Course description
Electron Microscopy Analysis of Fibre- and Polymer-based Materials
FCK3109, 7.5 credits, VT 2022

Course information

Welcome to the course of ***Electron Microscopy Analysis of Fibre- and Polymer-based Materials***! In this course you will be introduced to different electron microscopy techniques, sample preparation and recent state-of-the-art methodologies within the field of electron microscopy. The course consists of two parts: theoretical, including the lectures and seminars (3 credits) and hands-on parts (4.5 credits) where you will work with different electron microscopes that we have at FPT. Both parts are a prerequisite to independently run the electron microscopy facilities at FPT.

Canvas

All information related to the course will be available on Canvas. This includes lecture notes, instructions in the preparation of the proposal and schedules for the laboratory work. The Canvas page will continuously be updated throughout the course.

Intended learning outcomes

After completion of the course the doctoral student should have the knowledge and ability to

1) Explain the basic principles for electron microscopy (scanning electron and transmission electron microscopy) and demonstrate for the level of the course adequate acquired knowledge in the specialized topics of the course.
2) Suggest and explain, plan and carry out different types of electron microscopy related experiments.
3) Suggest, plan and perform sample preparation of a material so that it can be imaged with electron microscopy. Reflect on the selected sample preparation technique.
4) Present and orally motivate the selected electron microscopy instrumentation for a selected sample.

Electron Microscopy Analysis of Fibre- and Polymer-based Materials
FCK3109, 3 credits, VT 2021 KTH

W.	Time	Activity	Content	Teacher
7	**Monday 14/02/2022 "SEM, EDS and Sample Prep"** https://kth-se.zoom.us/j/68704904400			
	9:15 – 10:00	Lecture	Introduction to the course https://kth-se.zoom.us/j/64387049775 (only for registered PhD students)	**AH**
	10:15 –11:00		SEM basics	**AR**
	11:15 – 12:00			
	13:15 – 14:00		SEM-based microanalysis: EDS & WDS	**MH**
	14:15 – 15:00		SEM Sample preparation	**AH**
	15:15 – 16:00			
	16:15 – 17:00		Cross-sectional sample preparation for SEM: mechanical polishing and BIB	**MH**
	Tuesday 15/02/2022 "TEM" https://kth-se.zoom.us/j/67231653297			
	09:15 – 10:00	Lecture	TEM – the instrument and electron-matter interaction	**TW**
	10:15 – 11:00		Imaging and diffraction in TEM	
	11:15 – 12:00		STEM and other techniques in the TEM	
	13:15 – 14:00		TEM-based spectroscopy: EDS & EELS	**TT**
	14:15 – 15:00		TEM-based tomography and ETEM	**RW**
	15:15 – 16:00		TEM in Wood-related research	**TW**
	Wednesday 16/02/2022 "Ultramicrotomy and Dual Beam" https://kth-se.zoom.us/j/62442506014			
	09:15 – 10:00	Lecture	Ultramicrotomy	**AZ, AR**
	10:15 – 11:00			
	11:15 – 12:00			
	13:15 – 14:00			
	14:15 – 15:00		Dual Beam. Intro. TEM Sample preparation and 3D reconstruction	**AR**
	15:15 – 16:00			
	Thursday 17/02/2022 "Cryo-EM" https://kth-se.zoom.us/j/62393447145			
	09:15 – 10:00	Lecture	Cryo-SEM	**NL**
	10:15 – 11:00		Cryo-TEM. Introduction to electron tomography and single particle structure biology methods	**LS**
	11:15 – 12:00			
	Friday 18/02/2022 "In situ EM" https://kth-se.zoom.us/j/68444815584			
	09:15 – 10:00	Lecture	SEM and FIB-SEM for liquid experiments and 3D imaging	**EO**
	10:15 – 11:00		TEM: in situ advanced imaging and spectroscopy	
	11:15 – 11:30		EM Infrastructure overview	**AR**
	11:30 – 12:00		Summary of the course and instructions for the preparation of proposals	**AR, AH**
9	**Tuesday 02/03/2022 "Presentations"** https://kth-se.zoom.us/j/68871837777			
	08:30 – 12:00	Oral exam	Oral presentations of proposals by students	**AR, AH**
	13:00 – 17:30			

