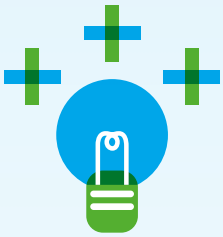
Enhancing product competitiveness

Medium-term goal

Create highly competitive next-generation products

Priority themes



Technology innovation aimed at creating value

Environmental contribution of products

Relevant SDGs

9 Industry, innovation and infrastructure

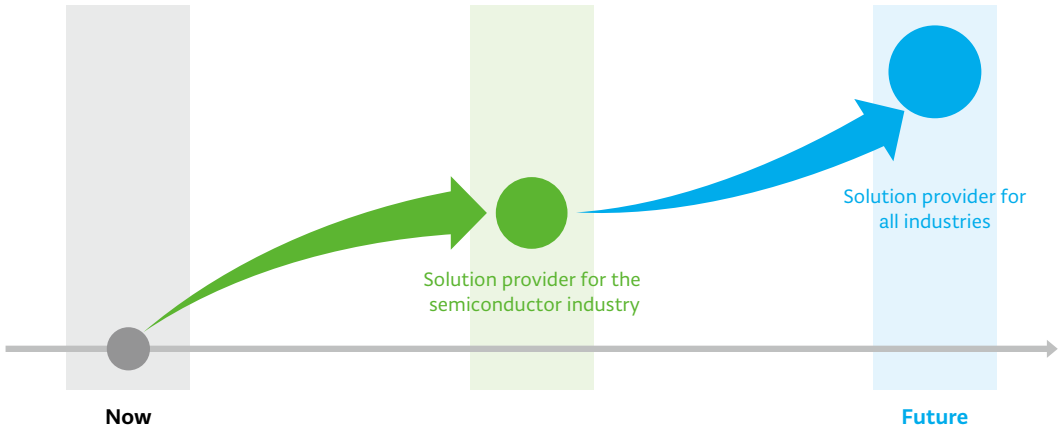
13 Climate action

SUSTAINABLE DEVELOPMENT GOALS

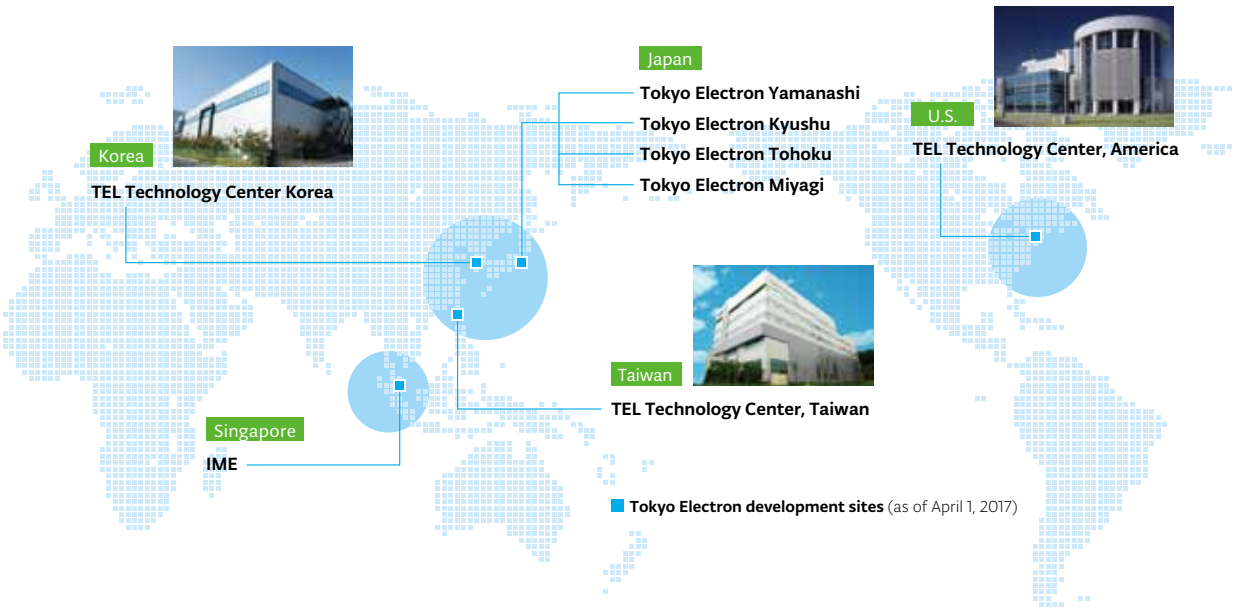
TEL's research and development

Pursuing innovation for the future

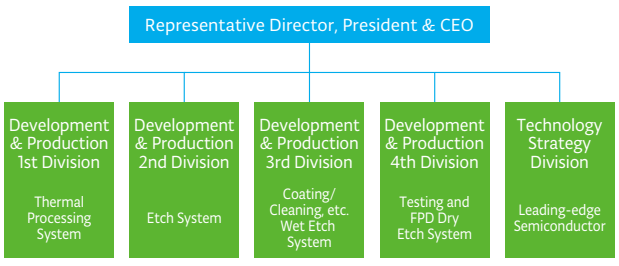
TEL is holding lively discussions regarding technology for the future as well as its contribution in order to prepare for a new era of greater familiarity with electronics and greater reliance on semiconductors. Using our technologies, we will add to the development of semiconductors with increasing importance across all industries, contributing to a richer, more vibrant society.



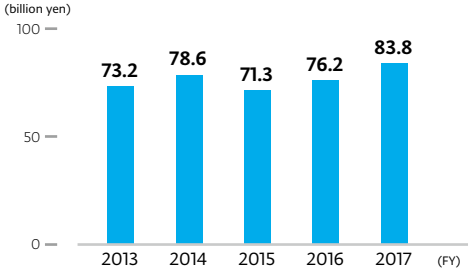
Global development sites



R&D organization



R&D expenses



Technology innovation aimed at creating value

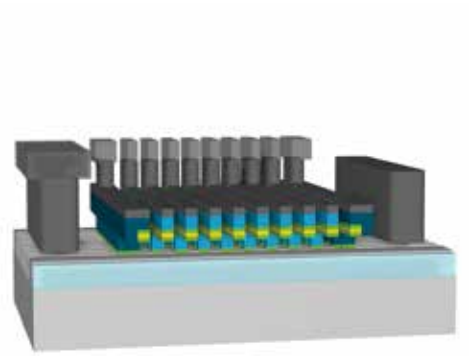
Innovative manufacturing technologies that support semiconductor evolution –3D NAND–

Mass production of 3D NAND chips, achieved through developments in manufacturing technologies, not only enables higher performance for electronic devices such as computers and smartphones, but also contributes to reduced energy usage. For example, if the huge number of hard disk drives[1] used in data centers could be replaced by 3D NAND solid state drives,[2] we could expect considerable savings in power consumption.

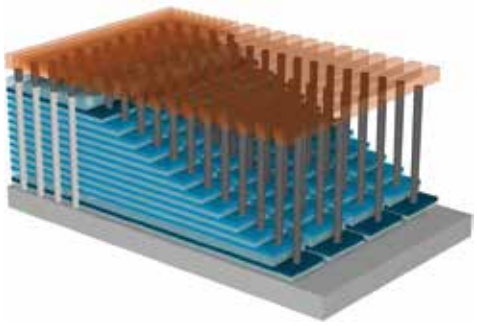
