Product Competitiveness

- Create the best, high-value-added equipment with innovative technology in a timely manner through the development of product marketing and the global promotion of R&D with an eye on future generations
- Boost competitiveness by assigning personnel at research, development and production sites worldwide, including corporate headquarters, to promote intellectual property (IP) management, and by building IP portfolios aligned with technology and product strategies
- Continuously strive to reduce the environmental impact of equipment and provide technology that contributes to the development of devices with even lower power consumption, to preserve the global environment
- Strengthen product competitiveness by deploying digital transformation, through the use of digital technology as “leverage” to improve added value and efficiency

SDGs Initiatives

9 INDUSTRY, INNOVATION AND INFRASTRUCTURE

- Create innovative technologies and contribute to the development of a sustainable society through the promotion of innovation
- Promote inclusive and sustainable industrialization
- Promote scientific research and improve technological capacity in the industrial sector of every country

13 CLIMATE ACTION

- Contribute to the reduction of environmental impact company-wide by providing products and services that are conscious of the environment
- Improve resource use efficiency and expand the introduction of clean and environmentally-friendly technologies

17 PARTNERSHIPS FOR THE GOALS

- Strengthen global partnerships for sustainable development

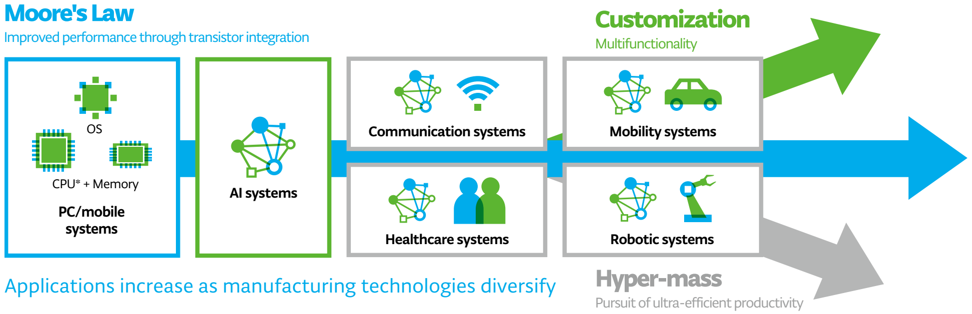
Research and Development

Research and Development for the Future

With the evolution of ICT, electronics are more and more indispensable to people's lives. In addition, there is an increasing need to realize both the development of a data-driven society and preservation of the global environment, with the growing demand for semiconductors and displays, which is the base of ICT and increasing global awareness of the environment. The performance required of semiconductors and displays is also becoming more diversified.

In order to contribute to the development of a dream-inspiring society, Tokyo Electron is engaged in R&D with an eye on the future to capture changes in society, including innovations in manufacturing technology and the pursuit of ultra-efficient productivity.

Market Heading toward Diversification



* CPU: Central Processing Unit. A semiconductor chip that serves as the brain of a computer.

Development System

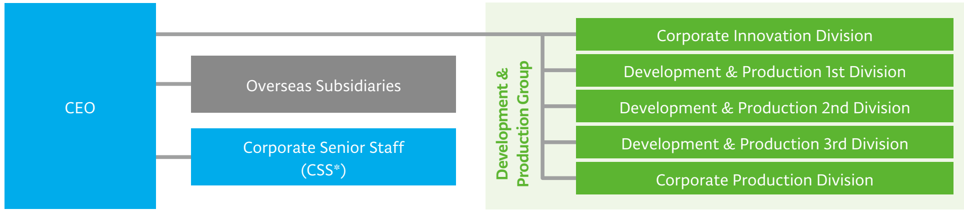
As semiconductor production technology grows more diverse and in order to bring high-value-added products to the market in a timely fashion, we have built a system that promotes R&D and technological innovation for the next generations with collaboration between the Development & Production Group and the Business Group.

In addition, we share technology roadmaps spanning multiple generations for the future with our customers, and by working with relevant divisions across the Company we accelerate the development of equipment with solutions that anticipate market needs.

