

## Late 1970s

# Field Emission Scanning Electron Microscope (FE-SEM)

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The prototype of scanning electron microscopy (SEM) that enabled the observation of fine three-dimensional structures was invented by Max Knoll of the Berlin Institute of Technology in 1936. It was first productized as a commercial machine by Cambridge Scientific Instrument Company in 1965 (Stereoscan MK 1). In Japan, JEOL (JSM-1) and Hitachi (HMS-2) began to sell the machine in 1966 and 1969 respectively. In the manufacturing technology development of LSI from the 1970s onwards, microstructure analysis of devices and minute dusts in electron microscope levels became indispensable, and SEM became a powerful tool.

In 1972, Hitachi (currently Hitachi High-Tech Corporation) developed and released SEM (FE-SEM) using a field emission electron source in collaboration with Chicago University (FES-2, Figure 1). It used an electron beam source that generated high brightness electron beams with small energy dispersion by applying a high electric field to tungsten cathode which was polished in extreme sharpness, thereby achieving high resolution of 3 nanometers. The principle of this electron beam source was invented by Albert V. Crewe of Chicago University in 1968.

FE-SEM came to be used for microstructural analysis in various fields, and in particular, it became an indispensable tool in the semiconductor device processes which have continued the proportionate shrinkage. The resolution continued to improve after that, and in the 1980's it was also used for CD-SEM measuring fine dimensions of semiconductors.

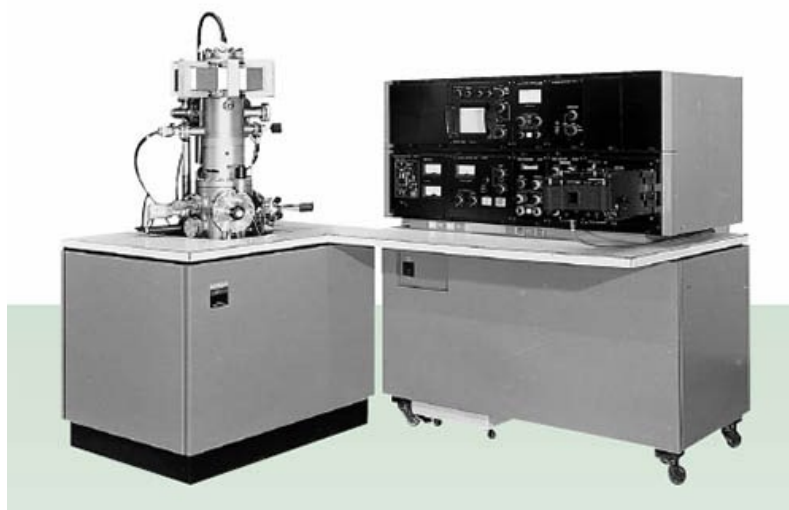


Figure 1 FE-SEM (FES-2)  
(provided by Hitachi High-Tech Corporation)