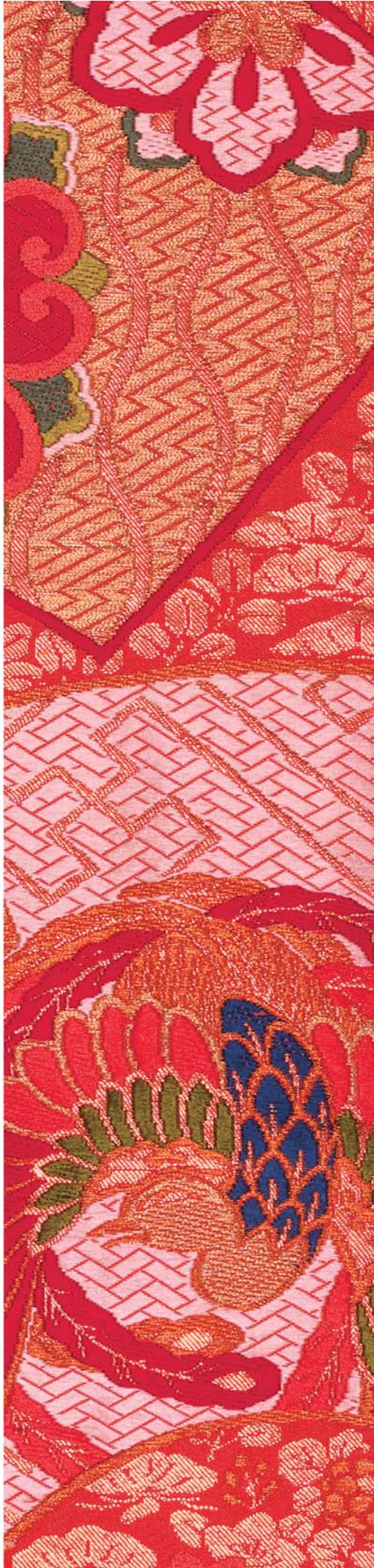
2009-2010
HITACHI TECHNOLOGY

Electronic Devices

- Semiconductor Manufacturing and Inspection Equipment
- Displays



"Okochi Memorial Production Prize" for Critical Dimension SEM's Contribution to Semiconductor Scaling

Hitachi, Ltd., Hitachi High-Technologies Corporation, and Hitachi High-Tech Fielding Corporation were awarded the 54th (2007) "Okochi Memorial Production Prize" by the Okochi Memorial Foundation for the development and practical application of a critical dimension SEM, an essential instrument for the production of semiconductors, a field in which pattern size reduction (scaling) continues to advance. Hitachi has made ongoing efforts to improve the performance of its organization which extends from research and development to services.

Back row (left to right): Toru Ikegami, Manager, Product Marketing Group CD Metrology, Process Control Systems Sales Department 1; Sho Takami, Senior Engineer, Metrology Systems Design Department, Naka Division, Nanotechnology Products Business Group; Maki Tanaka, Senior Engineer, 1st Department, Research and Development Division, Hitachi High-Technologies Corporation. Front row (left to right): Tadashi Takeshima, General Manager, Semiconductor Process Control System 1st Department; Kazuhiko Sakakibara, General Manager, Electromagnetic Instruments Department, Instruments Service 2nd Division, Hitachi High-Tech Fielding Corporation; Hiroyuki Shinada, Chief Researcher, Solution LSI Research Laboratory, Central Research Laboratory, Hitachi, Ltd.

Transforming Laboratory Equipment into Industrial Measuring Instruments

CD-SEM (critical dimension scanning electron microscope) is an instrument that uses SEM technology to measure the dimensions of semiconductor circuit patterns. Hitachi's first model was commercialized in 1984. Electron microscope technology has been a particular area of expertise for Hitachi since that time and was adopted because pattern size reduction (scaling) of semiconductors had gone beyond the limits of what could be measured with optical microscopes. However, SEMs are designed for use in research and adapting such laboratory devices for use in industrial production lines is no simple task.

A particular challenge was the risk of damage to the wafers being measured due to the electron beam impact or accumulated electric charge. This problem was addressed by lowering the energy of the electron beam to 1 keV or less. While lowering the energy on standard electron guns results in blurred images, a high-brightness field emission electron gun became available to achieve high resolution.

An accurate scale is required if a device such as an electron microscope, which was originally designed for viewing micro structures, is to be used for dimensional measurement. To ensure that the device could operate as an accurate measuring instrument, Hitachi developed a world-first "microscale" magnification calibration sample with a 240-nm pitch in cooperation with the National Research Laboratory of Metrology which is part of the Agency of Industrial Science and Technology at the Ministry of International Trade and Industry (now the National Institute of Advanced Industrial Science and Technology). Subsequently, a scale with a 100-nm pitch was also developed successfully.

