

# Semiconductor Device Manufacturing & Inspection Equipment

## Connective Industries

#Healthcare, QoL #Productivity Improvement #IoT/Data Utilization #Measurement & Analytical Systems

### 1. Isotropic Etching Tool for Fabrication of 3D Device Structures

Three-dimensional (3D) device fabrication is becoming more common, with gate-all-around (GAA) and 3D NAND among the structures now being used in advanced semiconductor devices. As the manufacture of these devices requires precise control of etching in the horizontal direction (isotropic processing), Hitachi has developed a dry chemical removal (DCR) module that satisfies this requirement.

The module uses an ion shielding plate between the plasma and wafer stage to exclude ions and only deliver chemically reactive radicals (excited gas) to the wafer. The lack of directionality in the action of the radicals allows for etching in the horizontal direction. The module is also equipped with an infra-red lamp and electrostatic chuck to enable wafer temperature to be varied rapidly between -5 and 300°C, achieving precise control by a repeated process of radical species adsorption at the atomic layer level and the etching reaction.

The newly developed module was supplied to a US company as an evaluation unit in 2018 and entered full-scale production in 2023. Along with the timely delivery of innovative solutions, Hitachi intends to continue contributing to advanced manufacturing.

(Hitachi High-Tech Corporation)

[01] 9000 series conductor etching tool with DCR unit



### 2. GT2000 Metrology System for Next-generation EUV Lithography

As the semiconductor fabrication processes continues to advance, research and development is now underway on the 2-nm (2N) and 14-Å (A14) generations of process technology. In addition to the use of extreme ultraviolet (EUV)\* lithography, it is anticipated that advanced semiconductors will adopt complex device structures featuring GAA.

Hitachi has developed the GT2000 metrology system to satisfy these requirements. This included the development and adoption of high-speed scanning and 100-V acceleration for low-damage EUV lithography as well as ultra-high-speed multi-point measurement and analysis functionality for the detection of stochastic defects that occur with a given probability in EUV lithography. To enable the 3D measurement of increasingly complex device structures, the GT2000 is also features the efficient detection of back-scattered electrons and a new 15-kV condition for the efficient generation of back-scattered electrons. Augmenting these new functions are improvements in the core performance of the system as a critical dimension scanning electron microscope (CD-SEM), specifically resolution, tool-to-tool CD matching, and processing time. To enhance the Hitachi brand image, the external appearance has also been refreshed by adoption of the Nano Blue design that has previously been used on analytical solution systems.

(Hitachi High-Tech Corporation)

[02] GT2000 metrology system for next-generation EUV lithography



\* Use of extreme ultraviolet light with a 13.5 nm wavelength for the lithography process

### 3. DI4600 Dark Field Wafer Defect Inspection System for Excellent Line Management

Reducing manufacturing costs is an essential requirement for semiconductor manufacturers' competitiveness. Maintaining high yield in semiconductor manufacturing is crucial to achieving this. Condition monitoring in manufacturing lines can help to reduce loss costs through the rapid detection of mal-site areas that can degrade semiconductor yield.

To realize yield monitoring, dark field wafer defect inspection systems, Hitachi High-Tech Corporation, uses specialized optics to achieve high speed and high level of defect detection performance, also incorporating the existing technologies, which are sheet-beam optics for rapid scanning of entire wafers and spatial filters for accurately discriminating back scatter light from the wafer pattern to detect signals from particles. The new DI4600 combines improved defect detection performance with higher throughput, featuring more advanced processing of the optical signal using an upgraded image processing system, enhanced signal processing algorithm, and improved auto-focus function. The DI4600 system is widely installed as an in-line defect management tool for the yield monitoring of the latest memory and logic devices.

(Hitachi High-Tech Corporation)

[03] DI4600 dark field wafer defect inspection system



4. SU9000II Ultrahigh-resolution Field Emission Scanning Electron Microscope

Advanced semiconductor devices are achieving ever higher levels of miniaturization with the introduction of increasingly complex structures. Cross-sectional structural analysis at ultra-high magnification is becoming increasingly important in the development field, and the acquisition of large amounts of data and its reflection in the analysis process is becoming critical.

The top field emission scanning electron microscope (FE-SEM) model, SU9000II, features an in-lens objective lens, the ultimate in low-aberration lenses, world-leading resolution of 0.4 nm (at 30 kV acceleration), and an innovative electron optics design that guarantees a resolution of 0.7 nm at low acceleration voltages (using the 1 kV landing voltage option). This enhanced core performance delivers fast throughput. To put this performance to good use, the microscope has an automatic adjustment function for the optics to ensure reliable data acquisition as well as continuous data acquisition and other functions that help to automate data collection.

Hitachi High-Tech Corporation intends to continue developing and supplying devices that satisfy diverse requirements in fields such as semiconductor device development and fabrication.

(Hitachi High-Tech Corporation)

[04] SU9000II ultrahigh-resolution FE-SEM



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