

Transmission Electron Microscopy and related techniques (2 CFU)

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Programme of the course

The electron microscope (Basic design of the electron microscope / Electron sources / Magnetic lenses (properties and their aberrations) / Illumination of the specimen: transmission and/or scanning electron microscopy / Sample thinning techniques: chemical/mechanical polishing, ion milling, focused ion beam)

Electron diffraction (Scattering of electrons from atoms / Scattering of electrons from unit cell / Scattering of electrons from perfect crystal: the reciprocal lattice, reflecting sphere construction, Laue zones, effects due to structure factor, diffraction from various crystal shapes / Extinction distance)

Kinematical theory of image contrast (Dark-field and bright-field imaging / Column approximation / Effect of two beams reaching the image / Contrast from crystal defects: stacking faults, Moiré patterns, Limits of validity of the kinematical theory)

Dynamical theory of image contrast (Wave-optical formulation of the dynamical theory of contrast / Pendellösung effect)

Direct structure imaging in electron microscopy (Propagation in an optical system / Wave-optics treatment of spherical aberration and defocus / Ultimate resolution / The weak phase object / Optimal "Scherzer defocus")

Electron energy loss spectroscopy and energy filtered imaging (The electron energy loss spectrum / Energy-analyzing and energy-selecting instrumentations / Excitation of Outer-Shell Electrons / Volume plasmons / Inner-Shell excitations)

Scanning transmission electron microscopy (The principle of reciprocity / Probe formation and aberration / Bright-field and annular dark-field imaging / Coherent and incoherent imaging / The effect of thermal diffuse scattering / Z-contrast / Atomic resolved X-ray energy dispersion and/or electron energy loss spectroscopy)

References

- Slides
- D.B. Williams, C. B. Carter, Transmission Electron Microscopy, A Textbook for Materials Science, Springer (2009)
- J. M. Zuo, J. C. H. Spence, Advanced Transmission Electron Microscopy, Springer-Verlag, New York (2017)
- R.F. Egerton, Electron Energy-Loss Spectroscopy in the Electron Microscope, 2nd edn. Springer, New York (2011)