

RESEARCH AND DEVELOPMENT/INTELLECTUAL PROPERTY

RESEARCH AND DEVELOPMENT

The Semiconductor Industry will Continue to Expand

Electronics loaded with semiconductors currently pervade every corner of the globe and semiconductors will play an ever more instrumental part in people's lives in the future. Semiconductor applications are also expanding. About 60% of semiconductors are currently used for computing and telecommunications, but as cloud computing and other types of network infrastructure become integrated into the energy, healthcare, agriculture, and other industries, it is clear there will be an increasing demand for semiconductors to support the new applications.

Technology is supporting this expansion. An important role of research and development is to create sophisticated technology in a timely manner. Tokyo Electron is improving the efficiency of its fundamental research activities by teaming up with universities and research consortia like SEMATECH and imec. As part of this approach, Tokyo Electron has decided to establish a new research facility in Tsukuba, Ibaraki Prefecture in the spring of 2012—TEL Technology Center Tsukuba—with the aim of leveraging the R&D-focused environment of Tsukuba to accelerate the pace of Tokyo Electron's research activities. The Company builds development facilities close to customers at the application stage in order to facilitate strong collaborative ties with customers and to accelerate commercialization of products.

From 2010, the corporate R&D division began to widen its research scope to include not only silicon (Si) integrated circuits, but also a range of new semiconductor materials, including compound semiconductors and organic semiconductors, along with new manufacturing technologies. Tokyo Electron is aiming to make a leap into a new semiconductor world through this combination of nanometer-level scaling technology and new materials.

Successfully Pushing the Boundaries of SPE Technology

The value of semiconductors is rooted in scaling, or miniaturization. Two technologies are pushing the boundaries of successful scaling: double patterning technology and extreme ultraviolet (EUV) lithography.

Tokyo Electron possesses a proprietary double patterning technology that uses the deposition of silicon oxide films at room temperature, enabling half pitch 13nm line and space patterns. The development of further improvements this year have successfully enabled scaling to 11nm patterns as Tokyo Electron continues to rewrite scaling records using current exposure tools.

EUV is regarded as the next-generation lithography technology. Tokyo Electron has not only developed an innovative coater/developer for EUV, but is enhancing process technology to minimize line edge roughness.

One technical issue that has threatened to impede higher levels of scaling is lowered yield caused by "variability" in transistor performance. One of the many causes of variability is the excess energy generated by the plasma and heat used in the manufacturing process.

Tokyo Electron is addressing this issue by developing low-temperature, low-energy plasma manufacturing technologies. One technology commercialized by Tokyo Electron is a novel dry etch system, Tactras™ RLSA™ Etch, which enables damage-free etching with low energy and high electron density.

New functional materials are indispensable to enable further scaling of semiconductors. Tokyo Electron develops CVD systems for making High-k/metal gates for logic devices, novel dielectric film and electrodes for DRAM capacitors, and phase change and resistive materials for the emerging memory devices.

Scaling is not the only hot topic in the industry. Three-dimensional (3D) memory cell stack and 3D chip stack technologies have also attracted significant attention in recent years.

In 3D memory cell stacks, flash memory cells are stacked vertically to increase density. Tokyo Electron has contributed to the development of this groundbreaking integration process with high aspect ratio contact hole (HARC) etching and metal filling technologies.

In 3D chip stacks, a multitude of complete chips are stacked to provide higher functionality. Tokyo Electron aims to be a top equipment supplier in this field as well, and has commercialized a high rate through-silicon via (TSV) etch system. Additionally, Tokyo Electron is also developing a dielectric polyimide deposition system for through holes.



TEL Technology Center Tsukuba to be opened in spring 2012

Tsukuba in Ibaraki Prefecture, the self-styled city of science and nature, is the ideal location for Tokyo Electron's new center. We shall pursue tie-ups with local research institutes and academic institutions to accelerate R&D for new base technologies and core technologies for semiconductor production equipment as well as for photovoltaic cell production equipment.

Tackling Environment and Energy-related Issues

The Tokyo Electron Group is leveraging all of its resources to tackle the global issues of the environment and energy.

The first major contribution is through the development of energy-saving technology. In the area of power devices, which have the potential to greatly contribute to energy-saving, silicon carbide (SiC) semiconductors are regarded as a once-in-several-decades breakthrough. In 2010, Tokyo Electron began sales of a SiC epitaxial CVD system the Company had developed that is critical for the manufacture of SiC semiconductors. Lighting is another area where energy-saving technology is needed. Tokyo Electron is developing proprietary production equipment for organic electro-luminescence devices, which are regarded as the next generation of power-saving technology.

