ENERGY DISPERSIVE X-RAY MICROANALYSIS (EDX)

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[1,2]
- Atomic site and species determination using electron channeling (the ALCHEMI technique)[3,4]

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.

Suitable Microscopes

This technique is available on the following instruments:

- JEOL JEM 2010F
- JEOL JEM 2000FX
- Philips CM200-FEG

References

1. N.R. Zaluzec, in: Introduction to Analytical Electron Microscopy, Eds. J.J. Hren, J.I. Goldstein, and D.C. Joy (Plenum Press, New York, 1979), p. 121.
2. J.E. Wood, D.B. Williams, and J.I. Goldstein. J. Microsc. 133, 255 (1984).
3. J.C.H. Spence and T. Tafto, J. Microsc. 130, 147 (1983).
4. J. Tafto and J.C.H. Spence, Ultramicroscopy 9, 243 (1982).