Energy Dispersive X-ray Microanalysis (EDX)

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EDX is a microanalytical technique that uses the characteristic spectrum of x-rays emitted by the specimen after excitation by high-energy electrons to obtain information about its elemental composition. The ranges of elements detectable by EDX and electron energy loss spectroscopy (EELS) are somewhat complementary; EDX is generally better suited to detecting elements of high atomic number (Z) whereas EELS can readily detect low-Z elements. Unlike EELS, EDX does not provide chemical information (except through quantitative analysis in some cases). Compared to EELS, EDX is a relatively simple technique and provides rapid qualitative microanalysis of the specimen. The spatial resolution is determined by the probe size, beam broadening within the specimen, and the effect of backscattered electrons on the specimen around the point of analysis.

Possible Applications

•Quantitative elemental analysis (fixed-point, time-resolved, mapping) with a sensitivity down to a few atomic percent

•Atomic site and species determination using electron channelling (the ALCHEMI technique)

Specimen Requirements

Specimens prepared by almost all methods (e.g. chemical thinning, ion beam milling, lift-off of layers, crushing (microcleaving), extraction replicas) are suitable. Thin specimens, a few hundred angstroms thick, in which self-absorption and fluorescence of the emitted x-rays are minimized, are needed for accurate quantitative analysis. For high spatial resolution analysis, the specimen should be beam-insensitive.

Limitations

Accurate quantitative analysis requires calibration of the EDX analysis system using standards of known composition, and thin specimens; for some combinations of elements, large differences in the self-absorption and fluorescence of emitted x-rays will limit the precision of quantitative analysis. Low Z ($Z < 11$) are not detectable by some systems and only detectable with limited sensitivity by others.

Source: http://www.asu.edu/clas/csss/chrem/Techniques.html

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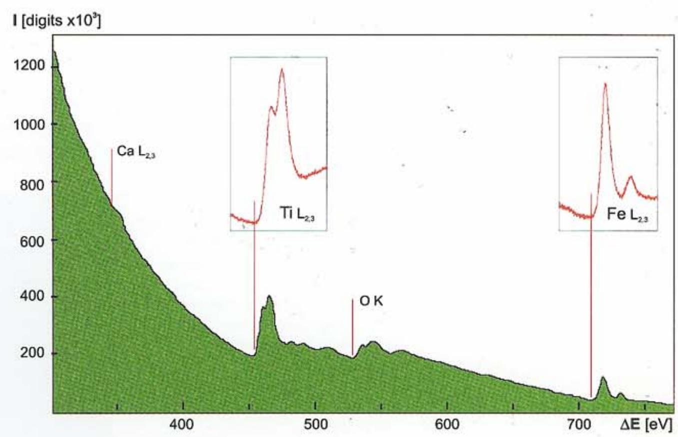
Electron energy loss spectra (EELS)

In order to produce **serial EELS**, the energy loss of the imaged electrons is scanned. The electron density is recorded with an electron detector according to the energy loss ΔE. **Parallel EELS** are recorded by drawing of an intensity profile over a spectrum which is imaged on a Slowscan CCD or TV camera target. The advantages of this technique include:
Spectra with high sensitivity and energy resolution can be produced for chemical analysis.
Element analysis of specimen areas is possible to a diameter of down to less than 2nm.
A stack of images with increasing energy loss is recorded for **imaging EELS** technique. Spectra of randomly selected areas can be generated by densitometric evaluation. This method is especially suitable if specimen structures to be investigated are of irregular shape or diffusely distributed over a large field.

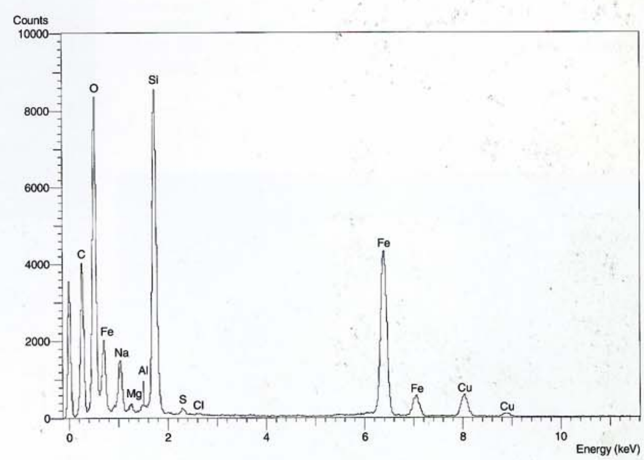
Parallel EELS
Energy loss spectrum recorded in parallel mode over an energy range of 500eV, using the VarioSpeed Slowscan CCD camera as detection system. The spectrum magnification of the in-column OMEGA filter can be varied continuously to allow a simultaneous detection of between 60eV (insets with titanium and iron L-edges) and 500eV of energy loss range.
Specimen: Powdered alloy.



Leading-edge EDX

The LEO 912 makes optimum use of all signals generated by the interaction between electron beam and specimen:

The truly symmetrical single-field condenser-objective lens is ideally suited to every analytical application, since all modes of operation are conjugate to the symmetric (eucentric) specimen plane without influencing the two halves of the lens.



The condenser-objective lens, in conjunction with the Koehler illumination system, allows switch-over from parallel wide-field TEM illumination to electron probe generation down to a minimum diameter of 1.6nm – at the push of a button and without the need for further adjustment.

Meticulous design means that a superior X-ray collection solid angle of up to 0.192 sr (for 30mm² detector) can be achieved at a 20° take-off angle. Moreover, ample space is provided for efficient collimation and shielding devices, resulting in minimum X-ray background and maximum signal detection. Simultaneous recording of EEL- and EDX-spectra is readily achieved.

EDX spectrum of asbestos fibre
Specimen: Ashed human lung tissue spot size 25nm, Oxford Si detector (136eV), SATW