# Electron Energy Loss Spectroscopy (EELS)

**Institution:** University of Cologne

**Scientist in charge:** Lhoussaine Belkoura

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EELS is a microanalytical technique that uses the characteristic spectrum of energy losses of transmitted electrons to obtain information about elemental composition, chemical bonding, and electronic structure. An EELS spectrum consists of a monotonically-decreasing background on which several broad peaks, each characteristic of a particular inelastic scattering process, are superimposed. The spatial resolution is limited by the diameter of the incident illumination focussed on the sample.

**Possible Applications**

•Quantitative elemental analysis, both fixed-point and time- and position-resolved with sensitivity down to 1 atomic percent
•Thickness determination
•Observation of band structure effects, oxidation state determination
•Measurement of short-range order (radial distribution function)

**Specimen Requirements**

Specimens should be thin (<50nm) to avoid plural scattering effects; for high spatial resolution, specimens should be beam-insensitive; specimens should have clean surface for quantitative analysis; may be prepared by all conventional techniques used to prepare specimens for high resolution imaging.

**Limitations**

Spectra from thick specimens (>50nm) may be difficult to interpret because of plural scattering. Characteristic edges on features are broad and often overlap. Interpretation of fine structure sometimes requires sophisticated calculations.

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

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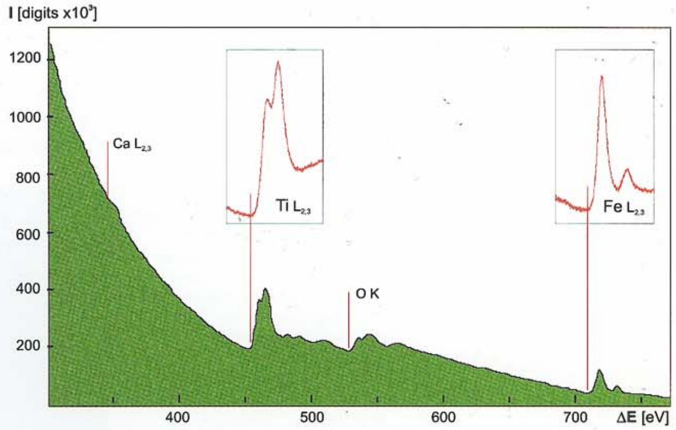
## Electron energy loss spectra (EELS)

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.

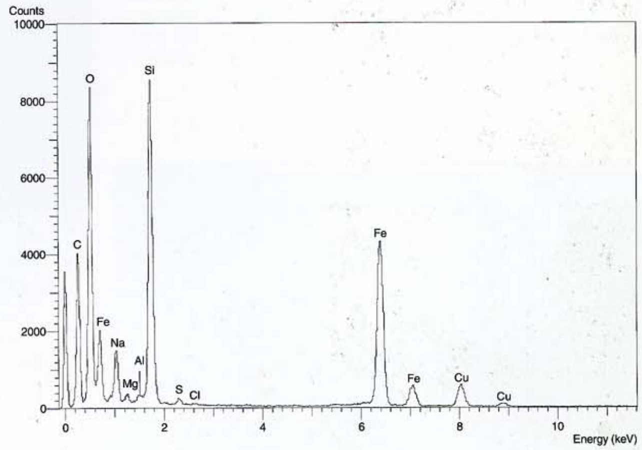
**Parallel EELS**
*Energy loss spectrum recorded in parallel mode over an energy range of 500eV, using the VarioSpeed Slowscan CCD camera as detection system. The spectrum magnification of the in-column OMEGA filter can be varied continuously to allow a simultaneous detection of between 60eV (insets 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.




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

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.