Abstract

Electron Energy Loss Spectroscopy is an analytical tool that allows local chemical characterisation in the nanoscale. EELS spectroscopy is based upon the interaction of fast primary electrons with matter in an electron microscope. Specifically, it deals with inelastic scattering of incident electrons by the atoms in the material. In that event, the primary electron loses some of its energy by transferring it to the material, thereby exciting it to a higher energy state. The energy distribution of the inelastically scattered electrons contains information on the chemical as well as the electronic nature of the material.

PART I: Analytical TEM
Inelastic electron scattering
Chemical information from electron scattering
Energy-dispersive X-ray spectroscopy
Electron Energy-loss spectroscopy (EELS)
  Principles
  Instrumentation
  Low-loss spectroscopy
  Core-loss spectroscopy

PART II. Applications of EELS

1. Low-loss: predicting the optic properties (Optical and dielectric functions, bandgap, size effects.
2. Elemental quantification protocols and associated programs (With DM and the new EELSmodel)
3. White line-based oxidation state determination protocols and associated programs
4. Automated fine structure fitting and fingerprinting protocols and associated programs
5. Single atom identification: effects of delocalisation
6. Spatially resolved EELS- Spectrum Imaging Techniques: surfaces and interfaces
7. Improving energy resolution by Deconvolution techniques

PART III.

To go deeper into mathematical procedures for Electron Energy Loss spectroscopy ELS data analysis involves the development of multivariate analysis methods for EELS analysis such as principal components analysis (PCA) and independent components analysis (ICA), improvement in the accuracy of the Kramers-Kronig transformation and application of deconvolution methods for energy resolution enhancement.

1. PCA analysis of EELS spectra (PCA)
Multivariate statistical analysis (MSA) comprehends a series of techniques that are used to analyze large datasets, which contain many known and/or unknown variables. It has been used in a wide range of research fields to gain insight into spectral data. Principal component analysis (PCA) is arguably the most popular of MSA approaches. The general concept of PCA is to reduce the dimensionality of an original large dataset by finding a minimum number of variables that describe the original dataset without losing any significant information. Without any prior knowledge of the dataset, PCA extracts the variables as mutually independent “abstract components”. PCA can be used in extended to EEL SIs, as well as in line scans and, in particular, it can be used to extract and map bonding components.

2. Independent components analysis (ICA)

ICA, a multivariate technique somewhat similar to the more familiar principal components analysis (PCA), reconstructs the dataset as a sum of increasingly insignificant components whose weights vary from place to place on the sampled zone. However the "significance" of the components is judged by their degree of mutual independence, rather than their high variance as in PCA.

**Tuesday 26th**: 10h to 13h/15h to 17h  
**Wednesday 27th**: 10h to 13h/15h to 17h  
**Thursday 28th**: 10h to 13h/15h to 17h

**Seminar 324. Facultat de Física. Universitat de Barcelona.**

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