In addition, Hitachi continuously makes efforts to secure higher added value in many areas, such as improving automated measuring functions to reduce the workload of production line operators, and innovations to prevent contamination by foreign objects especially particles which are among the greatest menace of semiconductor products.

Power of Service to Maximize Performance of Instruments

More than 3,500 of Hitachi's CD-SEMs have been put to use all over the world since the product was first released. According to data from a research firm in the USA, Hitachi's CD-SEMs had a market share of about 82% in 2008. Hitachi believes that an important factor behind this success is the product's high reliability which is a consequence of the fact that every step from developing the individual technologies used in the instrument through to its manufacture is carried out in-house.

Ongoing work by the service department aimed at working with customers to ensure that the instrument performs at its best 24 hours a day, seven days a week is also an important aspect of product quality. When installing a CD-SEM at a customer's factory, Hitachi takes environmental measurements from the installation site and, if necessary, installs magnetic field cancellers, vibration isolation platforms, or other additional equipment to minimize the effect on the instrument of any potential sources of interference such as magnetic fields, vibration, or sound. Once the instrument is in operation, Hitachi also provides assistance for improving production efficiency through troubleshooting and sophisticated preventive maintenance technology that can prevent problems before they occur. Site data and customer feedback obtained from this service work are shared with the development department and utilized in the development of the next generation of products.

It was as a result of this past success that Hitachi won the "Production Prize" at the "Okochi Memorial Prizes" which is awarded in recognition of outstanding performance in the field of production technology.

Production Process Supported by Both "Measurement" and "Imaging"

Hitachi's CD-SEM is being continuously improved to achieve higher throughput and greater measurement repeatability and resolution. The measurement repeatability improved from 25 nm in the first model to 0.3 nm in the new CG4000 model released in 2006 which supports the next-generation minimum pattern line width of 45 nm. Scaling of semiconductor devices will continue and this will likely involve the adoption of new materials and structures. This will increase the importance not only of measurement but also of pattern management. One of CD-SEM's major features is the ability to visually confirm device patterns and further improvements in resolution and image quality are anticipated. Encouraged by the winning of the prize, Hitachi will further improve performance, reliability, and added value, and contribute to the development of the semiconductor industry.

Super-resolution Patterning for Next-generation Microfabrication

Recent years have seen rapid advances in reducing the pattern size used in semiconductor devices, especially non-volatile memory.
Currently, double patterning technology is being considered as a way of extending the resolution limits of lithography as pattern size reaches circuit widths of 45 nm or less. A number of different methods have been proposed for double patterning, one of which is SADP (self-aligned double patterning).
Now, Hitachi has developed a super-resolution patterning technique for SADP using its batch ALD (atomic layer deposition) system. The technique uses an ALD film as the pattern-forming mask and is very dependent on having a highly uniform thin film. This requirement for high uniformity in thin film formation is a common challenge for all double patterning techniques and the Hitachi's batch ALD system achieves super-resolution patterning by utilizing the uniqueness of Hitachi's technologies to focus on this problem.
[Key features]
(1) ALD provides high uniformity, excellent step coverage, low-temperature film formation, and solves the problems of loading effects (pattern dependence).
(2) Hitachi's batch ALD system improves productivity through larger wafer loading sizes and contributes to energy saving in factory facilities.
(Hitachi Kokusai Electric Inc.)

Batch ALD system

M-8170XT Microwave ECR Plasma Etching System

The M-8170XT microwave ECR (electron cyclotron resonance) plasma etching system performs high-precision processing of hard masks (such as SiN, SiO_2) and gates in the etching process during the production of leading-edge memory and logic devices.


M-8170XT microwave ECR plasma etching system

The processing chamber in the system is perfectly axisymmetric about the wafer electrodes and the gas and exhaust systems are aligned coaxially with the electrodes. This structure facilitates control of processing shapes and uniformity and provides stable high-precision processing at low pressure. The main features include: (1) can maintain high CD (critical dimension) uniformity; (2) high throughput with consistent processing from hard mask to gate processing; (3) proven success in the use of new materials (such as metal gate materials and high-*k* dielectrics) and new structures (such as three-dimensional transistors); (4) provides repeatability and stable mass production using AEC (advanced equipment control) and APC (advanced process control); and (5) proven results demonstrated in testing with resist materials, lithography system and deposition system manufacturers, including for double-exposure processes.
The system has been selected by a logic manufacturer outside Japan as the base machine for developing the latest gates and testing is currently underway.
(Hitachi High-Technologies Corporation)