Specifically, the Corporate Innovation Division, which is headed by the CEO, along with the development divisions of the manufacturing sites in Japan and the marketing departments of business units, are leading efforts to enhance process integration capabilities and promote digital transformation* (DX) using AI technology. In addition, in January 2022 we established the Digital Transformation Promotion Department to further strengthen the promotion of DX.

Furthermore, as demands from society escalate with regard to the environment, health and safety, the Global Environment and Safety Council is playing a central role in promoting the review and formulation of basic policies, and each of our manufacturing sites in Japan are also building a development system that takes into account the environment and health and safety.

* Digital transformation: Refer to Strengthening of Product Competitiveness through Digital Transformation (DX) on p.18 and refer to Higher Productivity through Digital Transformation (DX) on p.26



* CSS: Composed of the Vice President and General Managers of Tokyo Electron, Presidents from overseas subsidiaries

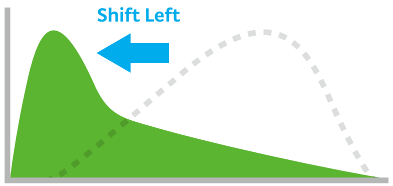
Shift Left

We are focused on using the Shift Left approach, investing resources such as technology, personnel and expense into the early processes of product development. Through this approach, we are endeavoring to develop various technologies and conducting research for multiple future generations in order to realize the technology roadmaps we have created with customers.

In fiscal year 2022, we continued working on using less space for equipment, which is one thing our customers require. By optimizing the layout of equipment in cleanrooms, we enhanced the productivity per unit area of equipment, and also contributed to reducing environmental impact. Furthermore, through activities for E-COMPASS*, an initiative for building sustainable supply chains, we are also pursuing more efficient product development from an environmental perspective in partnership with our suppliers.

Through promoting the Shift Left approach we gain an understanding of customer needs at an earlier stage, and by reflecting the information obtained from feedback into our R&D and proposing superior products, we are contributing to maximizing yield for customer devices and capacity utilization of their mass production line equipment.

We are also promoting on-site collaboration for early delivery of evaluation equipment to customers' fabs and development and research laboratories, and are working to accelerate the process in which R&D is reflected in mass production equipment as well as to optimize development efficiency.



- Joint development of technology roadmaps spanning multiple generations
- Promotion of early engagement
- Maximization of yield for customer devices and equipment operating rate from early stages of mass production, and also reduction of environmental impact
- Promotion of improvement in work efficiency and per person productivity, and further increase in investments into human resources and development
- Increase in equipment efficiency per unit area by achieving higher productivity and using less space

* E-COMPASS: Refer to E-COMPASS Initiative on p.46

Product Marketing

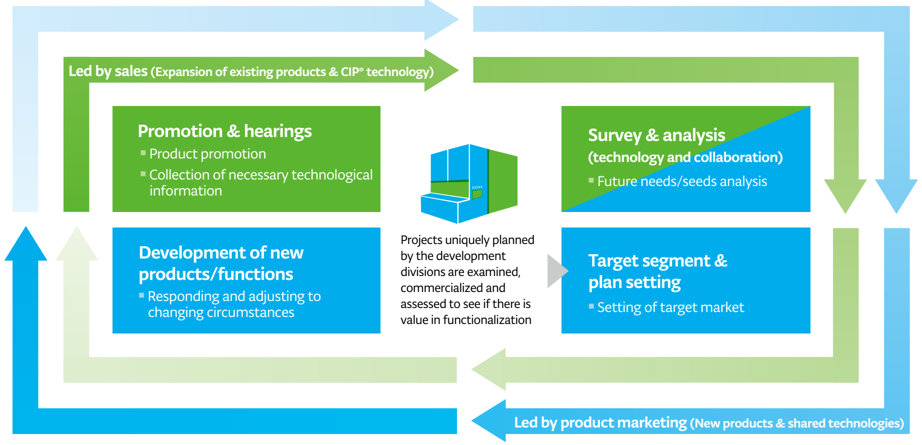
We are endeavoring to further enhance the productivity of product development by having our sales departments and product marketing departments appropriately fulfill their respective roles.

