

Transmission Electron Microscopy and related methodologies (3 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: mechanical polishing, ion milling, focused ion beam)

Electron diffraction (Scattering of electrons from atoms and perfect crystals: 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)

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

Scanning transmission electron microscopy (Probe formation and aberration / Bright-field and annular dark-field imaging / Coherent and incoherent imaging / Z-contrast / Atomic resolved X-ray energy dispersion and/or electron energy loss spectroscopy / differential phase contrast / applications)

In situ and operando microscopy and spectroscopy (experiments in real conditions: biasing, in gas environment, in liquid / applications)

Modelling and image simulation (image interpretation, linear STEM approximation, Multislice, applications)

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)
- P.W. Hawkes, J.C.H. Spence (Eds.), Springer Handbook of Microscopy, Springer Handbooks (2019)
<https://link.springer.com/book/10.1007/978-3-030-00069-1>
- E. J. Kirkland, Advanced Computing in Electron Microscopy, 2nd edition, Springer (2010)