Syllabus: MATSE 462, Electronic Materials Laboratory

(Fall Semester, 2015)

CATALOG DESCRIPTION:

Introduces seniors and new graduate students to the fabrication, analysis, and properties of thin film materials through a combination of lectures and experiments in the Materials Science and Engineering instructional laboratories. Covers both the principles and practice of (a) deposition of thin film materials by vacuum evaporation, sputtering, and plasma assisted processes; (b) modification of properties by thermal reaction, surface treatment, etc.; (c) measurement of key properties including electrical conductivity, optical indexes, magnetic hysteresis, and internal stress. Methods to optimize the film microstructure and engineering properties via the growth technique are emphasized. *Prerequisite:* Materials Science and Engineering 460, 461 or consent of instructor. 3 hours or 3/4 unit.

References

J. L. Vossen and W. Kern, "Thin Film Processes," Academic.
J. M. Poate, K. N. Tu and J. W. Mayer, "Thin Films," Wiley Interscience.
M. Ohring, "The Materials Science of Thin Films," Academic.

GOALS:

The objective of this course is to provide lab experience to students in the area of Thin Film Processing and Characterization. It will be organized using both lecture and laboratory sessions. The lectures will be based on topics in thin film physics, typically of metals and semiconductors. Each set of experiments will be done by the students with minimal help from the lab's technical specialist.

COURSE TOPICS:

1. Introduction; Thin films and vacuum
2. Deposition Principles and processes
   - Formation from the vapor state
   - Evaporation
3. Thermal Reactions
   - Annealing
   - Oxidation
4. Properties
   - Microstructure
   - Stress,
   - Optical
   - Electrical, magnetic

LABORATORY WORK:

1. Hall Effect and Resistivity Measurements

2-pt, 3-pt, and 4-pt sheet resistance
Hall Effect Known Semiconductor: GaAs
Hall Effect Unknown Semiconductor Si, GaAs, or Ge
Hall Effect ~100nm Aluminum

2. Deposition of Thin Metal films

2-pt, 3-pt, and 4-pt sheet resistance
Fabricate/calibrate various 2 wire and 3 wire thermocouples
Deposit three thicknesses of Au films: 5nm, 25nm, 100nm
    Electrical Characterize all films with 4-pt sheet resistance
    Optical Characterize all films: Transmission and Reflectance
Deposit of bilayer of Au/Al film
    In-situ measurement 4-pt resistance during annealing 30C-300C

3. Position Sensitive Detector (PSD)

Noise Analysis of ACD: Reading Rate, Range: Drift, RMS, …
  Precision, Accuracy, Drift
Calibrate (dV/dx)
Noise analysis of PSD compare with ADC,: Drift, RMS, …
Determine absolute resolution of PSD using 0.07um micrometer
Analysis of ultimate sensitivity of PSD in terms of stress.
Penny experiment: Mass vs Deflection

4. Thin Film Stress Measurement (Wafer Curvature)

Construct Schematic/Geometric configuration of system PSD→ Stress
Penny experiment: Mass vs Deflection
Effect of Fan ON/OFF, vibration, …
Temperature scan of Si, SiO_2/Si/SiO_2,
CTE of SiO_2: on Si/SiO_2,
Deposit Al on Si, determine CTE of Aluminum SiO_2/Si/SiO_2/Al
Track Phase reaction of Al/Au uisng stress.
3. Electromigration - Al lines
4. Stress - A1 thin films

LABORATORY SCHEDULE

Fall, 2015

Week	Group A	Group B	Group C	Group D	Week
1	Fab	Fab	Fab	Fab	8/25 – 8/28
2	Fab	Fab	Fab	Fab	9/1 – 9/4
3	Presentation	Presentation	Presentation	Presentation	9/8 – 9/11
4	Deposition	Hall	Stress/PSD	Hall	9/15-9/18
5	Deposition	Hall	Stress/PSD	Hall	9/22-9/25
6	Deposition	Hall	Stress/PSD	Hall	9/29-10/2
7	Deposition	Hall	Stress/PSD	Hall	10/6-10/9
8	Deposition	Hall	Stress/PSD	Hall	10/13-10/16
9	Presentation	Presentation	Presentation	Presentation	10/20-10/23
10	Hall	Stress/PSD	Hall	Deposition	10/27-10/30
11	Hall	Stress/PSD	Hall	Deposition	11/3-11/6
12	Hall	Stress/PSD	Hall	Deposition	11/10-11/13
13	Hall	Stress/PSD	Hall	Deposition	11/17-11/20
	Thanksgiving				11/24/-11/27
14	Hall	Stress/PSD	Hall	Deposition	12/1 – 12/4
15	Presentation	Presentation	Presentation	Presentation	12/8-12/10

Time and workload:

2x3=6 hours/week/student

Session-1 (11am to 2:00pm) Tuesday
Session-2 (2pm to 5:00pm) Tuesday
Session-3 (12pm to 3:00pm) Wednesday
Session-4 (3pm to 6:00pm) Wednesday
Session-5 (11am to2:00pm) Thursday
Session-6 (2pm to 5:00pm) Thursday
Session-7 (12pm to 3:00pm) Friday
Session-8 (3pm to 6:00pm) Friday

LECTURE SCHEDULE: 1 hours/week

Thursday (9:00 to 10:00am), as needed

EXPERIMENT PRESENTATION:

Each student will have a period of 30 minute time for "open" presentation for each lab.. Typically, the talk will be interrupted by impromptu questions. The instructor or any member of the class will be allowed to ask any questions at any time during the presentation.

WRITTEN REPORT:

The written report will be the same power point presentation which is presented orally. Students will have 3-7 days after presentation to submit the written report. Only electronic submission through Compass2g will be accepted.

INSTRUCTOR

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

TEACHING ASSISTANTS

OFFICE HOURS:

10:00 AM – 12:00 PM Friday or by appointment

GRADING:

Final grade = 15% lab performance (graded by TAs)
+ 15% voltmeter presentation and report
+ 35% each on presentation and report on 2 labs.,
graded by instructor and TAs