COURSE TITLE:

PHYSICAL MEASUREMENT METHODS

COURSE DESCRIPTION:

Aim of the course: Knowledge of advanced measurement equipments and methods used in experimental science at a level of understanding of literature, participation in teamwork, planning and selection of appropriate measurement method allows.

General description of the experimental diffraction methods: amplitude and intensity of the scattered beam. Reciprocal lattice. Bragg condition. Ewald construction. Atomic form factor, structure factor. Systematic extinction. Debye-Waller factor. Bragg scattering, diffuse scattering. X-ray techniques: X-ray sources. X-ray detectors. Absorption spectrometry. X-ray radiography. Single-crystal diffraction. Poly-crystal diffraction. X-ray diffractometer. Qualitative and quantitative phase analysis. Lattice parameter measurements. Determination of structure, phase problem. Dynamic interactions. X-ray topography. Application examples from several branches of science. Electron Methods: The characteristics of electron diffraction. Transmission Electron Microscopy. The structure of the microscope. Electron gun, objective lens. Features of diffraction image. The imaging modes. Bright and dark field image. Mapping of crystal defects. High-resolution electron microscopy. Scanning Electron Microscopy. Transmission scanning electron microscopy, X-ray quantitative spectroscopy. Electron energy loss spectroscopy. Applications in materials science, chemistry and biology. Neutron methods: Neutron sources. Neutron detectors. Neutron absorption. Characteristics of neutron diffraction, nucleus scattering, magnetic scattering. Scattering length. Neutron diffractometer. Flight time method. Comparison of X-ray diffraction. Application examples. Mössbauer spectroscopy: The basic method of physical processes: Radioactivity, natural line width, resonance absorption, recoil energy loss, Doppler effect, recoil-free emission, Mössbauer Lamb factor. Characterization of the measurement system: sources and detectors. Production of Doppler velocity. Measuring modes. Hyperfine interactions: isomer shift, quadrupole splitting, magnetic splitting. Applications in various disciplines. Surface Scanning Microscopy: Scanning tunneling microscope (STM). Image generation and spectroscopy. The structure of the tunneling microscope, the basic principles of the operation. Operating modes. Examples: metallic surfaces, insulators, layered materials, biological samples, imaging of molecules, nano-topography. A scanning atomic force microscopy (AFM). The structure of AFM. Operating modes: contact, non-contact and tapping mode.

LITERATURE:

R. W. Cahn, P. Haasen, E. J. Kramer (eds.). Material Science and Technology A Comprehensive Treatment. Volume 2A: Characterization of Materials (Part I) Volume Editor: E. Lifshin. VCH Weinheim; New York; Basel; Cambridge; 1992

R.W. Cahn, P. Haasen: Physical Metallurgy, 1996 Elsevier, ISBN: 978-0-444-89875-3

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