ECE 6960-006 (Fall 2019)
Advanced Electron Microscopy for Semiconductor Devices

Instructor: Heayoung Yoon
Assistant Professor in Electrical and Computer Engineering
2136 Merrill Engineering Building
heayoung.yoon@utah.edu

This course is ideal for MS and first-year PhD students, who are interested in
(1) research in emerging micro/nano materials and devices and/or
(2) seeking for a job in industry (failure analysis, in-situ nano imaging)

- This semester, the lab fee ($165) is waived (free).
- Only 8 seats are available due to the lab sessions.
- This course is interdisciplinary, and no prior knowledge of microscopy techniques
  is required.
- Students who receive a grade B0 (or above) become an authorized user for the SEM
  in the Nanofab without further training sessions.
- Permission code is required for ECE undergrad students and graduate students in
  other Departments.

Below is the system (Quanta 600; left) that we will use in this course. There will be demo
sessions for dual-beam system (Helios 650; middle). Final exam includes poster
presentation with invited speaker and guests (right picture).

Comments from previous students
“Great combination of hands-on and theory”
“Explained complex concepts very well!”
“Dr Yoon is very dedicated and knowledgeable in the topic”
Course Objectives:

The goal of this course is to introduce the students to both the theory and practical use of modern scanning electron microscopy (SEM) for micro/nano materials and devices. We will start from the principle of electron microscopy, proceed to the description of conventional and advanced modern technique, and evaluate advantages and disadvantages of each method. In particular, we will focus on metrologies for semiconductors devices, such as energy dispersive X-ray spectroscopy (EDX), electron beam induced current (EBIC), and cathodoluminescence (CL), to study active defects, junction interfaces, and excess carrier dynamics of the devices. The lab sessions will be held in the state-of-the-art laboratories of the Utah’s Nanofab. We will also use software to perform simulations and data analysis. Students will understand what studies can be addressed with each technique and what is the level of details that can be expected. This course is also designed to provide students from various field a practical introduction to nanoscale electrical and optical measurements of emerging semiconductor materials and devices.

Grading Policy:

The course grade will be distributed as follows:

- Lab Reports: 30 %
- Midterm exam: 30 %
- Final Presentation: 40 %
Course Outline

Week 1: SEM: capabilities and limitations
Week 2: SEM: modes, sources, brightness equation
Week 3: Electron beam interaction with materials (Monte Carlo simulation)
Week 4: Nanoscale imaging
Week 5: Charging, Low vacuum (how to make it and why it works)
Week 6: Qualitative / quantitative compositional analysis (EDS)
Week 7: Review, Midterm exam
Week 8: Fall Break
Week 9: Carrier generation and transport in semiconductor devices
Week 10: Focused ion beam (interconnection of devices)
Week 11: Focused ion beam (cross-section of devices)
Week 12: Local luminescence of semiconductor materials (CL)
Week 13: Local electrical characterizations (EBIC)
Week 14: EBIC analysis, Thanksgiving break
Week 15: Review, Student project presentation
Week 16: Student project presentation, Invited seminar