As demand for 3D NAND increases, we are focused on developing technologies that support these next-generation products. The density[3] of semiconductors is usually increased by reducing circuit line width. However, the circuit line width of NAND devices is currently around 15 nanometers[4] resulting in an extremely low number of electrons being stored in each cell (memory element). Therefore we are reaching the physical limit of what is possible by reductions in line width. As a solution to further increase density, semiconductor chip cells are stacked three-dimensionally in 24 layers or 48 layers to create a 3D NAND structure using shared pillar electrodes. This creates a need for manufacturing technologies that are completely different from previous technologies.

One of these technologies is multilayer formation technology, which is used to create the three-dimensional structure. 3D NAND requires the ability to lay two different layers on top of each other and then continue building up the layers, but difficulties include how to uniformly create two different layers on 300 mm wafers and how to control reaction to gases used in the formation process. Advanced etching technologies specific to 3D NAND are also required to etch high aspect ratio[5] holes (greater than 100 nanometers in diameter and 2.8 micrometers[6] in depth) in the multilayer wafers.

As a comprehensive manufacturer of semiconductor production equipment with a wide range of products, we are using our accumulated technologies to develop products that solve these various technical issues.



2D NAND



3D NAND

1 Hard disk drive (HDD): A type of external storage device for recording and retrieving data

2 Solid state drive (SSD): A semiconductor disk drive using NAND flash memory as a recording medium. With their high speed and low power consumption, SSDs dramatically reduce running costs, so demand for use in data centers is increasing.

