Stockholm University
Department of Materials and Environmental Chemistry

Electron Microscopy for Materials Characterization

Aug 29 – Sep 28, 2022

KZ7016 7.5hp https://sisu.it.su.se/search/info/KZ7016/en

The course will start on August 29 (Monday) at 9:15. Lectures, problem solutions and practical training sessions are conducted 9:15-12:00 and 13:00-16:00 according to the detailed schedule below. Demonstrations, exercises and practical labs are the *compulsory parts* of the course. Lectures and exercises will be given in K439/433 except for 6/9, 19/9 and 20/9 when the sessions will be in K441/447. The students will be divided into groups for the practical sessions.

Teachers:
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Course Responsible:
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Literature:
RE: *Physical Principles of Electron Microscopy: An introduction to TEM, SEM and AEM*, R.F. Egerton, Springer
WC: *Transmission Electron Microscopy: A Textbook for Materials Science*, D.B.Williams and C.B.Carter, 2nd edition, 2009, Springer. https://libris.kb.se/bib/11775751
ZHO: *Electron Crystallography - Electron microscopy and electron diffraction*, X. Zou, S. Hovmöller, P. Oleynikov, Oxford University Press. https://libris.kb.se/bib/12544168
CW: *Transmission Electron Microscopy*, C.B. Carter, D.B. Williams, eds., Cham, 2016, Springer. https://libris.kb.se/bib/19667958
* Additional materials handed out at the lectures and practical sessions.
# The actual date of lab and exercise depends on the number of participants and will be finalized at the beginning of the course.

Week	Date	Teacher		Lecture (9:15 – 12:00)	Literature	Lab (13:00 -16:00) #
35	29/8 (Mon)	L1	TW KJ	General introduction to electron microscopy as tools for materials characterization Introduction to scanning electron microscopy (SEM)	RE: 5	
	30/8 (Tue)	L2	KJ	Introduction to Energy Dispersive Spectroscopy (EDS) and Wave Dispersive Spectroscopy (WDS)	RE: 6	
	31/8 (Wed)			SEM lab (Group A) - LCP EDS demo lab (Group B) - JC		SEM lab (Group B) - LCP EDS demo lab (Group A) - JC
	1/9 (Thurs)			SEM lab (Group C) - LCP EDS demo lab (Group D) - JC		SEM lab (Group D) - LCP EDS demo lab (Group C) - JC
	2/9 (Fri)	L3	KJ	Applications of analytical SEM techniques for materials characterization	*	
36	5/9 (Mon)	L4	TT	Introduction to transmission electron microscopy (TEM), electron-matter interactions	WC: 1-3	
	6/9 (Tue)	L5	TT	Instrumentation and Electro-optics, aberration correction	WC: 5-10	Exercise 1 (All) – TT & LCP
	7/9 (Wed)	L6	TW	TEM sample preparation (powder, FIB, ion milling, ultramicrotome, cryo-transfer)	WC: 10	Introduction of TEM & sample preparation (Group A+B) - JC
	8/9 (Thurs)					Introduction of TEM & sample preparation (Group C+D) - JC

	9/9 (Fri)	L7	TW	Electron diffraction (ED) and phase analysis	WC: 11-13, 18 ZHO: 5	TEM + ED lab (Group A) - LCP
37	12/9 (Mon)			TEM + ED lab (Group B) - LCP		TEM + ED lab (Group C) - LCP
	13/9 (Tue)	L8	TT	Scanning transmission electron microscopy (STEM) techniques: BF, ADF, HAADF, iDPC	CW 11*	TEM + ED lab (Group D) - LCP
	14/9 (Wed)	L9	TT	TEM/STEM Spectroscopy (EDS and Electron energy loss spectroscopy (EELS)	WC 4, 37-40*	STEM+EELS lab (Group A) - TT
	15/9 (Thu)			Exercise 2 (All) – JC		STEM+EELS lab (Group B) - TT
	16/9 (Fri)			STEM+EELS lab (Group C) - TT		STEM+EELS lab (Group D) - TT
38	19/9 (Mon)	L10	TW	Imaging: BF, DF and phase contrast	WC: 22-23	
	20/9 (Tue)	L11	TW	Contrast transfer function (CTF) and high-resolution transmission electron microscopy (HRTEM)	ZHO: 6 WC: 28, 30	HRTEM lab (Group A) - JC
	21/9 (Wed)			HRTEM lab (Group B) - JC		HRTEM lab (Group C) - JC
	22/9 (Thurs)					HRTEM lab (Group D) - JC
	23/9 (Fri)	L12	TW		CW: 2	In situ TEM characterization techniques, Applications of analytical EM in sustainable materials chemistry
39	26/9 (Mon)	L13	ALL	Repetition: questions and answers		
	28/9 (Wed)	**Examination (9:15-14:00)**				