TEM Transmission Electron Microscopy

MATERIALS & SURFACE SCIENCE INSTITUTE

Introduction

Transmission electron microscopy (TEM) is a powerful tool for examining materials at high resolution. In the microscope, electrons are directed through a series of lenses through a thin sample (<200 nm thick). The transmitted electrons then pass through additional lenses to be projected onto a viewing screen or recorded with a digital camera. TEM can provide microstructural details down to an atomic level and can be utilised to examine crystal structures and crystalline defects. Much of the work performed in MSSI to date has centred on determining structure-property relationships for a wide range of materials, including metals, alloys, semi- and superconductors, ceramics, nanoporous supports and polymers.

The JEOL JEM-2100F is a multipurpose, high resolution, electron microscope with a field emission source. Standard techniques available include bright-/dark field imaging, high resolution lattice imaging and electron diffraction. In addition, there is a STEM attachment, which simultaneously obtains bright field (BF) and high angle annular dark field (HAADF) atomic resolution images. The microscope also includes an SEI/BSE detector enabling topographical data to be collected. The energy dispersive X-ray analyser allows qualitative/quantitative elemental composition analysis even at atomic resolution due to the very small probe size. Digital micrographs and diffraction patterns can be obtained with a state-of-the-art digital camera and software. In addition, computer controlled 3D reconstruction high angle tomography can be achieved.

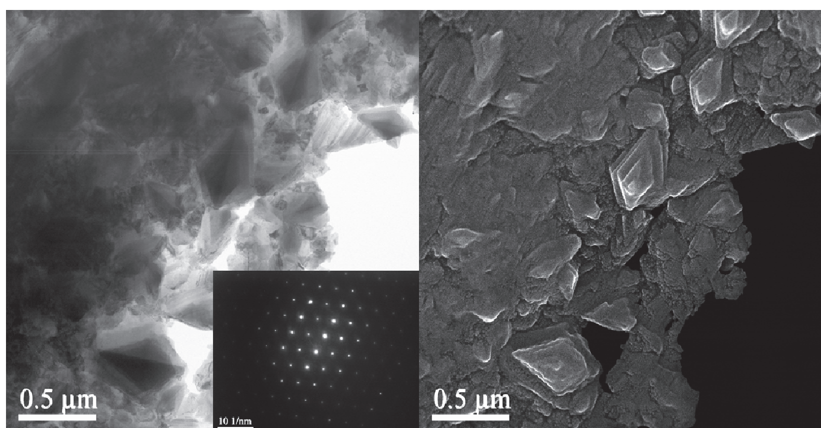

Figure 1. Images of copper crystals using the STEM mode using (left) bright field and (right) SEI/BSE detectors. SEI/BSE detector allows for topography data to be collected. Inset is nano-beam electron diffraction (NBD) showing a single crystal [110] pattern of an individual particle.

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TEM

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Technical Specifications

- Operating voltage of 80 – 200 kV with resolution to 0.14 nm.
- Magnification of 50x – 1, 500, 000 with probe size to 0.5 nm
- SEI/BSE detector and STEM unit
- Double Tilt holder
- Multi sample and bulk sample holders
- Single and dual axis tilt (±70) tomography holders
- TEM/STEM tomography software
- Diffraction pattern mapping software
- Gatan Ultrascan 1000 digital camera
- EDAX Genesis XM 4 system 60

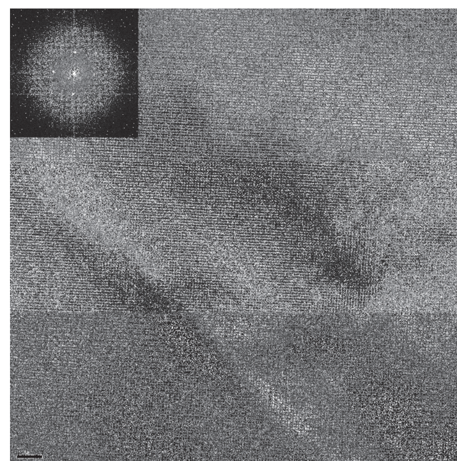

Figure 2. Image in HRTEM mode of a single crystal Au (dark contrast). Inset is a Fourier transform. Each white dot is a column of atoms.

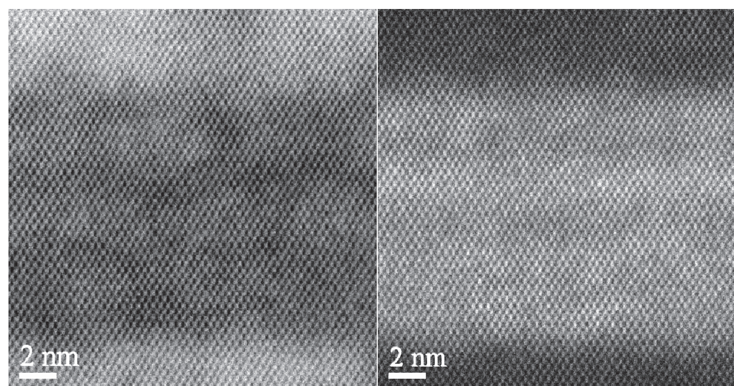

Figure 3. STEM images using BF and HAADF detectors of Si single crystal with Ge interlayer. As germanium is a heavier atom than silicon, the contrast is different in HAADF mode between the atoms and the germanium atoms (middle) will appear brighter than the Si atoms (top and bottom).

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