30-inch High-definition LCD Module for Medical Use

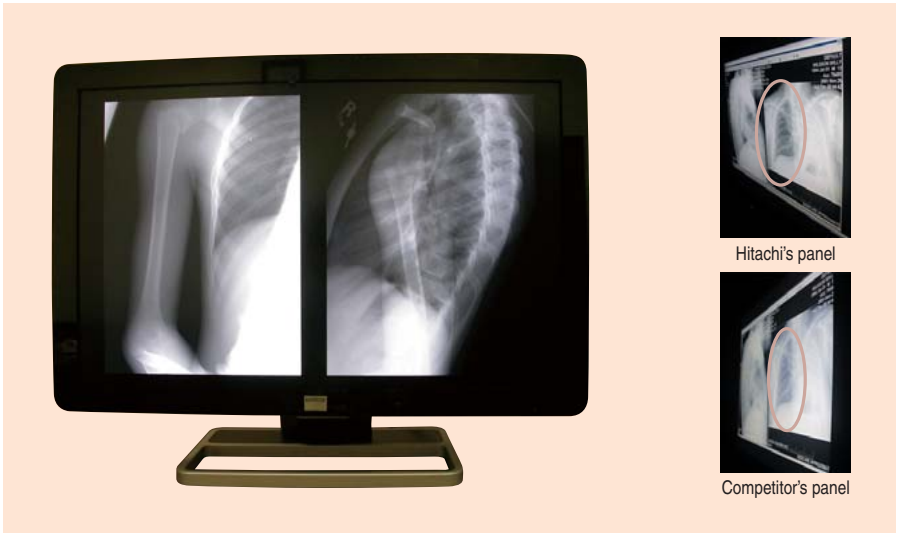
Developments in medical IT (information technology) have seen a growing number of hospitals adopting electronic data formats for medical images. This includes X-ray images that were previously recorded on film, as well as MRI (magnetic resonance imaging) and CT (computed tomography) images. As medical images used for diagnosis must be precisely reproduced on every terminal in the hospital, LCD (liquid crystal display) monitors are used in a controlled environment to ensure consistent image quality.

The 30-inch (about 76.2-cm) high-definition LCD module can reproduce a wide range of different medical images precisely, with 3,280×2,048 (about 6.7 million pixels) resolution which provides more than three times as much information as Hi-Vision (high-definition television, 1,920×1,080). In addition, Hitachi's original IPS-Pro (advanced version of in-plane-switching mode) drive mode and latest process technology produce bright images with high contrast. As a result, the LCD modules have been well received for helping improve the accuracy of diagnosis and because they provide "consistent image quality from any viewing angle."

From the perspective of environmental protection, the backlight has an innovative cooling system that significantly reduces power consumption.

Hitachi will make further contributions to the incorporation of high technology into medical systems by working on technical innovation based around IPS and by taking advantage of its manufacturing know-how to realize Hitachi's dreams.

(Hitachi Displays, Ltd.)



30-inch high-definition LCD module for medical use (shown in a monitor unit made by Barco) and an example of how images are distorted when viewed from an angle

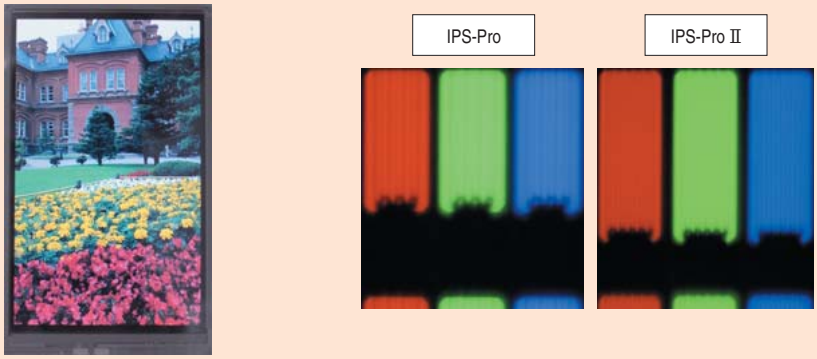
3-inch Wide VGA Display for Mobile Phones

The adoption of advanced functions in mobile devices has led to demand for LCDs (liquid crystal displays) with wider screens and higher definition.

To meet these demands, Hitachi Displays, Ltd. has developed a 480×800 pixel 3-inch (about 7.62-cm) wide VGA (video graphics array) display that incorporates high-transparency IPS (in-plane-switching mode) technology [IPS-Pro (advanced version of in-plane-switching mode) II] using low-temperature polysilicon. The IPS-Pro II features improved production process dimensions and interlayer alignment accuracy compared to the previous IPS-Pro technology and transmittance has been improved by 1.4 times. As a result, the luminance of 370 cd/m^2 produced by this screen size is among the best available.

Reducing power consumption is an important issue for making the display more environmentally friendly. Because of the display's high luminance, the current in the LED (light emitting diode) backlight can be reduced when operating at the normal luminance level of about 300 cd/m^2 to save energy.

(Hitachi Displays, Ltd.)



3-inch wide VGA display for mobile applications (left) and difference between IPS-Pro and IPS-Pro II (right)