3 Density: The number of transistors per semiconductor integrated circuit

4 Nanometer: 1 billionth of a meter

5 Aspect ratio: Ratio of depth and width of patterns formed on wafers

6 Micrometer: 1 millionth of a meter

Making semiconductor production equipment more intelligent –AI–

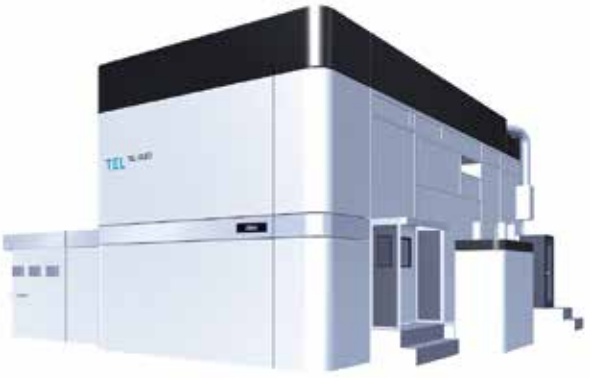
TEL is using AI* to make the semiconductor production equipment it manufactures more intelligent. Semiconductor production equipment uses various fabrication processes in a nanometer-level world that is invisible to the human eye. We are working on visualizing this nanoscale world through the power of data and AI helping us to understand the condition of our equipment. We are also currently developing a range of applications that use AI to analyze the vast amounts of digital data coming from the equipment, including operating logs, sensors, and measurement data, to avoid unexpected downtime, maintain equipment performance during operation, and achieve uniform accuracy when processing wafers.

We already offer a TELeMetrics™ remote diagnostic service via the Internet for real-time monitoring of our semiconductor production equipment. Going forward, we will continue to evolve the equipment to enable it to conduct self-diagnostics, adjustments, and autonomous operation.

* Artificial intelligence

Development of high value-added display production technologies –Organic electroluminescent displays–

Organic electroluminescent displays use light-emitting diodes made from organic compounds. Unlike liquid crystal displays, organic electroluminescent displays emit light themselves when powered rather than requiring backlights or other light sources. This gives them great potential for use as next-generation display devices producing high quality images with low power consumption. The organic luminescent layer of these displays is conventionally formed using vapor deposition in a vacuum, but our organic electroluminescent display panel production equipment employs an inkjet method to form this layer. This method enables us to form the layer by applying only the required amount of organic material to large glass substrates at atmosphere, which improves productivity by reducing material usage and fine particle contamination. To meet the expected growth in demand in the large panel TV market, we will continue developing systems based on these cutting-edge inkjet technologies, including drying and baking processes after applying the organic material. These systems will contribute to improved productivity in organic electroluminescent display manufacture and further growth in the market.



Inkjet Printing System
for manufacturing OLED panels
Elius™

Collaborating with international consortiums

TEL collaborates with international consortiums to pursue cutting-edge technologies and enhance its product competitiveness.

One consortium that we have been collaborating with for many years is Imec.[1] Imec includes several semiconductor production equipment suppliers as well as major semiconductor manufacturers, the latter being our important customers. We conduct many different joint research projects with Imec focused in areas that will lead to future innovations in semiconductors, such as new technologies, new materials, and lithography. Within these consortiums, globally leading semiconductor manufacturers and semiconductor production equipment manufacturers each bring their cutting-edge knowledge to the table, enabling effective technical innovation for next-generation production equipment.

Our collaboration with Imec has led to other collaborations with industry-leading companies. For example, we worked with a major optical equipment manufacturer in an advanced equipment environment to jointly develop EUV[2] technologies, a leading-edge technology for lithography. Together, we also developed immersion ArF,[3] a technology that is becoming widely used for fine pattern formation.

Collaborations with international consortiums like this also help us develop our own engineers. About 10 of our engineers are currently stationed locally at Imec. By working alongside world-class engineers and researchers, including our competitors, they are honing their technical skills and better preparing for the future.

1 Imec: Interuniversity Microelectronics Centre is an international research institute headquartered in Leuven, Belgium

2 Extreme ultraviolet lithography (EUV): A next-generation lithography technology

3 Immersion ArF: Immersion ArF is a lithography technology that uses argon fluoride (ArF) excimer lasers as the light source and water as the immersion medium between the lens and wafers

Protecting and using intellectual property

TEL's basic policy for intellectual property (IP) is to increase corporate revenues by supporting operations through IP protection. In line with this policy, we allocate IP personnel to product development centers and manufacturing facilities where research and development are performed, as well as to corporate headquarters where our sales and marketing departments are concentrated. These employees work closely with their departments to develop an IP portfolio that aligns with our technological and product strategies. They also work to minimize the risk of IP disputes by monitoring the competitive environment.

