University of Nottingham
Nanoscale and Microscale Research Centre

Scanning electron microscopy (SEM)

Scanning electron microscopy uses a beam of electrons to characterise the topography and structure of a sample. High depth of field images with a 3D perspective and lateral resolutions down to 1-nm can be supplemented with simultaneous chemical and mechanical data.

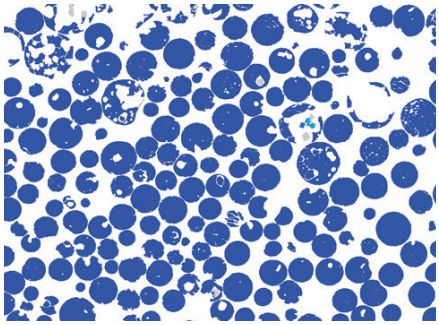
Variations of SEM allow for analysis options and sample manipulations that can accommodate a variety of sample types and formats.

Capabilities

- High magnification imaging of conducting and non-conducting materials
- Microscale topography and morphology analysis
- Elemental and compositional analysis
- Surface feature identification and measurement
- Sample sectioning, cryo-handling and micro-manipulation (FIB-SEM)
- Crystallographic analysis, micro-electron diffraction
- Wet, uncoated or dynamic environmental analysis (ESEM)

Typical applications

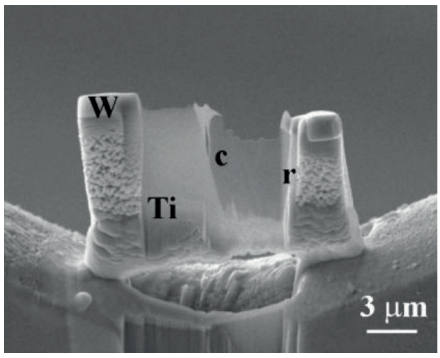
- Manufacturing analytics (stress and strain artefacts, wear and failure analysis and others)
- Micro- and nano-structural imaging and component identification
- Sample sectioning and high magnification full-structure visualisation
- Micro- and nano-particle/system sizing and localisation
- Grain sizing and qualitative/quantitative elemental mapping



Mineral mapping of compositionally uniform, magnetic microspheres

Mineral liberation analysis (MLA) enables automated large area analysis of sectioned samples in order to identify and quantify mineral distribution and composition. Image adjacent reveals high homogeneity for dense and porous, magnetic microspheres. A total of 1501 particles (99.7 wt%) were quantified and classified as $Ca_2Fe_2O_5$. Notably, this technique can be used to obtain a statistically significant set of data.

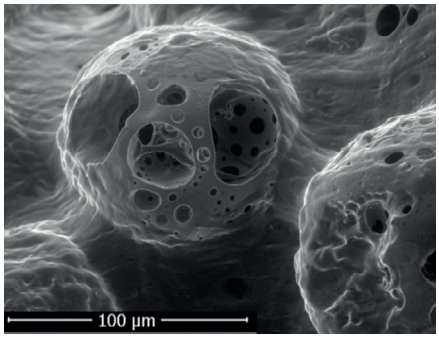
J Molinar Díaz, SA Samad, E Steer, N Neate, H Constantin, MT Islam, PD Brown, I Ahmed. *Materials Advances* (2020), DOI: 10.1039/D0MA00564A.



FIB sectioning of a biological Cryo-SEM sample

FIB-SEM manipulation allows delicate sample processing, such as cross sectional milling and 'lift-outs' which can in turn be imaged, or removed for analysis with further techniques (such as Raman spectroscopy, ToF-SIMS and TEM). This figure shows a lift-out section of a biomaterial interface between a Human Osteoblast (HOb) cell and a Titanium (Ti) foil. The lift-out section from a cryogenically frozen sample can be seen to contain a cell (c), resin (r), Ti and Tungsten (W) and is attached to a TEM support grid ready for further higher resolution analysis.

Microscopy at the life sciences/physical sciences interface. Paul D Brown, Hannah K Edwards and Mike W Fay. *Journal of Physics: Conference Series* 241 (2010), 012019



ESEM of phosphate-based porous microspheres interacting with mesenchymal cells

Environmental SEM (ESEM) was utilised to image phosphate-based glasses, porous microspheres (with Mg and Ti modifications, in this case M24T0) interacting with human mesenchymal cells. The technique allows the investigation of these materials in a hydrated or uncoated state. This is necessary to visualise the cellular interactions of the microspheres to assess growth and osteogenic potential. The image to the right shows cells migrating inside the pores of the microspheres in cell cultures on day 21.

MT Islam, L Macri-Pellizzeri, KMZ Hossain, V Sottile, I Ahmed. *Materials Science and Engineering: C* 120 (2021), 111668.

Our facilities

Zeiss Crossbeam 550 (HR-CAT-SEM): The high resolution cryogenic analytical and transfer (HR-CAT-SEM) instrument is a cryo-FIBSEM system with Field Emission Gun (FEG) optics that enables the highest levels of spatial resolution with cutting edge in-situ preservation and processing of a large variety of materials including biological, wet and magnetic samples. Extensive peripherals including a gas injection system (GIS), STEM detector and electron backscatter detector (EBSD) enable holistic interrogation of materials.

JEOL 7100F FEG-SEM: FEG-SEM for nanometre resolution imaging, with energy dispersive X-ray spectroscopy (EDS), wavelength dispersive X-ray spectroscopy (WDS) and electron backscatter diffraction (EBSD) capabilities in addition to a heating stage for exhaustive characterisation.

ThermoFisher (FEI) Quanta200 3D DualBeam FIB/SEM: FIB-SEM with cryogenic capability especially suited to biological samples and complex sample manipulations or lift out preparation.

ThermoFisher (FEI) Quanta 650 ESEM: State of the art ESEM for the imaging of uncoated or wet samples in an air, water vapour or nitrogen environment with a high sensitivity EDS detector. A Peltier cooling stage allows for dynamic analysis with temperature and relative humidity control.

ThermoFisher (FEI) Quanta 600: Performs fully automated, large area and high-resolution analyses of polished sample specimens. Used to identify and quantify mineral composition and distribution (Mineral Liberation Analysis) with the provision of complex statistical analytics.

Also available... JEOL 7000F, ThermoFisher (FEI) XL30 SEM, JEOL JSM IT-200 SEM, JEOL 6490LV SEM.

Find out how SEM could help with your applications, designs or solutions:
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