

# EMA 3414L Electronic Materials Laboratory

Fall 2014

1. Catalog Description (1 credit): This course provides hands-on experience for students specializing in electronic materials. Laboratory topics include characterization of optical and electronic properties of semiconductor materials, electronic devices characterization, and semiconductor processing.

2. Pre-requisites and Co-requisites:

Pre-req: EMA 3414 – Introduction to electronic Materials

EEL3003 – Introduction to Circuits

3. Course Objectives: The course emphasizes the identification and testing of electronic devices, and fabrication and testing of electronic materials. The influence of material and interface properties on device performance will also be stressed.

4. Contribution of course to meeting the professional component: This is a 1 credit course.

5. Relationship of course to program outcomes: This course addresses the following MSE Program outcomes (note: Numbers refer to the list of MSE Program outcomes):

1. Ability to apply knowledge of mathematics, science, and engineering to materials systems. This course requires for the students to assess and calculate material parameters from data obtained experimentally. Device structures that are produced in the laboratories will be tested to see if certain device performance requirements are satisfied.
2. Ability to conduct experiments, analyze and interpret data. For this course, the students will have to follow instructions, set-up experiments, collect data and interpret data, and discover any sources of error.

3. Ability to conduct and analyze design of experiments (DOE). The students will be exposed to a simple experiment, identify the control variables, the uncontrolled variables and asked to expose sources of error and solutions to those sources. Students will explore parameters related to oxide film growth and metal deposition experiments.
  
4. Ability to apply and integrate knowledge of structure, properties, processing, and performance to solve materials selection and design problems within realistic constraints. The students will be asked to compare the published material property values with the experimentally obtained values and give reason for any discrepancies.
  
6. Ability to identify, formulate, and solve engineering problems. The students will be asked to provide realistic solutions to issues associated with the material processing and material testing to improve the experimental data sets.
  
7. Understanding of professional and ethical responsibility. The students will be placed into laboratory groups and will work together collaboratively to solve problems associated with experimental data collection, and device processing.
  
8. Ability to communicate effectively in both oral and written form. The students will have to submit a written laboratory report, and will have to document progress towards completion of device manufacturing. These will be graded on both technical content and clarity.
  
13. Ability to use the techniques, skills, and tools needed for practice as a materials engineer. The course provides students with hands on laboratory experience in the field of electronic materials testing and processing. This knowledge will be applicable in either the academic arena or the industrial arena. (HIGH)

6. Instructor: Dr. Nancy Ruzycki

- a. Office location: RHN 150
- b. Telephone: 352.846.2991
- c. E-mail address: nruzycki@mse.ufl.edu

d. Office hours: Wednesday 4<sup>th</sup>–5<sup>th</sup> period or by appointment

7. Teaching Assistant: Ryan Murray

8. Meeting Times: Tuesday 10<sup>th</sup> -11<sup>th</sup> period, Thursday 10<sup>th</sup>-11<sup>th</sup> period.

9. Class/laboratory schedule: lecture and lab 2 hours, each week

10. Meeting Location: Lecture – NRF facilities

Lab – NRF facilities unless notified by instructor.

11. Materials and Supply Fees: see ISIS

12. Textbooks and Software Required: No required text. All assessments and projects will be based on material presented in class as well as handouts. You will need a separate composition or laboratory notebook for this course.

13. Recommended Reading:

a) Hummel, R. E. (2011). *Electronic properties of materials*. Springer.

b) Kasap, S. O. (2006). *Principles of electronic materials and devices* (Vol. 81). New York, NY: McGraw-Hill.

c) The labs mirror the content taught in EMA 4614 Production of Electron Materials.

14. Course Outline - Below is the tentative schedule of topics, activities, reading assignments, See Sakai for Chapter and Unit Objectives, Learning Outcomes, assignments, and rubrics.

This outline is subject to change.

Session	Topic	Labs and Activities	Expected outcome
1	Lab Safety, Semiconductor device background	Lab Safety and Protocols. Error Analysis in Laboratory	Student notebook with questions, safety quiz
2	4-point resistance measurement, Hall probe measurements	Measuring resistance using 4-point probe, Hall probe measurements.	Student notebook, prelab quiz, questions, IEEE report
3			
4	Ion Implantation	Ion Implantation simulation	Simulation and questions, notebook, MATLAB program
5	Wet and Dry Etching	Wet and Dry Etching, characterization with profilometer	Prelab quiz, Student notebook with questions, student device check
5	Oxide Growth	Oxide Growth experiment, profilometry, AFM	Prelab quiz, Student notebook with questions, device check
6			
7	Sputtering	Sputtering experiment	Prelab quiz, student notebook with questions, device check
8			
9	Photolithography	Photolithography experiments	Prelab quiz, student notebook with questions, device check
10			
11	Thermal Evaporation	Thermal Evaporation experiments	Prelab quiz, student notebook with questions, device check
12			
13	MOS characterization	Characteristic of MOS device	Prelab quiz, student notebook with questions, device check
14			

Each Topic will have a student product which will be graded as a formal assessment. It is expected that students keep There will be a rubric for each product. Student products may include, but are not limited to; lab reports, posters, abstracts, research proposals, users manuals, program codes, technical letters, oral presentations.

