Syllabus MSE 581: Advanced Electron Microscopy

Course description: Present the theory of transmission electron microscopy and techniques in relationship to materials structure characterization and microanalysis. Topics include physics of wave optics, dynamical electron diffraction theory, high resolution electron microscopy, aberrations and aberration correction, electron probe formation, STEM and inelastic scattering and microanalysis. Practical experience is included through project assignments. Prerequisite MSE 405, 481 or equivalent, or with consent of the instructor.

Textbook

J.M. Zuo and J.C.H. Spence, Advanced Transmission Electron Microscopy, Imaging and Diffraction in Nanoscience, Springer, 2017 (Available online through UIUC library)

Reading Materials:

1. D. Williams and B. Carter, "Transmission Electron Microscopy-A Textbook for Materials Science", Plenum Press, New York, 2nd Edition, 2009 (Good introductory textbook, recommended for background reading; available online through UIUC library)
2. L. Reimer and H Kohl, "Transmission Electron Microscopy: Physics of Image Formation and Microanalysis", 5th ed., Springer, 2008 (Main reference book; available online through UIUC library)
3. Marc De Graf, "Introduction to Conventional Transmission Electron Microscopy", Cambridge, 2003 (Has an extensive coverage of electron diffraction and imaging theory at the graduate student level, including software)
4. P. B. Hirsch et al., "Electron Microscopy of Thin Crystals", Krieger Publishing Company, 1977 (A bible for theory of diffraction contrast of defects and practice).
5. "Science of Microscopy", Edited by P.W. Hawkes and J.C.H. Spence, Springer, 2006 (An advanced reference book; Available online)

Software Suggested for the Course:

ImageJ, a free software for image display and processing
DigitalMicrograph, available upon request from www.gatan.com
pyemaps, (details will be given in class)
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Course Topics:

	Subject	Hours
1.	Electron Waves, wave Properties and wave propagation	6
2.	Electron diffraction, kinematical theory	6
3.	Electron diffraction, dynamical theory	6
4.	Electron imaging, magnetic lens, lens aberrations, aberration correction	6
5.	High-Resolution Electron Microscopy	6
6.	Electron probes and probe formation	3
7.	Scanning Transmission Electron Microscopy	3
8.	Inelastic Scattering and Electron Energy Loss Spectroscopy	7
Total hours		**43**

Grade: Homework assignments 30% (about 2-3 problems each and 6 to 8 assignments in total). Midterm (35%) and final examination (35%).

Office hours

Friday, 11am to 12 pm

or by appointments

Contact
Prof. Jian-Min Zuo
jianzuo@illinois.edu