□*The Okochi Memorial Production Prize 3*

Development and Commercialization of Critical Dimension Scanning Electron Microscope for Measurement of Ultra-fine Semiconductor Patterns.

Hitachi Ltd.
Hitachi High-Technologies Corporation
Hitachi High-Tech Fielding Corporation

Background

The minimum feature size of large-scale integrated (LSI) circuit patterns has continued to be miniaturized by about 70% every three years for the past three decades. The permissive tolerance percentage of pattern size is less than ±10-15%, and the accuracy of measurement equipment is required to be within 2-3% of the minimum feature size of the semiconductor pattern. The optical metrology system has been used when the minimum feature size of the semiconductor pattern has been up to 1 μm. However a metrology system using a scanning electron microscope (SEM) has been desired in order to correspond to 1-μm patterns and below. Although SEMs have been used by academic researchers for some time, we have recently developed several novel technologies to achieve an SEM metrology system for industrial use.

Features and results achieved

1) First commercial system "critical dimension SEM (CD-SEM)" in 1984.
  - Low acceleration voltage SEM; uncoated sample treatment and damage-free inspection
  - High brightness field emission gun; out of dark room and *in-situ* measurement in factory
  - Auto measurement system; foolproof operation for factory line staff
2) Recently released CD-SEM in 2006.
  - High resolution optics, highly efficient signal detection system and noise reduction technology; measurement repeatability of 0.3 nm in 3σ corresponding to 45-nm node semiconductor LSI expected to be in mass production in 2010
3) "Standard microscale" reference—traceable to national standard for calibrating SEM magnification. We have developed the world's smallest 240-nm pitch reference in collaboration with the National Research Laboratory of Metrology (now, the National Institute of Advanced Industrial Science and Technology (AIST)) and the Japan Quality Insurance Organization (JQA) in 1994. We also developed a 100-nm pitch reference in conformity with the Japan Calibration Service System with AIST and JQA in 2007.

Thus we released new CD-SEMs and standard references that continuously precede the progress of semiconductor LSI. We have sold in total over 3000 CD-SEMs and achieved a top share of 77 and 83% in the worldwide and domestic markets respectively, according to an American research firm. Thus our technology and products have contributed widely to semiconductor development over a long period.

Future prospects

Our technology will contribute to semiconductor expansion in the future through the development of line-width measurement and secondary dimensional image analysis, and is also expected to contribute to the recently watched nano-technology industry.