materials for LCD and OLED technologies, as well as silane coupling agents for semiconductor encapsulation materials. JNC's performance products for liquid crystals and organic EL can contribute to energy conservation, while the company's blue light-emitting materials support the creation of OLED displays with high color reproducibility that are less stressful on the eyes.

"In the silicone field, we are developing reactive silicon agents and silicon coupling agents that can be applied to contact lenses and heat dissipation materials. Many coupling agents are also used as semiconductor encapsulants," says JNC president Keizo Yamada, who also reveals that the company hopes to play a role in a recently announced joint venture between Japan Display

Inc and China's HKC on OLED technology. "Some companies have expressed interest in our silicon products in Europe and other regions outside of the U.S. and Asia, and we would like to launch and spread our silicon products in those regions in the near future," he adds.

The growing electronics industry has become a priority area for Sanwa Pump, whose stainless steel magnetic pumps are used in the petrochemicals industry, electronics and semiconductor IC manufacturing, as well in pharmaceuticals and food processing. "The electronics industry has become a focus area for us, along with the food industry. While petrochemicals remain important, we are actively pursuing further diversification of our applications," explains president Kiyotaka Horiuchi, who hopes to establish more successful business partnerships like that which led to the development of a new type of pump suited for semiconductor applications.

"Looking to the future, we recognize the global trend towards carbon neutrality. We aim to contribute to this goal by aligning our business with the carbon-neutral field. We anticipate the need for new technology, products, equipment, and development in this area. I believe that our stainless steel magnetic pumps are well-suited for applications that require liquid agents in achieving carbon neutrality. We are committed to playing a role in this important endeavor."

Supporting the shift to carbon neutrality is also an important endeavor for Nitto Kohki, which manufactures couplings for electric vehicles (EVs), hydrogen fuel stations and lithium-ion batteries (LiBs). "The material used for lithium-ion batteries is a liquid electrolyte solution that requires couplings for its transportation," says president and CEO, Akinobu Ogata. "And the increased need for LiBs is leading to an increase in Nitto Kohki's business as our products are a crucial part of the battery-making process. Additionally, with the advancements made in hydrogen, we are seeing an increase in our business opportunities in that sector too. We have great potential in both directions."

Due to the heaviness of LiBs, aluminum, which has emerged as an alternative to ferrous steel in the automotive industry, plays a crucial role in offsetting the weight of these batteries in EVs. SEC Carbon, which offers a range of innovative graphite and carbon products used in several industries, produces SK-B graphitized cathode blocks crucial for aluminum production. "Utilizing aluminum helps to reduce overall CO₂ emissions, so we are indirectly contributing to a carbon-neutral society, as our cathode blocks facilitate aluminum production," says Nakajima Koh, President of SEC Carbon.

"With the increasing prevalence of EVs, we anticipate further opportunities to fortify this aspect of our business. To align with global trends, we have set our sights on targeting the domestic market in Japan, as well as China and the U.S. for expansion in this sector."

"Our goal is to maintain our position as the world's leading provider of cathode blocks," adds Mr. Koh. "We are dedicated to pushing the boundaries of innovation and introducing special products that pave the way toward a carbon-neutral society."