UNIVERSITY OF LIMERICK
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Bernal Institute

Scanning Electron microscopy
SEM

Overview

Scanning electron microscopy (SEM) is a powerful technique for examining a materials surface. In the microscope, electrons are directed through a series of lenses onto a sample. Many different types of electrons are then detected by various detectors. With the recent
developments in the electron source and the advancement in the technologies of the detectors, higher resolutions have been achieved that can be utilised to examine beam sensitive material, nanomaterial and grain structure. 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 Hitachi SU-70 is a multipurpose, high resolution, scanning electron microscope with a thermal field emission source. With upper and lower detectors, secondary electron imaging with a resolution of 1 nm can be achieved whilst keeping topographical data. There is also a dedicated back scattered electron (BSE) detector, allowing for images with contrast relating to the atomic weight of the elements in the sample. With the source being very stable, due to being thermal field emission, the SEM can have a wide range of attachments. With both energy dispersive X-ray spectroscopy (EDS) and wavelength dispersive X-ray spectroscopy (WDS), the composition of a sample can be measured as well as mapped. In addition to these detectors, there is an electron back scattered diffraction detector (EBSD). This can be used to investigate and map crystal grain boundaries in materials down to ~0.1micron.

Technical Specifications

- Operating voltage of 0.1-30 kV with resolution of 1 nm.
- Magnification of 35x – 800, 000
- Working distances 1.5-40 mm with tilt -5 – 70 degrees
- BSE Detector with 3 nm resolution
- Oxford Instruments EDS and WDS spectrum and mapping
- Oxford instruments EBSD mapping with ~ 0.1 micron resolution

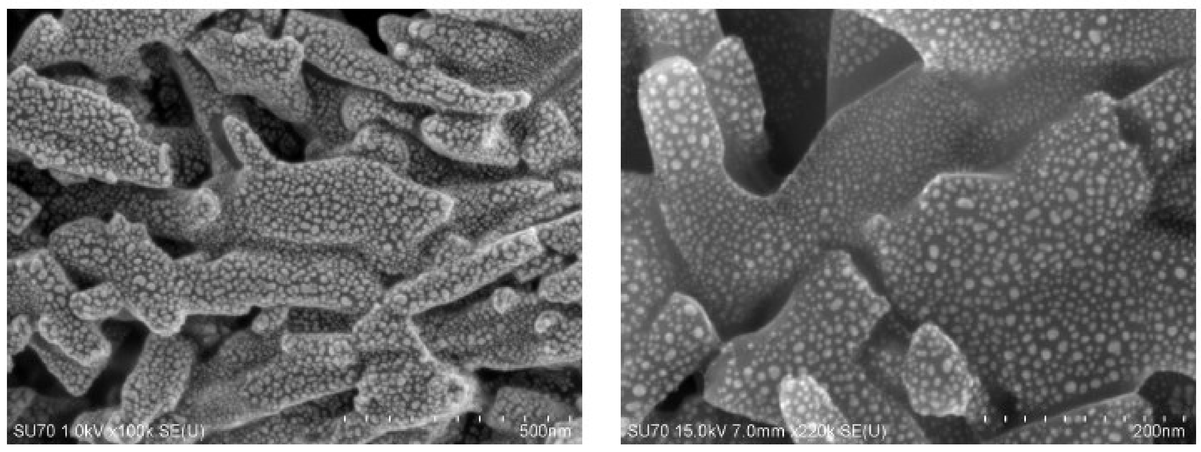

Figure 1. Images of gold islands on conducting film using the upper SE detector at (left) 1kV and (right) 15kV. The resolution remains similar indicating that using the lower voltages for uncoated beam sensitive materials can be done without loss in resolution

