

1984

Critical Dimension-Scanning Electron Microscope

(CD-SEM)

~ **Discrete Semiconductor/Others** ~

Microfabrication in the submicron range by optical lithography was enabled by means of reduction-projection exposure system in the 1980s ⁽¹⁾. However, because this fineness was near the optical resolution limit, dimension measurement and control using the conventional optical microscope method became unsuitable. Scanning electron microscopes (SEM) had superior in depth of focus and resolution in comparison with optical microscopes, but were unsuitable for dimension inspection because of image degradation and damage to transistor caused by charging due to electron beam irradiation.

Hitachi (after Hitachi High-Technologies) solved the problems of the SEM method and developed the CD-SEM (Critical Dimension Scanning Electron Microscope) system (S-6000 CD-SEM) in 1984 ⁽²⁾ ⁽³⁾. Hitachi enabled high-resolution measurement using a low acceleration voltage of approximately 1 KeV adapting the field emission electron gun of the FE-SEM developed by the company in 1972 in order to prevent charging and element damaging. Hitachi realized a high-throughput automated inspection system by supplementing through-the-lens system that detected secondary electrons through a lens magnetic field to ensure signal symmetry. CD control in the submicron range became possible with the commercialization of the CD-SEM.

Hitachi (after Hitachi High-Technologies) subsequently continued to improve resolution through the adoption of the semi-in-lens method (1989), which shortened the focal length by generating a lens magnetic field on the wafer side, and the use of the SE (Schottky Emission) electron gun (1994), which has excellent electron emission stability, and the retarding method (1994), which increased resolution ⁽⁴⁾. The CD-SEM was an indispensable inspection system for development of semiconductor technology, in which devices were shrinking its dimensions according to Dennard- Scaling rule.



CD-SEM (S-6000)

(Courtesy of Hitachi High-Tech Corporation)

References:

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