We file patent applications to protect and use IP effectively in the relevant countries where we and our customers operate. Our global patent application rate[4] has remained high, at around 70% for six consecutive years. In 2015, our patent application success rates in Japan and in the United States were 66.5% and 72.3%, respectively.

Under our worldwide structure, we are able to build a strong, strategic portfolio. This strong portfolio allows us to differentiate our products, enhance our competitiveness, and ultimately increase our revenue.

4 Global patent application rate: Percentage of invention applications filed in multiple countries

Environmental contribution of products

Products that contribute to a sustainable society

The total CO_2 emissions from the TEL value chain (including raw material procurement and product manufacture, transport, use, and disposal) was calculated according to the GHG Protocol.[1] Emissions arising from product use currently account for 90% of our total CO_2 emissions. For this reason, we have made it a key corporate objective to promote environmentally friendly product design, and lower the energy consumption of our products, thereby reducing impact on the environment from product use. In fiscal 2015, we established a goal to reduce energy and pure water consumption by 10% by fiscal 2019, using fiscal 2014 consumption as the baseline. To achieve this goal, we are working to reduce energy use and improve overall throughput. In fiscal 2016, we reached this goal with the Trias*e*+™ EX-II™ TiN Plus system. In fiscal 2017, we once again achieved the goal earlier than planned with the Precio™ XL wafer prober, the Certas LEAGA™ gas chemical etch system, and the CLEAN TRACK™ LITHIUS Pro™ Z coater/developer. In addition, the percentage of sales from energy-saving models[2] increased in fiscal 2017 to 93.9% of total product sales.

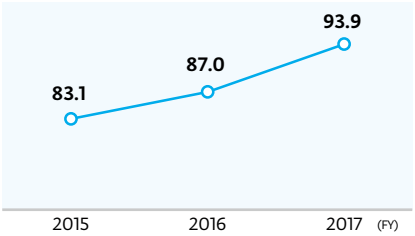
To further reduce the overall environmental impact of our products, we must examine our primary equipment, peripherals, associated facilities, and management at our customers' factories. Going forward, it will become increasingly important to improve the operational efficiency of our equipment and encourage overall energy-efficient operations at our customers' factories. Therefore, we will continue to focus on monitoring and controlling our own energy use. We also plan to demonstrate the importance of energy saving measures through compliance with SEMI S23, the semiconductor industry standard for assessing energy conservation.

To meet our goals, we are promoting environmentally friendly manufacturing, development of new technologies, proactive measures to contain greenhouse gases, and further reductions in the use of energy, water, and chemicals.

1 GHG Protocol: Accounting and reporting standards for greenhouse gases (GHG)

2 Based on in-house standards

Percentage of energy-saving model sales in total sales (%)



* Changes from last year's report: Figures have been updated due to revision of the applicable models

Management of chemical substances in products

In order to manufacture environmentally friendly products, TEL has set up a system for managing hazardous chemicals in products it uses. In addition, we proactively collect information on relevant laws and regulations in Japan and abroad to properly ensure compliance. We had no legal or regulatory violations or penalties during fiscal 2017.

When any substance of very high concern (SVHC) is present in our products at a level of 0.1% or higher, we disclose the information appropriately, based on EU REACH[3] regulations. We also provide safety data sheets (SDS) in accordance with GHS[4] requirements. To comply more effectively with regulations such as EU REACH and China RoHS,[5] in April 2015, we conducted a survey of our Japanese suppliers regarding the chemical substances contained in their products based on JAMP AIS.[6] In fiscal 2017, we made capital investments to strengthen our IT systems with the aim of enhancing supply chain management of chemical substances in products we use.

We are also focusing on employee education. We now offer a seminar on Product Compliance with Environmental Laws and Regulations to all employees, including not only managers but also staff members from relevant departments. The seminar consists of an overview of frequently revised environmental laws and regulations, lectures on target chemical substances, and comprehension tests. In fiscal 2017, 97% of our employees took the course.

We will continue to closely monitor and appropriately respond to relevant laws and regulations worldwide, further increasing our efforts to reduce hazardous chemical substances.

3 EU REACH: An EU regulation pertaining to the registration, evaluation, authorization, and restriction of chemicals

4 GHS: Globally Harmonized System of Classification and Labelling of Chemicals

5 China RoHS: Chinese regulation on materials including lead, mercury, cadmium, hexavalent chromium, polybrominated biphenyls (PBBs), and polybrominated diphenyl ethers (PBDEs). Businesses are required to provide customers with relevant information on the use of these materials.

6 JAMP AIS: Article Information Sheet (AIS) promoted by the Joint Article Management Promotion-consortium (JAMP). This sheet is used to communicate basic information on regulated chemical substances contained in products.