Advanced scanning electron microscopy in materials science

(Year 2, semester I, 10 h, exam)

Lectures given by: Dr **Marek Faryna** Ph.D., D.Sc.

1. title: **Electron Beam –Specimen Interaction (part I)**

scope: Elastic and inelastic scattering, interaction volume, Monte Carlo simulation, electron range.

2. title: **Electron Beam Specimen Interaction (part II)**

scope: Imaging signals from interaction volume (backscatter electrons, secondary electrons).

3. title: **Scanning Electron Microscope (part I)**

scope: Introductory remarks about spatial resolution and depth of field (focus), electron probe diameter versus electron current, how the SEM works, electron guns and their characteristics.

4. title: **Scanning Electron Microscope (part II)**

scope: Electron optics, lenses and their aberrations, electron detectors, the role of specimen and detectors in contrast formation.

5. title: **Energy Dispersive Spectrometry**

scope: Generation of X-Rays production, continuum X-Ray production (Brehmsstrahlung), characteristic X-Ray production, depth of X-Ray production, X-Ray absorption, X-Ray Fluorescence, Energy dispersive X-ray Spectrometer - operating principles, detection process, artefacts.

6. title: **Wavelength Dispersive Spectrometry**

scope: Introduction, basic principles, diffraction conditions, diffraction crystals, X-ray proportional counter, comparison of Wavelength Dispersive Spectrometers with Conventional Energy Dispersive Spectrometers.

7. title: **Quantitative X-ray Microanalysis**

scope: Introduction, Quantitative analysis procedures, the approach to X-Ray Quantification: the need of matrix correction, the physical origin of matrix effects, ZAF factors in Microanalysis, calculation of ZAF factors, practical aspects.

8. title: **Variable Pressure/Environmental Scanning Electron Microscopy**

scope: General principles of VP-SEM: utilizing a gas, imaging and analysis in VP-SEM: the influence of a gas, imaging uncoated specimens in the VP-SEM, X-Ray microanalysis in low vacuum conditions.

9. title: **Electron Backscatter Diffraction (part I)**

scope: Theoretical framework for electron backscatter diffraction, fundamentals of automated EBSD, the influence of microstructure and SEM settings on quality of diffraction pattern, phase identification.

10. title: **Electron Backscatter Diffraction (part II)**

scope: Advanced software capabilities for automated EBSD, EBSD from non-conductive specimens, special EBSD techniques: 3 dimensional EBSD, EBSD at elevated temperatures.