Research and Development

Continuous Technological Innovation is Required in the Semiconductor Industry

The advance of miniaturization and the use of larger wafers have allowed the semiconductor industry to simultaneously achieve higher functionality (faster operation and lower power consumption) and cost reduction, building the foundation for the broad adoption of electronics around the world. In addition to demand for performance improvements, the arrival of smartphones has created new technical demand for application-oriented semiconductor device development, aimed at realizing the functions and performance that more users want.

In application-oriented device development, customers look not only for differentiation in device design, but for diversity of materials and process technology as well. Semiconductor production equipment manufacturers engage all technical possibilities; Tokyo Electron implements strategic, efficient technological development according to the level of necessity of each technology.

Tokyo Electron engages in development aimed at near-term commercialization as well as medium-term development in close collaboration with strategic customers when it is deemed necessary to incorporate core technologies to accelerate commercialization. In medium- and long-term development, which will produce the Company's mainstay technologies of the future, Tokyo Electron collaborates with universities and consortia to facilitate wide-ranging data gathering and the acquisition of technologies. These measures ensure that the Company is comprehensively prepared for future technologies. Cutting-edge technology changes rapidly. Tokyo Electron is boldly advancing groundbreaking technological innovation in these areas, laying the path for future growth.

Initiatives in Miniaturization, 3DI Packaging and Larger Wafer Sizes

The evolution of semiconductors has long been synonymous with progress in miniaturization. Tokyo Electron has greatly contributed to device scaling by developing adjacent processes for the latest lithography, which has been a driver of miniaturization. Now, the various technologies related to semiconductors stand at an inflection point. Tokyo Electron is developing innovative equipment to meet the demands of new technologies.

In the area of Extreme Ultraviolet (EUV) lithography, hailed as the next generation of lithography, Tokyo Electron is engaged in joint development with imec* and other consortia worldwide as well as with ASML Holding, the world's largest supplier of lithography systems. In double and multiple patterning, which achieves miniaturization through the use of deposition and etching technologies, Tokyo Electron is focused on process technologies with priority to reducing patterning cost, aiming to bring 10nm nodes to practical use. Directed self-assembly (DSA) uses the chemical properties of materials to form circuit patterns, without relying on lithography. To quickly establish technology to bring DSA into practical use, Tokyo Electron collaborates with imec and participates in EIDEC's DSA research program.

At the same time, in the field of 3DI (three-dimensional integration), which utilizes technology for creating high-performance semiconductors through the three-dimensional stacking of chips, Tokyo Electron is developing equipment and process technology through the process integration evaluation of imec, Sematech and other consortia. With regard to making silicon wafers larger to improve productivity, Tokyo Electron is steadily advancing efforts to meet customer demand for 450mm wafers as a leader in the production equipment market.

* imec: imec performs world-leading research in nanoelectronics. Imec leverages its scientific knowledge with the innovative power of its global partnerships in ICT, healthcare and energy.

Going forward, Tokyo Electron will continue to rapidly reflect innovative technologies in its products and advance R&D aimed at providing even greater value to customers.

Initiatives in Reducing Semiconductor Power Consumption

Device development going forward is aimed at rapidly processing large-scale data and using less power. Technologies for higher-speed processing include conventional miniaturization with silicon, new materials to overcome the limits of such miniaturization, notably indium gallium arsenide (InGaAs) and other III-V semiconductors, which have high carrier mobility*, as well as layered semiconductor technologies, such as the use of graphene. Tokyo Electron is actively incorporating the insights of research institutions around the world in its development of these next-generation semiconductor technologies.

Tokyo Electron is engaged in R&D aimed at developing carbon materials for future practical use with the Low-power Electronics Association & Project (LEAP). The Company is furthermore developing technologies related to silicon photonics** for low-power consumption telecommunications, seeking to realize equipment and processes that contribute to further power use reduction.

As part of efforts to reduce power consumption with next generation devices that operate on new principles, Tokyo Electron participates in a research program focused on STT-MRAM (Spin Transfer Torque-Magnetoresistive Random Access Memory) at Tohoku University's Center for Innovated Integrated Electronic Systems, Research and Development.

Going forward, Tokyo Electron aims to quickly establish manufacturing technologies for new materials and devices.

* Carrier mobility: The ease with which electrons can move within a solid substance
** Silicon photonics: Technology for creating integrated circuits that use photons out of silicon

Initiatives in New Areas

Looking to realize sustained growth, Tokyo Electron is also focused on utilizing core technologies developed for semiconductor and flat panel display production equipment to cultivate new business areas.

In displays, Tokyo Electron is developing production technology for OLED panels, which realize reduced power consumption. The Company has released *Elius™ 2500*, an inkjet printing system for manufacturing OLED panels. In place of the evaporation technology currently used in mass production of OLED panels, this system uses inkjet printing to discharge only the necessary amount of organic luminescent material onto large glass substrates without need of a vacuum, greatly improving productivity in film forming.

Furthermore, in terms of possible applications of printing technology to flat panel display production processes, Tokyo Electron is involved in JAPERA (Japan Advanced Printed Electronics Technology Research Association), assessing cutting-edge application-oriented technologies. Going forward, Tokyo Electron will continue R&D aimed at further growth, exploring business opportunities in semiconductor and flat panel display production and their peripheral areas as well as new business areas.

Aiming for sales expansion through product development in response to new technologies

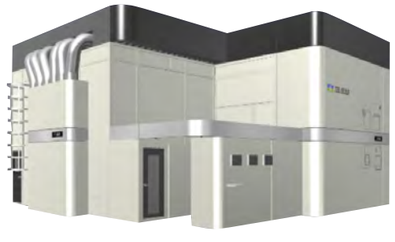
ALD System
NT333™

Semi-batch ALD system employing a concept different from existing ALD processes, realizing high-quality nano-scale deposition while maintaining high productivity.

Zoom

Metallization System
Triase+™ EX-II™ TiN

The newest single-wafer metallization system, for next-generation devices. Compatible with a wide range of deposition materials, this system features lower temperatures, excellent step coverage and film control.



Inkjet Printing System for Manufacturing OLED Panels *Elius™ 2500*

The inkjet process can dispense to ink to just selected areas of substrate without a mask (direct patterning), realizing low material consumption to greatly reduce production costs. The inkjet process is excellent for use with large panels and can be used without a vacuum.

Zoom

Tohoku University Center for Innovative Integrated Electronic Systems

Tokyo Electron is taking part in the research and development program conducted by Tohoku University Center for Innovative Integrated Electronic Systems, with the aim of quickly establishing production equipment technology for STT-MRAM, which is attracting attention as a next-generation memory device.

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