15. Attendance and Expectations - Attendance is **REQUIRED** since labs cannot be made up outside of the scheduled time. **Students are expected to comply with all laboratory guidelines, protocols, and procedures. Students who do not comply with these requirements or who behave disorderly or disrespectfully WILL be asked to leave.**

**All electronic devices (laptops, cell-phones, etc.) should be turned off or in silent mode.** You may not use your cell phone during class, owing to lab safety protocols. There will be a time during characterization of the MOS device that you may use your phone to record data.

**You may not come late to class.** The class is held behind locked doors, and another swipe code doors, and once class starts, we will not be able to hear or see anyone who has not arrived.

**You must be properly attired for class.** You must bring or wear long sleeved shirts, long pants, and close toed leather or non porous shoes. You may not wear loose fitting clothes to lab. If you bring clothes to change into, you must be properly attired prior to class time.

**You must be prepared for class by doing the pre-reading with questions.** You will have a pre-lab quiz every week based on the pre-reading. If you do not pass the quiz, you will not be allowed to attend the lab.

Students will be graded according to the following:

Student daily notebook	50% of final grade
Student products	30% of final grade
Student assessments (pre-labs, in class quizzes, surveys, exit tickets, quick writes, etc...)	15% of final grade
Device characteristics	5 % of final grade

17. Grading Scale - Grades will not be curved and there is no extra credit.

Grade	Earned percentiles total
A	95
A-	90
B+	88
B	85
B-	80
C+	78
C	75
C-	70
D+	68
D	65
D-	60
E	59 or less

This statement must be included in every grade scale for undergraduate level 1000-5000 syllabi:

“A C- will not be a qualifying grade for critical tracking courses. In order to graduate, students must have an overall GPA and an upper-division GPA of 2.0 or better (C or better). Note: a C- average is equivalent to a GPA of 1.67, and therefore, it does not satisfy this graduation requirement. For more information on grades and grading policies, please visit: <https://catalog.ufl.edu/ugrad/current/regulations/info/grades.aspx>

18. Make-up Exam Policy – Make up exams will be provided only with the **prior approval of the instructor in accordance with university policies**. In general, acceptable reasons for excused absence include illness, serious family emergencies, special curricular requirements, military obligation, court-imposed legal obligations, and religious holidays. In all cases you will be required to provide written documentation, and obtain prior instructor approval. You will not be excused from any exam without following the policy above, with no exceptions. Students not in attendance for the scheduled exam will receive a score of zero.

To be clear, Make-up exams will only be allowed in exceptional cases, with prior instructor approval, sufficient documentation, and in accordance of university policies. Make-up exams for excused absences as well as exam conflicts must occur within 1 week of the missed exam, and may occur before the missed exam.

19. Honesty Policy – All students admitted to the University of Florida have signed a statement of academic honesty committing themselves to be honest in all academic work and understanding that failure to comply with this commitment will result in disciplinary action. This statement is a reminder to uphold your obligation as a UF student and to be honest in all work submitted and exams taken in this course and all others.

20. Accommodation for Students with Disabilities – Students Requesting classroom accommodation must first register with the Dean of Students Office. That office will provide the student with documentation that he/she must provide to the course instructor when requesting accommodation.

21. UF Counseling Services –Resources are available on-campus for students having personal problems or lacking clear career and academic goals. The resources include:

- UF Counseling & Wellness Center, 3190 Radio Rd, 392-1575, psychological and psychiatric services.
- Career Resource Center, Reitz Union, 392-1601, career and job search services.

22. Software Use – All faculty, staff and student of the University are required and expected to obey the laws and legal agreements governing software use. Failure to do so can lead to monetary damages and/or criminal penalties for the individual violator. Because such violations are also against University policies and rules, disciplinary action will be taken as appropriate. We, the members of the University of Florida community, pledge to uphold ourselves and our peers to the highest standards of honesty and integrity.