

Syllabus

for course at advanced level

Advanced Transmission Electron Microscopy
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7.5 Higher Education
Credits
7.5 ECTS credits

Course code:	KZ8010
Valid from:	Autumn 2015
Date of approval:	2013-11-18
Department	Department of Materials and Environmental Chemistry
Main field:	Chemistry
Specialisation:	A1F - Second cycle, has second-cycle course/s as entry requirements

Decision

Prerequisites and special admittance requirements

Course structure

Examination code	Name	Higher Education Credits
MOM1	Theory	4
MOM2	Laboratory Exercises	3.5

Course content

a. The course covers the topic of transmission electron microscopy (TEM) used for quantitative structural studies, especially at the atomic level (electron crystallography). It includes determination of unit cell size, plane and space groups using different diffraction and high-resolution electron microscopy. In addition, the course covers the use of quantitative structural models directly from electron diffraction and from the images. The course also includes dynamic diffraction theory (block wave, dispersion surface, Kikuchi lines) and scanning transmission electron microscopy (STEM), which can be used for studying defect structures such as dislocations and nanomaterials. The course also deals with how the spectroscopic analysis technique ("electron energy loss spectroscopy, EELS") can be used to obtain structural information at atomic level and the chemical composition of different types of materials and nanoparticles.

The course also includes practical exercises on electron microscopes and use of software for interpretation and quantification of images and problem solving.

b. The course includes the following elements:

- 1) Theory 4 credits
- 2) Laboratory Exercises 3.5 credits

Learning outcomes

It is expected that the student after taking the course will be able to:

- *Demonstrate a deeper understanding of electron optics and image formation in a transmission electron microscope.
- *Determine the unit cell, plane and space group from electron diffraction and high-resolution transmission electron microscopy images.
- *Use quantitative electron crystallography based on electron diffraction data and high-resolution

transmission electron microscopy to obtain structural information at atomic level

*Describe how the atomic structures and defect structures in a material / nano materials can be studied in a transmission electron microscope

*Describe how to use EELS to obtain information on the structure and chemical composition with different types of materials

Education

The education consists of lectures, group work, exercises and laboratory work.

Participation in the practical laboratory work and group education associated with this is compulsory. After consultation with the relevant teacher, an examiner may rule that a student is not obliged to participate in certain compulsory education, if there are special grounds for this.

Forms of examination

a. Measurement of knowledge for the theoretical part takes place through:

*written and/or oral examination

b. Grading is carried out according to a 7-point scales related to learning objectives:

A = Excellent, B = Very good, C = Good, D = Satisfactory,

E = Sufficient, Fx = Fail, F = Fail.

c. Grading criteria for the course will be distributed at the beginning of the course.

d. A minimum grade of E is required to pass the course, together with:

completion of all practical laboratory work, followed by the written reports.

e. Students who fail to achieve a pass grade in an ordinary examination have the right to take at least further four examinations, as long as the course is given. The term "examination" here is used to denote also other compulsory elements of the course. Students who have achieved a pass grade on an examination may not retake this examination in order to attempt to achieve a higher grade. Students who have failed to reach a pass grade on two occasions have the right to request that a different teacher be appointed to set the grade of the course. A request for such appointment must be sent to the departmental board.

Interim

Students may request that the examination is carried out in accordance with this syllabus even after it has ceased to apply. This right is limited, however, to a maximum of three occasions during a two-year-period after the end of giving the course. A request for such examination must be sent to the departmental board.

Limitations

The course is equivalent to Electron Microscopy of Inorganic Materials (Advanced level, 7p, KE4520) and may not be included in the degree together with the course Advance Transmission Electron Microscopy (7.5 hp, KZ8007).

Misc

The course is a component of the Masters programme in Materials Chemistry, and it can also be taken as an individual course.

Required reading

Course literature is decided by the departmental board and is described in an appendix to the syllabus.