

Program

**Applications of electron microscope for
the characterization of catalytic materials**

Electron microscopy block course at the Dalian Institute of Chemical Physics

by

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On Wednesday 14 March 2018, instrument check for SEM and TEM will be made together with lab manager Dr. Miao Shu

Lectures 1-2 + 1-3, Basics of the scanning electron microscope II (SEM)

beam-specimen interaction, detectors, secondary electrons (SE), backscattered electrons (BSE), depth of focus, in-lens detection (high-resolution SEM), avoiding specimen charging, C_s/C_c -corrected SEM (ultra-high resolution)

Lecture 2-1, Basics of the transmission electron microscope I (TEM)

history, virology, fundamentals, lens in wave optics, the 3-stage TEM, optical path for imaging and diffraction, resolution limit, Fourier optics, diffraction absorption contrast

Lecture 2-2, Basics of the transmission electron microscope II (TEM)

phase contrast (high-resolution TEM), phase-amplitude diagrams, $\lambda/4$ phase plate, phase-contrast transfer function, point resolution, delocalisation, C_s -corrected microscope, contrast simulation (multislice method), focal series reconstruction

Lecture 3-1, Diffraction and elemental analysis in the transmission electron microscope

analogies and differences between electron diffraction and x-ray diffraction, selected area electron diffraction (SAED), from parallel to convergent illumination, convergent beam electron diffraction (CBED), scanning transmission electron microscopy (STEM), analytical electron microscopy (AEM), x-ray spectroscopy (EDXS, WDXS, EMPA), electron energy-loss spectroscopy (EELS)

Lecture 3-2, Some practical advice (SEM + TEM)

sample preparation, media for image acquisition, avoiding beam damage

Practical Exercises

SEM (8 courses times 4 students = 32 students; all courses given by lab manager Dr. Miao Shu)

Demonstration of effect of working distance (objective lens focal length) on resolution and depth of focus; secondary electron imaging and energy-dispersive X-ray spectroscopy.

TEM (8 courses times 4 students = 32 students; all courses given by Prof. Armin Feldhoff)

Demonstration of absorption contrast (bright-field, dark field) and selected area electron diffraction; how to avoid damage of beam-sensitive materials during observation.

Examination

Written test (45 minutes) allows monitor the transfer of knowledge. Final discussion on results of test and issuing a certificate will close the block course.