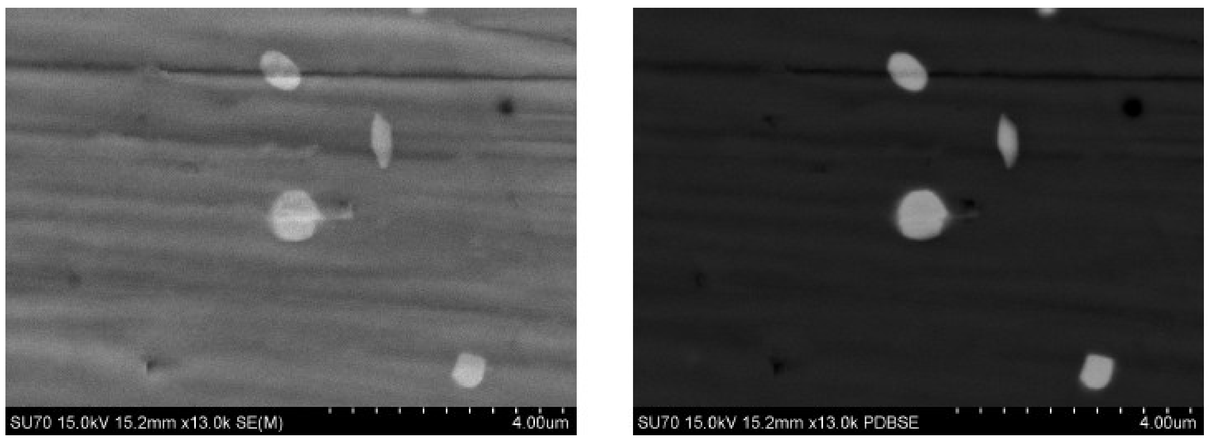

Figure 2. SEM images using (left) SE detectors and (right) BSE detector on a transition metal containing a lanthanide metal. The lanthanide is heavier, and therefore the contrast is stronger in BSE mode. Material is courtesy of Dr Tofail Syed

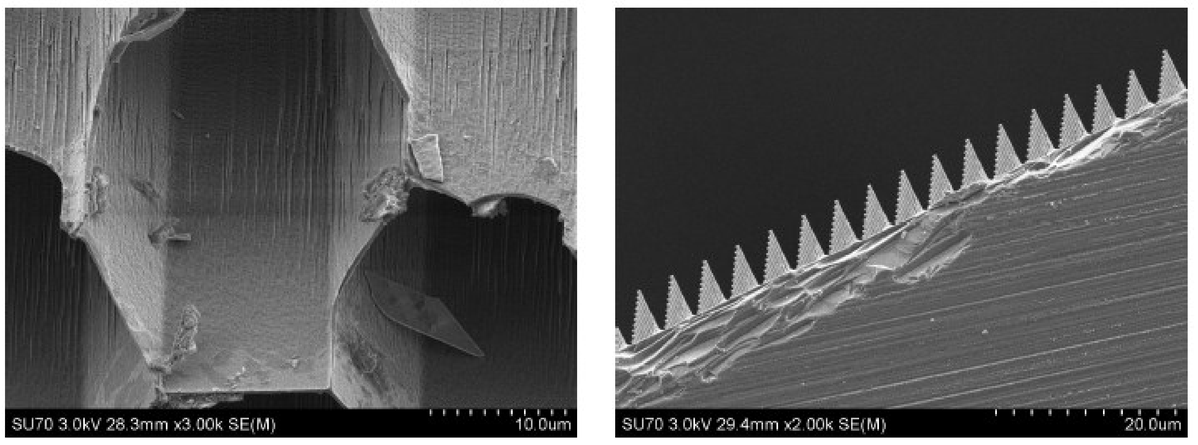

Figure 3. SEM images of lithography etched devices in a (left) honeycomb pattern and (right) pillar pattern. The picture on the left shows the defects in the walls with the inset revealing the overall structure. The picture on the right shows the well aligned pillars tilted at 15 degrees. Material is courtesy of Dr Ryan Enright (Stokes).

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