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Recent development of an UHR and ULV FE-SEM with various signal detection capabilities and its applications

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A new concept field emission SEM, Hitachi's model S-4800, has been developed with a newly designed snorkel lens, enhanced mechanical/electrical stability (close to that of an in-lens FE-SEM), imaging magnifications up to 800kX, and an 8 inch specimen handling capability. Fig.1 shows its ultra-high resolution imaging performance with a catalyst. The 1 to 2nm size Pt particles (indicated by arrows) and the carbon substrate are clearly visible.

This instrument employs a selectable signal detection system, which allows the detection of SE, BSE, or a combination of these signals for an optimized image contrast that suits the specimen or purpose of the microscopy investigation. Fig.2 shows an example of a FIB milled transistor from a LCD. The BSE image reveals multi-layered composite information (indicated by arrows)/ On the other hand, the SE image shows the depth and inner structure of the defect area.

The S-4800 has another imaging technique, beam retarding, for achieving high-resolution at ultra-low voltages. Image resolution under this beam retarding mode has been calculated and verified as 2.0 nm at 500V (Fig.3).

The instrument's evaluation capabilities are further broadened with various additional detectors such as YAG-BSE, EDS, and STEM. It is said that STEM imaging with a limited accelerating voltage of up to 30kV leads to good contrast of lower atomic number materials due to wider spread angles of transmitted electrons [1]. The STEM micrograph of carbon nanotubes (Fig.4) shows multi-walled inner structure and inner hole size clearly.

Additional applications are reported such as the combinations of EDS and STEM and the performance for a wider field of applications.

[1] Shiraga, et al. kobunshi ronbunshu. **49**, 4 (1992) 353-359

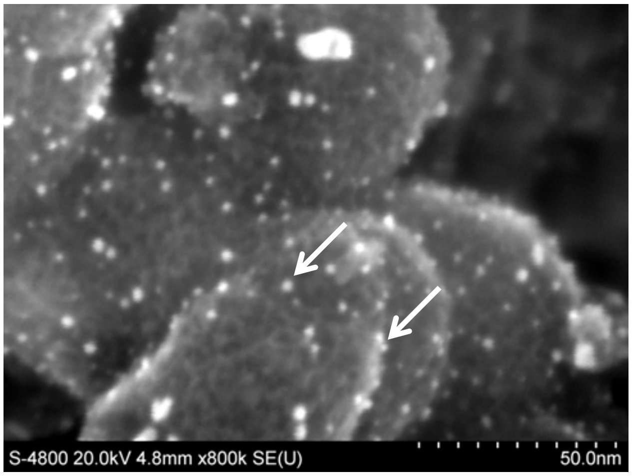

Figure 1. Ultra high resolution microscopy of Catalyst

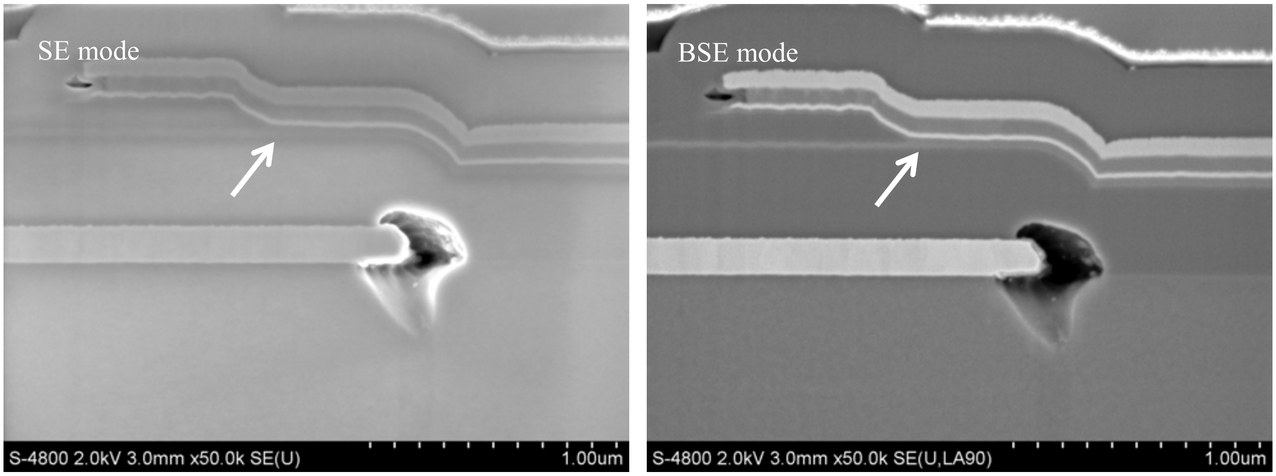

Figure 2. Cross sectional observation of FIB-milled transistor

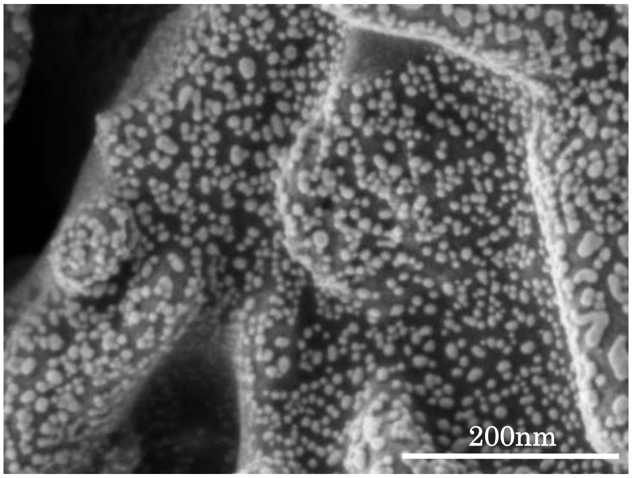

Figure 3. Resolution micrograph at 500V under retarding mode (Specimen : Au on magnetic tape)

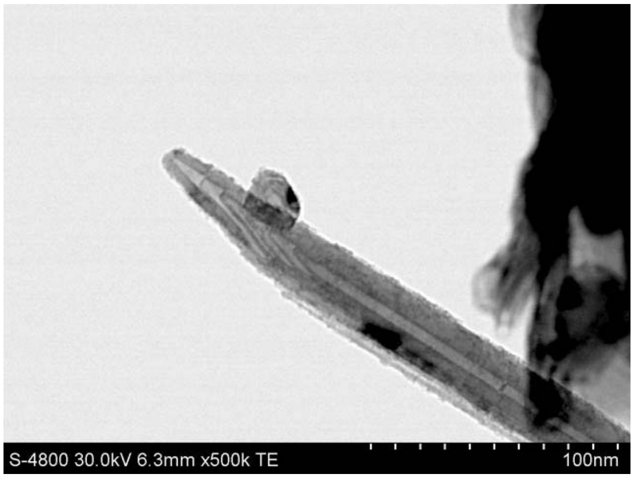

Figure 4. STEM micrograph of multi-layered carbon nanotube