Oregon State University
Professional and
Continuing Education

# Hands On Electron Microscopy

## Fall 2024 | Mondays from September 30 – November 18, 2024

### Instructors

Peter Eschbach, Director OSU Electron Microscopy Facility, Peter.eschbach@oregonstate.edu
Rebecca Jackson, Assistant Director OSU Electron Microscopy Facility, Rebecca.jackson@oregonstate.edu

### Prerequisites

None

### Course Description

This course was developed by popular demand for folks starting out in electron microscopy (think research laboratories, universities, and nanotechnology centers) who have always wondered "how does this actually work." The goal is to give you hands-on demonstrations and pertinent theory that will serve you your whole scientific career.

You'll learn the following electron microscopy topics:

- vacuum pumps and vacuum science
- electron sources
- creation of a fine beam with apertures and crossover (spot size explained)
- focus and "stigmation" in the SEM, X-ray analysis including monte-carlo simulations of x-ray volume
- sample prep for SEM including coating systems and why we coat
- sample prep for TEM both for materials science and biology
- focus in the TEM,
- STEM EDS and STEM EELS in the TEM

### Course Format and Time Commitment

Learners have two options for course participation:

- Onsite with online option
- Online (webinar) only

Roughly the first 45 minutes of class is a semi-informal lecture with a small break then a 30-minute demonstration of topics from lecture.

### Course Content

**1. Electron imaging**

- Why electrons for imaging? Resolution, depth of field, chemical analysis possible using x rays.
- SEM vs TEM advantages disadvantages
- Real world examples from Biology, Chemistry, Engineering
- Other topics

- Hands on demo SEM images in the lab

**2. Sources, optics and imaging**

- Electron sources, tungsten, Lab6, FEG
- Review of basic optics and thin lens behavoir, where object is determines if we minimize or magnify
- Spot size TEM and SEM are backwards from each other
- Function of Condenser is to? Minimize size of source and collimate the beam for proper focus. Apertures in the upper beam.
- Objective lens, where most of magnification occurs
- Hands on demo: SEM images at a range of magnifications, What happens with depth of field as we move the sample closer? And depth of field when we increase magnification.

**3. Beam solid interactions**

- Scattering volume vs keV
- Best voltage for you is compromise between resolution and surface sensitivity
- Best resolution is not always finest aperture as diffraction effects come into play.
- Hands on demo: Monte Carlo simulations of beam scattering on the computer using freeware and a demo on the Helios with low voltage 500 volt vs 15 keV imaging.

**4. TEM**

- High voltage beam and its effect on samples. Voltage and contrast, better contrast at lower voltages!
- In TEM we have a super thin sample what does this do for scattering volume, x-ray analysis?
- Contrast agents, because in most cases the TEM resolution is not the problem.
- Spot size in TEM, now that you thought you understood spot size.
- Diffraction plane, 1/f points, image plane 2/f images
- Different detectors and schemes, bright field/dark field, STEM detector vs TEM camera.
- Hands on TEM: images of biological samples on the TEM

**5. Sample prep is 90% of the electron microscope job**

- How much time does biological sample prep take a few cases: critical point drying, full embedding and sectioning on the ultra microtome.
- Fixation of biological tissue
- Embedding of biological tissue
- Examining thick sections optically first
- Cutting to thin section and staining of biological tissue.
- Hands on demo, imaging bio sci. sections.

**6. Materials science prep**

- EBSD prep
- Tripod polish prep for TEM
- FIB prep for TEM
- Hands on Demo , final thinning of FIB prep sample and putting it in the TEM.

**7. Bio Science imaging various transmission techniques**

- Optical images on thick sections, setting Kohler illumination, ...
- 30 keV STEM in SEM on Helios real world examples, pros and cons
- 80 keV TEM on Titan on same samples done with STEM in SEM
- Switching keV and using registers on Titan Tecnai platforms
- Hands on 80 keV TEM on Titan

**8. Materials Science imaging on the TEM**

- Always, eucentric height and hit that eucentric focus button

- STEM: How often should I get into the weeds and do full STEM alignment? I say never, come get us. But, if you want, check pivot points, rotation center
- Quick TEM, set register brush up pivot points, rotation center then go!
- Spot size, coherence of beam
- Electron dose and pleased not to turn your sample into a potato chip
- Carbon deposition from sample and chamber adventitious carbon. Strategies: plasma clean sample, beam shower, let sample sit overnight, reduced current!
- Hands on demo, HRTEM on copper sample with sharp grain boundaries.

**9. STEM EDS and STEM EELS, maybe some EFTEM as well!**
- EDS map examples from OSU Titan with ChemiSTEM
- Quant with Bruker Esprit software. Deconvolve, background models, saving methods.
- What is EELS Why EELS? When to EELS?
- Hands on example, mapping of semiconductor or NIST 213 using EDS and EFTEM or EELS.

**10. Image processing, Digital micrograph, Image J, Avizo, Matlab, Photo shop**
- Diffraction analysis using Mitchell's Digital Micrograph plugins
- Quick introduction to ICDD , diffraction data base. Including exporting CIF files to JEMS and or EBSD software.
- Using Image J to measure particles.
- Unsharp masking in Matlab/Python
- Art and electron microscopy, photoshop to colorize and or make 3D objects.
- Hands on Demo, segmentation in Image J and Avizo. 3D reconstruction in Avizo.

## Accessibility Accommodations

To request accessibility accommodation for online and/or onsite course participation, please contact the PACE office (541-737-4197 or pace@oregonstate.edu) as soon as possible.