AH: Anna Hanner (KTH), **AR:** Anastasia Riazanova (KTH), **TW:** Tom Willhammar (SU),
TT: Thomas Thersleff (SU), **MH:** Magnus Hummelgård (MIUN), **RW**: Reine Wallenberg (LU),
AZ: Agnieszka Ziolkowska (UCEM), **NL**: Nikki Lee (UCEM), **LS**: Linda Sandblad (UCEM),
EO: Eva Olsson (Chalmers)
Lab work starts on 7/03/2022

Laboratory work (LAB1) (20 h):

The laboratory will be divided as follows:

Type of instrument/task	Demonstration	Practice
Lab safety	1h	
Sample preparation SEM	1h	0.5h
Table top SEM	1h	1.5h
Hitachi-SEM	4h	1.5h
EDS Microanalysis	3h	1h
TEM	2h	2h
Sample preparation TEM	1h	0.5h
Total	**13h**	**7h**

The schedule for the laboratory work will be published on Canvas after the course has started. This laboratory work starts on 7/03.

Course contents

The course includes both *lectures*, *seminars* and *laboratory work*. The course covers the basic principles of different types of:

- Electron microscopy techniques: scanning electron microscopy (SEM), tabletop SEM, transmission electron microscopy (TEM), cryo-SEM, cryo-TEM, focused ion beam (FIB), Dual Beam (SEM-FIB), energy dispersive X-ray spectroscopy (EDS).
- More advanced analysis techniques (in situ analysis) and 3D tomography.
- Different types of sample preparation techniques for optimal analysis of a specific sample.
- Hands-on experience of electron microscopy imaging.

Lectures

The course consists of 24 hours of lectures where the topics mentioned above will be covered. Due to the present Covid-19 restrictions the lectures will be given online via a Zoom link that will be available on Canvas.
The lectures will end with a full day of presentation by the students (live on Zoom), where students present their individual proposal. Each student will be asked to write an application for utilizing a specific electron microscopy technique. The proposal will be presented orally (7 min) and feedback on the proposal will be provided by two other students in the course including the teachers (7 min questions and answers). A template of a proposal can be found on Canvas.

Laboratory work

The laboratory part (20 hours) of the course is a prerequisite to run the electron microscopy instruments at FPT. It is compulsory to attend all laboratory work sessions in order to pass this part of the course. The students are expected to come prepared before each session and in the end the students must be able to operate the instruments by themselves. Their performance will be evaluated by the lab responsible person. All information about the laboratory work, including schedule, will be provided during the course. If you fail on this part, you will have to redo the laboratory part the next time the course is given.

Important information! Due to the current COVID-19 restrictions, only FPT PhD students can participate in the labs. The max number of lab attendees is 12.

Responsible persons for the laboratory part:

Anastasia Riazanova, anaria@kth.se

Literature

Hand-outs from presentations, scientific articles and instruction manuals for running the electron microscopy facilities will be provided on Canvas, including:

1. FEI interactive booklet "An Introduction to Electron Microscopy", https://www.fei.com/documents/introduction-to-microscopy-document/#gsc.tab=0

Further reading:

1. P. J. Goodhew, J. Humphreys and R. Beanland "Electron Microscopy and Analysis", CRC Press, 30 Nov 2000, Technology & Engineering
2. Goldstein et al. "Scanning Electron Microscopy and X-ray Microanalysis" Springer 2018
3. David B. Williams, C. Barry Carter "Transmission Electron Microscopy. A Textbook for Materials Science" Springer 2009

Important dates:

Thursday 24th February; hand in of proposal

Tuesday 2/3: Oral examination. Presentation of the proposal.

Examination

SEM1 - Seminars, 3,0 hp, grades: P, F

LAB1 - Laboratory work, 4,5 hp, grades: P, F

To pass the lecture part, the students are expected to attend at least in 80% of the lectures, pass the seminar part, be approved on the home-assignment.

To pass the LAB1 the students are expected to participate in all lab activities and pass the performance evaluation part. The evaluation will be performed by the lab responsible.

Grading scale

Pass (P), Fail (F)

Contact information

Examiner: Anna Hanner e-mail: svagan@kth.se

Course responsible: Anastasia Riazanova, e-mail: anaria@kth.se