Our sales departments are responsible for ensuring that products and services are provided based on solid relationships of trust with customers.

Meanwhile, our product marketing departments work to plan and realize products that meet the future needs of customers in target markets, such as development planning to increase the value of products and services, and the examination of value-adding mechanisms. In conducting these initiatives, in addition to considering new products and functions based on the seeds of our development divisions, they also formulate plans for optimal collaboration including tie-ups with partner companies and consortiums.

Our sales departments and product marketing departments work together in developing product marketing activities that anticipate market needs and contribute to customers' products, and in doing so, help improve our product competitiveness and promote our Shift Left approach.

Roles of Sales Departments and Product Marketing for Product Development



* CIP: Continuous Improvement Program

Collaboration with Consortiums and Academia

We have focused on collaborative efforts with domestic and international consortiums and academic institutions (universities) to enhance our R&D capabilities and to create leading-edge technologies for a very long time.

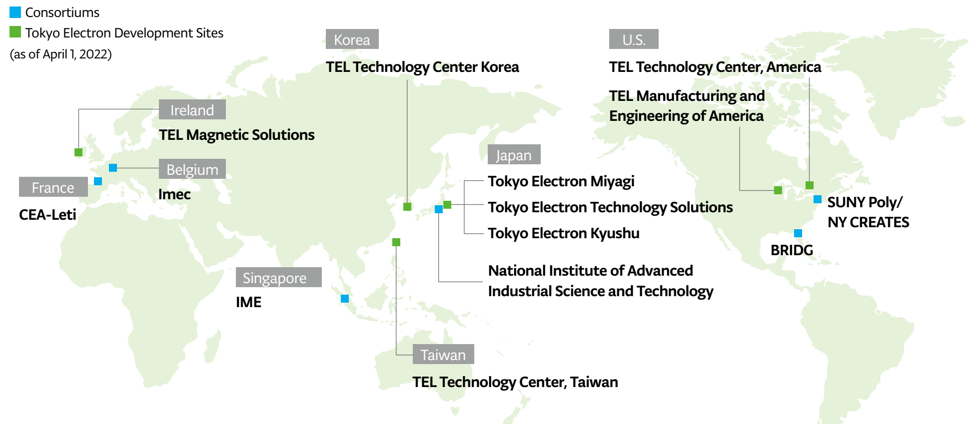
Today, we continue our engagement in a wide range of areas from applications to product development. In the area of EUV and high-NA EUV[1] lithography processes[2], this is achieved through collaboration with imec located in Belgium. Furthermore, we participate in a global research hub for hardware development of next-generation AI in the U.S. state of New York, and have formed a partnership with BRIDG[3], which is a non-profit public-private partnership located in the U.S. state of Florida, as well. At our research center in TEL Technology Center, America[4], advanced R&D in the areas of front-end, back-end[5], and advanced packaging process areas are being carried out daily.

Additionally, we collaborate with the National Institute of Advanced Industrial Science and Technology (AIST), one of

1 EUV and high-NA EUV: Extreme Ultraviolet. Ultraviolet radiation (ultraviolet rays) in the wavelength range of 1 to 100 nm. High-NA EUV refers to next-generation EUV.
2 Refer to Lithography Process on p. 5
3 BRIDG: Bridging the Innovation Development Gap (BRIDG) provides the physical foundry infrastructure and collaborative process to connect challenges and opportunities with solutions making commercialization possible.
4 TEL Technology Center, America: Our R&D center in the U.S.
5 Front-end/Back-end: In semiconductor device production, the beginning section of the manufacturing process where the device element is formed is called the front-end (FEOL), and the latter section is called the back-end (BEOL) where the wiring is traditionally accomplished.

Japan's largest public research institutions. There we leverage AIST's world-class research environment and personnel to enhance our own development by conducting MRAM[1] and 2D material-related research. We do this to address the needs in the field of semiconductor technology development, which is becoming increasingly diverse.