The second major contribution is through the development of photovoltaic cell (PV) production equipment. For the Si thin film PV, which has high growth potential, Tokyo Electron is leveraging its semiconductor and FPD production equipment technology to develop equipment with high productivity. Moreover, the Company is conducting R&D on high-efficiency, low-cost PV production equipment which uses materials other than Si thin films.

Exploring New Fields

Tokyo Electron is exploring medicine, energy, and other fields where there is potential to apply its accumulated semiconductor production equipment (SPE) technology. Digital cameras and portable digital music players paved the way for NAND flash memory and are an example of how new products can drive the development of new manufacturing technologies. For this reason, Tokyo Electron's business units collaborate closely with the R&D division to study the possibility of entering new fields from both the market and technological perspectives.

To enhance new technology development, Tokyo Electron has formed collaborations with universities, business consortia, and venture companies that possess complementary technology. These collaborations are not limited to Japanese universities but include research programs in foreign countries as part of the Company's quest to achieve excellent research activities and pursue promising technologies through active collaborations worldwide.



Tokyo Electron achieved an extremely fine pattern with a half pitch of 11nm by applying its proprietary “double patterning” technology twice.

INTELLECTUAL PROPERTY

Policy for Intellectual Property Activities

Tokyo Electron understands that the significance of intellectual property activities at manufacturing companies is its contribution to increasing corporate revenues by supporting business activities. In order to make our intellectual property strategy effective, it is important to integrate this strategy with our technological and product strategies.

Thus, in building and implementing our intellectual property strategy, our primary goal is to differentiate our own products and bolstering our competitive advantages with our intellectual property rights, rather than generating income from licensing them to other companies.

Technologies are becoming increasingly advanced and complicated in our business fields; the risk in developing new products increases significantly unless we fully respect the intellectual property rights of other companies. From this viewpoint, Tokyo Electron appropriately monitors intellectual property held by other companies. To minimize the risks of disputes, we take appropriate approaches, including obtaining licenses from others if necessary.

Management of Intellectual Property Activities

Tokyo Electron continues to conduct aggressive R&D activities to respond to the advanced needs of device manufacturers, who are our customers. In order to maintain our competitiveness based on the outcome of R&D activities, it is necessary that we steadily protect these achievements through our intellectual property rights. To cooperate closely with our R&D operations, patent engineers in charge of patent prosecutions are assigned to every plant that has R&D functions.

At the same time, Tokyo Electron must respond flexibly to dramatically changing markets and various technological trends in order to effectively conduct intellectual property activities. To

cooperate closely with sales and marketing departments and to grasp the market and technological trends, patent engineers in charge of surveys and external affairs related to intellectual properties are assigned to headquarters, which has sales and marketing functions. In addition, patent engineers assigned to the plant and headquarters, a sales or marketing division manager, and an R&D division manager have meetings periodically so that our intellectual property activities are conducted along with the market and technological trends.

Status of Intellectual Property Rights

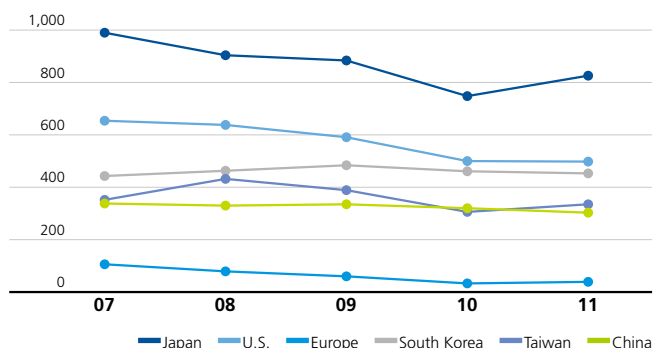
In addition to filing applications for core technologies vital to our strategies in each business division, Tokyo Electron vigorously builds a patent portfolio that also encompasses the technologies adjacent to core ones.

In each country, we always optimize the numbers of our patent applications and patents held, reflecting market and competitor trends in our business fields. The graph in this section shows the numbers of patent applications and patents held by Tokyo Electron in each country. In recent years, we have filed about 70% *¹ of our applications globally, reflecting the importance of overseas markets for our business. In particular, we have been increasing the numbers of patent applications and patents held in South Korea and China. These numbers are based on our patent strategies reflecting the recent growing importance of the South Korean and Chinese markets for our business, as well as the rise of semiconductor and FPD production equipment manufacturers in South Korea.

*¹ This figure is the percentage of patents filed overseas out of all our patents filed with the Japan Patent Office. The average among Japanese companies is about 25%.

Number of Tokyo Electron Patent Applications

(Fiscal year)



Number of Patents Held by Tokyo Electron

(As of March 31)

