KTH Materialvetenskap

PM

Introduction to high-performance scanning electron microscopy in materials science with focus on metallurgy PhD course, 6 credits

Purpose

The course aims at introducing primarily Ph.D. students in Materials Science and Engineering and related research areas to scanning electron microscopy (SEM). The course further aims at providing an account of the state-of-the-art of SEM and its applications in metallurgy and materials science.

Learning objectives

After the course the student should have acquired:

- A fundamental understanding of scanning electron microscopy (SEM) and its applications in metallurgy and materials science.
- Basic skills in SEM operation and analysis of SEM data.
- Capability to understand the scientific literature in the field to further develop in SEM characterization by themselves.
- An overview of the state-of-the-art in SEM.

Content

Lectures will cover the following topics: the scanning electron microscope, interaction between electron beam and sample, diffraction, sample preparation, imaging in secondary electron and backscattered electron modes, chemical analysis using energy-dispersive x-ray spectroscopy (EDS) and wavelength-dispersive x-ray spectroscopy (WDS), electron channeling contrast imaging (ECCI), electron backscatter diffraction (EBSD), transmission Kikuchi diffraction (TKD), focused ion beam (FIB).

The students should select a topic that would be of interest to study using SEM, the topic could preferentially be from the student's thesis work. The student should then make a literature survey as well as plan, conduct and analyze some SEM experiments. The work should be presented in a written report (like a scientific paper) and all the reports will be collected in a volume "current works in scanning electron microscopy for metallurgy and materials science". Further, a seminar will be arranged with oral presentations from all students.

Examination

- Mandatory participation at lectures and demonstration.
- At least 6 hours hands-on SEM work.
- Written report on a selected SEM topic
- Oral presentation of the selected SEM topic.

- Peer-review of one written report to be included in the volume “current account of scanning electron microscopy in metallurgy and materials science”.

Literature

Primary literature:

1. Goodhew P.J., Electron Microscopy and Analysis.

This book will be made available in pdf via Canvas and the lectures follow the structure of the book, which is a rather concise overview. The lectures will also contain material from additional more elaborated literature references.

2. Hand-outs, including scientific papers and book chapters.

The hand-outs will be made available in pdf via Canvas.

Suggested additional reading:

Goldstein J. et al., Scanning electron microscopy and x-ray microanalysis

Schwartz A. et al. Electron backscatter diffraction in materials science

Teachers

Peter Hedström (PH), KTH, 08-790 6217, pheds@kth.se (responsible teacher)
Prasath Babu (PB), KTH
Fredrik Gustavsson (FG), Swerim
Joacim Hagström (JH), Swerim
TBD

Lectures physically and digitally

Most lectures will be given both physically at Brinellvägen 23 and through zoom. Some lectures will only be given through zoom. The number of students joining physically may be limited depending on how many students register.

Course Fee

Graduate students 6000 SEK

The course fee includes 6h of SEM time on one of the electron microscopes Hitachi S3400N, JEOL 7800F or FEI Nova 600. The designated microscope depends on prior experience and scope of project. Each participant will receive the final collected volume “current works in scanning electron microscopy for metallurgy and materials science” as a reference for SEM application areas.

Tentative schedule

Time	**Teacher**	**Topic**
10/9 10-12	PH	Introduction to course and SEM
13/9 15-17	PH	Interaction between electron beam and sample
14/9 14-16	PB	Diffraction
15/9 10-12	PB	The scanning electron microscope

15/9 14-16	PB	Imaging
16/9 10-12	FG	Compositional analysis
16/9 13-15	FG	Compositional analysis
17/9 10-12	PH and others	Sample preparation theory and demonstrations
17/9 14-16	PB	Principles of EBSD and TKD
20/9 14-16	PB	Principles of FIB
21/9 10-12	JH	Metallurgy applications
TBD	TBD	Materials science applications
TBD	TBD	Materials science applications
1/11 9-12	PH	Final seminar