Introduction to Transmission Electron Microscopy techniques in (nano) materials science

Transmission Electron Microscopy (TEM) represents an essential technique to perform characterization down to atomic scale, especially in the continuously developing world of the nanostructured materials.

The main reason for the use of the TEM resides in the superior resolution it allows due to the very small wavelength of the electrons that, depending on the accelerating voltage, varies in the picometer range. However, it is worth using electrons for many reasons other than the capability of imaging individual atoms in a lattice: interacting with matter, they produce a wide range of secondary signals, giving the materials scientists a lot of details on the examined samples. Among these, information can be obtained on the crystal lattice parameter, the crystal structure, the presence of ordering or different phases, defect nature and distribution. More importantly, chemical information can also be obtained from nanometric regions of the specimen with atomic resolution.

Scope of this lesson is to introduce to the principles of the microscope operation, to the fundamentals of the interpretation of the diffraction, the phase contrast and to some TEM analytical techniques in the Scanning mode (HAADF (Z) contrast, EELS).

Some emblematic applications to low dimensional structures will be presented in order to show the possibilities of these techniques and the problems they can solve.