Syllabus: MATSE 404, Thin Film Electrical Properties  
(Fall Semester, 2019)

COURSE DESCRIPTION:
Introduce seniors and new graduate students to electrical properties of thin film materials and semiconductors through hands-on experiments in the Materials Science and Engineering instructional laboratories. Covers both the principles and measurements of (a) thin-film resistance; (b) modification of electrical properties by thermal processing; (c) carrier mobility and Hall effect; and d) size-effect of thin-film resistance. 

Prerequisite: MSE 307 and MSE 308 or permission of instructor. Senior standing.

References
Laboratory manuals provided.
Thin film electrical properties in Physics of thin films, TU Wien, Chapter 4, PDF provided.
General reading about thin films:

GOALS:
The objective of this course is to provide lab experience to students in the area of Thin Film Processing and Electrical Property Characterization. It will be organized using a set of experiments performed in laboratory sessions, problem solving and student presentation. Students will be encouraged to read background materials before the class. Each set of experiments will be done by the students with minimal help from the lab's technical specialist.

COURSE TOPICS:
1. Measurement of thin films resistivity, 2, 3, 4 points probe
2. Van der Pauw method of measuring resistivity
3. Hall effect and carrier mobility
4. Thin-film resistivity and microstructure
5. Size dependence of electron mobility and resistivity
LABORATORY WORK:

1. Thin Film Resistivity
   Resistivity of TiN Thin Film, 2-pt, 3-pt and 4-pt resistance measurements
   Measurement of contact resistance by varying contact probe distances

2. Van der Pauw method of measuring resistivity
   Prepare Au/Ti Films on Glass Slides by sputtering deposition
   Measurement of resistivity using Van der Pauw method

3. Hall Effect and Resistivity
   Measurement of Resistivity and Hall Voltage of GaAs
   Unknown Samples,
   Identify the unknown samples

4. Temperature Annealing and Thin Film Conductivity
   Prepare Au/Ti Films on glass by sputtering deposition
   X-ray diffraction of as-deposited film
   Thermal Annealing and In-situ Resistivity Measurement
   X-ray diffraction of annealed film

5. Size dependence of thin-film resistivity and mobility
   Prepare Au/Ti Films on Glass Slides of different thicknesses
   Measurement of thin-film resistivity and electron mobility
   Examine their film thickness dependence

LABORATORY GROUP:

The class will be organized in groups for instrument sign-up and the laboratory work.
Student will be responsible for his/her own reports
**Time and workload:** 2x3=6 hours/week/student
Session-1 (2pm to 5:00pm)  Monday
Session-2 (2pm to 5:00pm)  Tuesday
Session-3 (2pm to 5:00pm)  Wednesday
Session-4 (2pm to 5:00pm)  Thursday

**MINI-REPORTS (3 IN TOTAL):**
At end of labs 1-3, hand in mini-report, before moving on to next lab. The mini-report should include solutions to thinking questions and a summary of measurement results. The members of group are encouraged to discuss the solutions, but each member should hand-in his/her own mini-report.

**GROUP VIDEO PRESENTATION:**
Each group will select resistivity measurement or Hall effect as the topic, and prepare an instruction-style video on the selected topic, incorporating your experimental results as presentation materials. The video will be uploaded and graded during 2\textsuperscript{nd} half of the lab session.

**FINAL REPORT:**
Each student will provide a final report on “Thin film electrical properties and microstructure”. Instructions for written report will be given separately. Only electronic submission through Compass2g will be accepted.

**INSTRUCTOR**
Jian-Min (Jim) Zuo, 1006 MRL, 244-6504, jianzuo@illinois.edu

**TEACHING ASSISTANTS**
Aram Yoon

**OFFICE HOURS:**
10:00 AM – 12:00 PM Thursday or by appointment

**GRADING:**
Final grade = 10% lab performance and class participation
+ 30% group presentation video
+ 30% on mini-reports
+ 30% final report, graded by instructor