From fiscal year 2022, we are also participating in iSyMs[2], an open consortium led by the Tokyo Institute of Technology and the University of Tokyo, to broaden the scope of our collaboration. We have also been working with SRC[3], a globally known U.S. consortium, and contributed to the production of the Decadal Plan for Semiconductors[4] published in October 2020.



1 MRAM: Magneto-resistive Random Access Memory
2 iSyMs: Industry-University Consortium for Integrated System-Materials
3 SRC: Semiconductor Research Corporation. An advanced research and technology consortium active in the semiconductor industry.
4 The report that explains the potential of semiconductors over the next 10 years and the challenges that must be overcome to realize the vision.

Joint Research Selection Program with Academic Institutions

Since 2018, we have been conducting a joint research selection program with academic institutions. The aim is to discover and collaborate on advanced elemental technology research pertaining to semiconductors. Under this program, 23 themes have been selected over the past four years, and a variety of joint research projects are currently underway.

Although applicants are free to propose any research topic, we adopt proposals that (1) meet our technological needs and show original perspectives and ideas only possible in academia and (2) are expected to improve our technical and planning capabilities and contribute to the expansion of our business domain in the future.

Technical advisors selected from our development divisions, business units (BUs) and manufacturing sites in Japan are responsible for selecting the topics, with subsequent joint research activities managed by the administrative staff. The research period is up to three years but is extendable if valid results are confirmed during the regular term.

We will continue to promote the selection program in order to contribute to the development of semiconductor-related technologies and devices, as well as to the advancement of science and technologies by revitalizing research activities in academia.

Intellectual Property Management

We are promoting intellectual property (IP) management based on the fundamental principles that IP protection supports business activities and leads to an increase of corporate profits.

In order to achieve sustainable growth in the semiconductor industry, where the growth is driven by technological innovation, we are globally expanding our R&D activity including industry-academia collaborations. As well as at corporate headquarters, we have allocated IP professionals at R&D and production sites around the world to evaluate projects from various angles such as R&D and marketing perspectives, and we are striving to enhance our competitiveness through building IP portfolios aligned with our technology and product strategies.

In 2021, the number of inventions created in Japan was 1,269 and 225 in other countries. The global patent filing rate has been approximately 70% for 10 consecutive years, and the approval rate of the filed patents has reached 79% in Japan and 83% in the United States. As proven by these statistics, we maintain our competitive advantage in the IP domain at the global level. Over the last two years, we have collaborated with partner companies and research institutes such as universities around the world and have succeeded in filing 43 joint patent applications together with 15 companies and 16 organizations.

As a result of these activities, we were selected as one of the "Clarivate Top 100 Global Innovators 2022." In this award, Clarivate, a global information service company, makes an original evaluation based on patent data, and once a year selects "companies or institutions providing new value to the world with capabilities, consistency, incredible creativity, and new thinking."

Tackling Technological Innovation

Research and Development for Next-Generation Computing

Demand for semiconductors is increasing on a global scale and production is expected to grow even further in the future. Under such conditions, an unchecked increase in power consumption due to the growing use of semiconductors may lead to an energy supply risk in the market. In modern-day computing, focus for edge devices is placed on lower power consumption, but for the server-side the focus is more on performance rather than power consumption. This is in response to the market needs. Therefore in the future, we may need to rethink the balance of Power usage, Performance, Area of silicon, Cost and Environmental impact (PPACE) of our devices in order to address this energy issue. At Tokyo Electron, we recognize these and other issues and are working to resolve them through our semiconductor production equipment business.

One solution to the power efficiency problem is to place memory devices closer to logic devices (computational circuits). By shortening the electrical pathway, one can reduce the electrical resistance and thereby reduce power consumption during information transfer between the devices. Optimization of device architecture using this technique is effective, and development in this area has been gaining momentum in recent years.

