MONASH University

MONASH CENTRE FOR
ELECTRON MICROSCOPY

SEMINAR

Mapping Composition and Chemistry in the Scanning Transmission Electron Microscope

Professor Alan J. Craven
Department of Physics and Astronomy, University of Glasgow
SuperSTEM Laboratory, Daresbury

Thursday 17 July, 11.00am – 12 noon
Engineering Lecture Theatre E4, Bldg 32

Abstract

Electron energy loss spectroscopy (EELS) gives a wealth of information on the properties of a thin solid including thickness, composition and local chemistry. With modern instrumentation not only light elements but medium and heavy elements can be investigated allowing systems such as lead zirconate titanate (PZT) and high-k dielectrics to be studied. The chemical information is found in the electron loss near edge structure (ELNES). ELNES is closely related to the appropriate unoccupied partial density of states and this is determined by the local atomic environment. ELNES provides information on the ionisation state of the element, the phase in which it sits and even its magnetic state.

Combining EELS with the sub-nm spatial resolution (sub-Å if aberration corrected) available in a modern scanning transmission electron microscope (STEM) increases the power tremendously. Now the information can be obtained on the scale of the probe size. This allows the analysis of a wide range of problems including interfaces (e.g. in high-k dielectrics) and small particles, even those within a matrix (e.g. precipitates in steel).

Computer control allows a spectrum to be recorded at each spatial pixel in a technique known as spectrum imaging. This provides a powerful tool for high spatial resolution analysis. With suitable instrumentation, it is possible to record at each pixel the whole EELS spectrum under the same electron optical conditions along with the x-ray spectrum, the image signals and even the diffraction pattern. This whole data set has "perfect" spatial resolution so direct correlation of signals can be made. Having the whole EELS spectrum allows:

- accurate calibration of edge energies, allowing full use of chemical shifts;
- deconvolution of multiple scattering, making background subtraction and comparison to standards more effective;
- normalisation to the low loss intensity to remove diffraction contrast and determination of absolute numbers of atoms per unit area;
- determination of the absolute thickness and hence the removal of the effect of thickness change and the determination of the absolute number of atoms per unit volume.

Where do the problems lie? They lie in the specimen. Is it sufficiently thin? Is the interface flat? Does the electron beam cause modification? How do the electrons interact with the specimen?

Convenor: Dr. Joanne Etheridge

Email: joanne.etheridge@mcem.monash.edu.au

Visitors are most welcome: Please note that there is a designated Visitors Car Park (N1) clearly ground-marked by white paint and tickets, at a cost of $1.4/hour for up to 3 hours, available from a dispensing machine. This high-rise carpark is located on the following Clayton Campus Map, Ref. B2.

Printable version of the Clayton campus map (pdf 833 kb) (Please right click to open link)