Study program: PhD

Module title: Experimental techniques for the characterization of nanostructures

Module status: **Optional**

ECTS: **15**

Requirements: **none**

Learning objectives: The aim of this course is to teach students the basic principles of experimental techniques that are commonly used to investigate the structure and physical properties of nanomaterials. The course is planned in the form of theoretical and experimental modules.

Learning outcomes

Students should develop:

- General abilities: Students will learn the basic principles of conventional techniques that are based on the processes of scattering X rays, electrons, neutrons, visible and infrared light.
- Course specific abilities: Students will be able to work on microscopic techniques, to analyze information on morphology and microstructure and to analyze magnetic and electrical properties of nanomaterials.

Syllabus: Theoretical foundations and principles of experimental methods for the characterization of nanomaterials. SEM, TEM, STEM, HRTEM, XPS, AFM and SPM techniques. Methods based on emission / absorption of electrons / photon or particle emitted X-rays. X-ray fluorescence spectroscopy (XRF). Photoelectron spectroscopy, infrared spectroscopy, Raman spectroscopy. Resonant-spectroscopic techniques. Diffraction of X rays, electrons and neutrons. Magnetometers (SQUID and vibration magnetometer-VSM) - fundamentals, instrumentation, sample preparation, parameters of the hysteresis loop – specificity in nanomaterials, interparticle interactions, AC susceptibility, temperature dependence of magnetization (FC-ZFC curve). Specifics of techniques for measuring electrical properties of nanomaterials.Students are expected to implement a method for characterization of nanostructures throuhg project making.

Literature:

1. *A Laboratory Course in Nanoscience and Nanotechnology*, Dr Gérrard Eddy Jai Poinern, CRS Press, Taylor&Francis Group (2015)
2. *Nanostructures and Nanomaterials,* Guozhong Cao, Ying Wang , World Scientific Series in Nanoscience and Nanotechnology: Volume 2 (2011)
3. *Principles of Condensed Matter Physics*, Chaikin RM, Lubensky TC. , Cambridge University Press, Cambridge, (2000)

Weekly teaching load				Other:
Lectures: 4	Exercises:	Other forms of teaching:	Student research: 6	