Additionally, for logic devices, SoCs[1] that take advantage of the computing characteristics of CPUs, GPUs[2] and NPUs[3] and distribute computational tasks to the most efficient circuits are increasingly popular. This SoC architecture can be built by a monolithic process that does not use bonding technology, but can also be built using 3D system integration techniques which leverage bonding technology. Also called "heterogeneous integration[4]", 3D system integration technology combines and packages a variety of different materials such as silicon and non-silicon elements, CPUs and DRAMs[5], analog and other electronic components.

In AI technology, development of analog neural devices[6] and nonvolatile resistive random access memories[7] which mimic the energy-efficient human brain function is well underway. Our film deposition technology contributes to this development.

By combining and applying these technologies, we will be able to further reduce power consumption and improve computing efficiencies in a variety of devices.

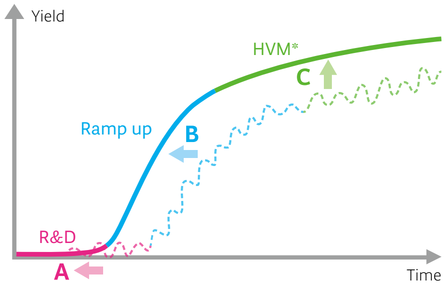
Realizing next-generation computing requires the development of AI chipsets with an even higher processing speed and greater energy efficiency. By taking maximum advantage of a wide range of technologies and techniques from semiconductor production, we are working to create high-value-added equipment that can help meet one of the next-generation computing needs of bringing computer performance closer to that of the human brain. We are expanding the technological areas in which we can contribute by developing new materials and boosting the performance of chipsets through 3D system integration equipment offerings, which in turn optimize the power efficiency of semiconductors by realizing next-generation computing requirements.

We are also working on the development and application of quantum computing technology for the next generation and beyond.

1 SoC: System on a Chip, a design technique in which many or all of the functions required for system operation are mounted on a single semiconductor chip, or a chip built using this technique.
2 GPU: Graphics Processing Unit, a dedicated electronic circuit designed to manipulate and modify memory to speed up the generation of images used for displays.
3 NPU: Neural network Processing Unit, a processor dedicated to AI that incorporates a neural network that is modeled after the human cranial nervous system.
4 Heterogeneous Integration: Packaging that unites different kinds of chips
5 DRAM: Dynamic Random Access Memory. A type of semiconductor memory used in the main storage unit (or other electronic devices) of a computer as a large-capacity working memory
6 Analog neural devices: Electronic devices capable of continuously changing resistance
7 Nonvolatile Resistive random access memory: Random access memory that uses nonvolatile resistive memory elements.

Strengthening of Product Competitiveness through Digital Transformation (DX)

DX, which is expanding globally across all industries, is accelerating in the semiconductor and flat panel display production equipment industries as a method to resolve a variety of issues that are becoming more complex every year.

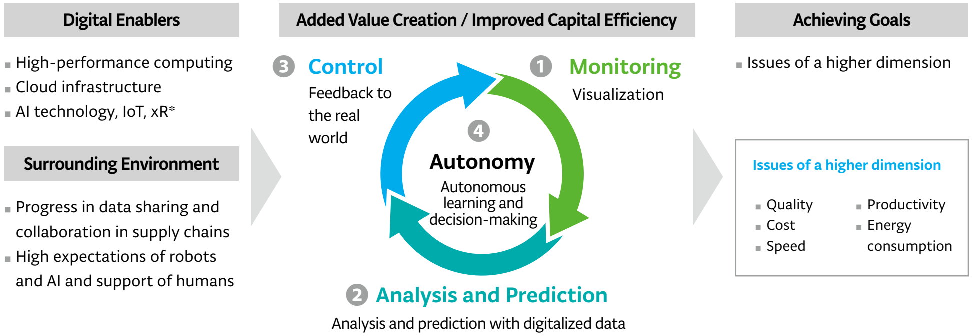


* HVM: High Volume Manufacturing

Data application and Use Opportunities	Examples
A Shortening business processes for research and development	Accelerating the customer proposal process based on accurate simulations
B Shortening the time to mass production	Reduced mechanical error difference, automatic adjustment functions
C Improving productivity/ product yield	Predictive maintenance, fault detection, process adjustment functions via monitoring and analysis functions

Having positioned DX as an important part of the solution for the demand for further miniaturization and multi-layering of semiconductors, we formulated the TEL DX Vision in January 2021 to become "a global company where all employees drive enterprise value creation sustainably through activities such as value addition and efficiency improvements by leveraging digital technology." We will make full use of a variety of digital enablers*, aim to resolve high-level problems via a cycle of 1) monitoring, 2) analysis and prediction, 3) control and 4) autonomy, and further strengthen the competitiveness of our production equipment.

