Department of Materials and Environmental Chemistry

Stockholm University

# Syllabus

for course at advanced level

**Introduction to Analytical Electron Microscopy**
**Introduktion till analytisk elektronmikroskopi**

**7.5 Higher Education Credits**
**7.5 ECTS credits**

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| **Course code:** | KZ8009 |
| **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

The course covers the analytical electron microscopy (EM) that can be used in materials chemistry studies, in particular nanomaterials. Both scanning electron microscopy (SEM) and transmission electron microscopy (TEM) will be introduced. The course provides a description of instrumentation of electron microscope and the fundamental physics of the image formation. It also includes electron diffraction technique in kinematical and dynamical condition as well as image formation based on mass contrast (low resolution), bright- and dark-field imaging, and phase contrast at atomic resolution. In addition, the course covers how to interpret the images or diffraction patterns taken by the above techniques, for example, indexing and identification of the unit cell of crystalline material and theoretical calculations and analysis. The course also introduces various EM preparation methods. The course also deals with the chemical and spectroscopic analysis techniques in SEM and TEM - energy dispersive X-ray spectroscopy, can be used to obtain information about the chemistry of materials.

## Learning outcomes

It is expected that the student after taking the course will be able to:
*Describe the basic principles of how a transmission electron microscope (TEM) and scanning electron microscope (SEM) operate and function.
*Propose appropriate sample preparation methods for EM studies
*Demonstrate a basic understanding of the physics behind the electron diffraction pattern formed in a microscope
*Interpret electron diffraction patterns and TEM images
*Describe how to get information about the chemical composition of a material
*Describe the type of material chemistry problems that can be solved by analytical EM

## 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 Introduction to analytical transmission electron microscopy (7.5 hp, KY8002) and may not be included in the degree together with the course Introduction to Analytical Electron Microscopy (7.5 hp, KY8010).

### 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.