* Enablers: People, organizations, factors and means that enable success and achievement of objectives

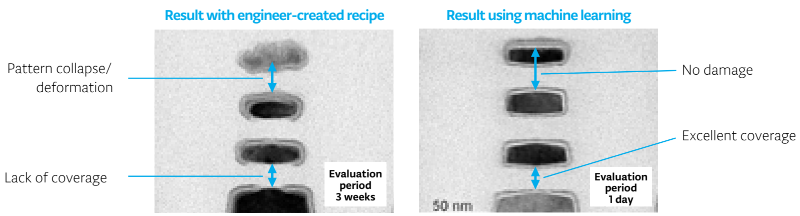


* xR: Extended Reality. Collective name for Virtual Reality (VR), Augmented Reality (AR), Mixed Reality (MR) and Substitutional Reality (SR).

Example Initiative

We use AI-based machine learning to adjust film coverage by plasma-enhanced atomic layer deposition (PE-ALD)* in order to ensure film deposition with even thickness around the nanosheet structure. As a result of using AI to collect experimental data and optimize the analysis and process, we have established an optimal process for film deposition with high coverage in a short time without damage such as pattern collapse or deformation. Through the use of AI, the amount of wafers and energy used in development is minimized, and engineers are able to engage in high-value-added work without being bound by conventional ideas and practices.

*Plasma-enhanced atomic layer deposition (PE-ALD): Atomic layer deposition is a thin-film deposition technology that uses continuous vapor-phase chemical reactions. PE-ALD is a method of applying plasma to activate a reaction on the substrate.



Source: Tokyo Electron Technology Solutions Limited / Tokyo Electron Limited

Comparison of exploration results of a film coverage process in a simulated nanosheet structure using a 300 mm PE-ALD system, conducted by a human engineer and machine learning respectively.

Support for Evolving Displays

In recent years, with the development of ICT, new work options that are not bound by time or place, such as remote work, have expanded. As a result, there have been dramatic changes in areas such as lifestyles and health awareness.

Amid this change, displays are expected to continue to develop and support people's daily lives as an interface between people and data. For example, organic light emitting diode (OLED) displays have evolved to be lighter, thinner and with a higher image quality, and are expected to be used for computers and tablets as well as large screens for televisions and other devices. The key to this widespread use is the establishment of production technology using large substrates, and improving technology to control production defects as well as reducing environmental impact in the manufacturing process are important issues. Larger substrates will contribute to improved production efficiency and reduced manufacturing costs.

Our product lineup in the flat panel display (FPD) market includes the Impressio™ and the Betelex™ FPD etch/ash systems, the Exceliner™ FPD coater/developer and the Elius™ inkjet printing system for manufacturing OLED displays.

Impressio™ and Betelex™ use PICP™[1], a plasma module with improved energy efficiency, reducing power consumption by up to 20% and achieving precise processing and stability during the mass production process. In addition, PICP™ Pro, which was released in 2021 and designed for high-definition displays, enables both yield improvements and mass production stability by reducing the generation of microscopic particles.

The Exceliner™, equipped with our original Air Floating Coater, permits higher throughput[2] while maintaining excellent film uniformity and saving chemical consumption.

We will continue contributing to the further development of diverse display products, tackling effective technological innovation based on market needs such as improving productivity and yield and using energy and materials more efficiently.

1 PICP™: A plasma module that produces extremely uniform high-density plasma on panel substrates
2 Throughput: Processing ability and data transfer amount per unit of time