

ADVANCED ELECTRONIC MATERIALS PROCESSING

EMA 6616/ 4614

Class Periods: MWF, 1.55-2.45 PM

Location: EDGE Studios, NEB 201

Academic Term: Fall 2019

Instructor: S.J. Pearton

343 Nuclear Science Building

Phone:352/846-1086

E-mail:spear@mse.ufl.edu

<http://pearton.mse.ufl.edu>

Office Hours: 9.30-10.30 pm Monday & Wednesday

Teaching Assistants:

There are usually none for this course

Course Description

This is a 3 credit graduate class. The goal is to give an overview of the properties of semiconductor and related material for particular applications, and some detail of individual processing steps such as lithography, etching, deposition, implantation, annealing and oxidation. Some basic electronic and photonic devices such as bipolar transistors, metal-semiconductor field effect transistors, metal-oxide semiconductor field effect transistors, diode lasers and light-emitting diodes will be discussed. Examples of current individual and integrated processes will also be covered.

Course Pre-Requisites / Co-Requisites

None, but some knowledge of semiconductor physics is assumed.

Course Objectives

To provide the student with an up-to-date picture of how modern semiconductor chips are fabricated; comparison of Si versus compound semiconductors; processing modules such as diffusion, ion implantation, wet and dry etching and metal deposition; materials selection requirements; yield and reliability requirements; basics of component devices such as MOSFETs, bipolar transistors, LEDs and laser diodes.

Materials and Supply Fees

None

Professional Component (ABET):

This course addresses the following MSE Program outcomes:

(a)To apply mathematics, science, engineering basics and the fundamentals of materials science to envision solutions to and to solve engineering problems. (High coverage)

This course builds on fundamental concepts learned in previous courses and applies them to materials processing. Students are assigned homework and exam problems in which they must describe appropriate applications of the various processing techniques.

There is also some discussion of economic impact of the semiconductor industry (Low coverage) and trends in this technology (contemporary issues, low coverage)

Relation to Program Outcomes (ABET):

Outcome	Coverage*
1. An ability to identify, formulate, and solve engineering problems by applying principles of engineering, science, and mathematics.	High

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2. An ability to apply both analysis and synthesis in the engineering design process, resulting in designs that meet desired needs.	High
3. An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.	
4. An ability to communicate effectively with a range of audiences	Low
5. An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.	
6. An ability to recognize the ongoing need for additional knowledge and locate, evaluate, integrate, and apply this knowledge appropriately.	Medium
7. An ability to function effectively on teams that establish goals, plan tasks, meet deadlines, and analyze risk and uncertainty	

*Coverage is given as high, medium, or low. An empty box indicates that this outcome is not covered or assessed in the course.

Required Textbooks and Software

None

Recommended Materials

- Title Text: Fabrication Engineering at the Micro- and Nanoscale, Stephen A. Campbell, fourth edition, Oxford University Press, 2012, ISBN-13: 978-0199861224, ISBN-10: 0199861226 (available in the University Bookstore in paperback edition).
- There is a E-Learning System page for the course containing additional relevant material, including lecture notes, solution sets from the text book and semiconductor videos <http://elearning.ufl.edu/>

Course Schedule

Lecture	Day/Date	Topic	Assigned Problems
1	Wednesday, 8/21	General Introduction/Electronics video	
2	Friday, 8/23	Properties of Semiconductors	
3	Monday, 8/26	Video (Microchip)	
4	Wednesday, 8/28	Properties of Semiconductors	1-3
5	Friday, 8/30	Bulk Growth	
-	Monday, 9/2	Labor Day-no class	
6	Wednesday, 9/4	Epitaxial Growth	
7	Friday, 9/6	Epitaxial Growth	
8	Monday, 9/09	Growth and characterization	
9	Wednesday, 9/11	Characterization	
10	Friday, 9/13	Lithography	
11	Monday, 9/16	Lithography /(Video Lithography)	

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12	Wednesday, 9/18	Lithography	
13	Friday, 9/20	Wet Etching	
14	Monday, 9/23	Dry Etching	
15	Wednesday, 9/25	Video (Si Run I)	
16	Friday, 9/27	Dry Etching (Video Etch)	
17	Monday, 9/30	Quiz #1	****
18	Wednesday, 10/02	Deposition (Video Deposition)	
-	Friday, 10/04	HOMECOMING-no class	4-6
19	Monday, 10/07	Implantation	
20	Wednesday, 10/09	Implantation (Video Implantation)	To be distributed
21	Friday, 10/11	Quiz #2	****
22	Monday, 10/14	Diffusion	
23	Wednesday, 10/16	Video (Intel Video)	
24	Friday, 10/18	Annealing	
25	Monday, 10/21	RTA	
26	Wednesday, 10/23	First Exam	****
27	Friday 10/25	Contacts	
28	Monday, 10/28	Contacts	
29	Wednesday, 10/30	Process Integration/MOSFET	
30	Friday, 11/01	Video (Si Run II)	
31	Monday, 11/04	Gate Dielectrics	
32	Wednesday, 11/06	Video (Semiconductor Devices)	
33	Friday, 11/08	MESFETs	
-	Monday, 11/11	Veteran's Day (no class)	
34	Wednesday, 11/13	MESFETs/HEMTs	
35	Friday, 11/15	HBTs	
36	Monday, 11/18	LEDs	
37	Wednesday, 11/20	Lasers	
38	Friday, 11/22	Detectors	
-	Monday, 11/25	Thanksgiving (no class)	
-	Wednesday, 11/27	Thanksgiving (no class)	
-	Friday, 11/29	Thanksgiving (no class)	
39	Monday, 12/2	Review of class	
40	Wednesday, 12/4	Second Exam (optional date)***	*****

*** to be decided by consultation with students. Individuals may schedule taking the exam at other times.

Attendance Policy, Class Expectations, and Make-Up Policy

Attendance at the lectures is not required, but experience has shown it is more beneficial to the student's understanding of the course materials. If you attend the lectures, be prompt in your arrival as a courtesy to the other students. Cell phones must be turned off during lectures. Missed quizzes or exams must be re-scheduled in consultation with the lecturer. Excused absences are consistent with university policies in the undergraduate catalog (<https://catalog.ufl.edu/ugrad/current/regulations/info/attendance.aspx>) and require appropriate documentation.

Evaluation of Grades

Assignment	Total Points	Percentage of Final Grade
Quizzes (2)	15 each	30%
Midterm Exam	30	30%

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Final Exam	40	40%
		100%

Homework: Optional, but any serious student will do it.

Make-up Exam Policy: Reasonable excuses will be entertained for absences from exams or quizzes and the student will be expected to take the exam as soon as possible after it was originally scheduled.

Grade Scale:	90-100%	A	85-89%	B ⁺
	80-84%	B	75-79%	C ⁺
	65-74%	C	61-64%	D ⁺
	56-60%	D	0-55%	F

Grades are absolute and are not curved

For EMA 4614 students-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>

For EMA 6616 students-In order to graduate, graduate students must have an overall GPA and an upper-division GPA of 3.0 or better (B or better). Note: a B- average is equivalent to a GPA of 2.67, and therefore, it does not satisfy this graduation requirement. For more information on grades and grading policies, please visit:

<http://gradschool.ufl.edu/catalog/current-catalog/catalog-general-regulations.html#grades>

More information on UF grading policy may be found at:

<https://catalog.ufl.edu/ugrad/current/regulations/info/grades.aspx>

Students Requiring Accommodations

Students with disabilities requesting accommodations should first register with the Disability Resource Center (352-392-8565, <https://www.dso.ufl.edu/drc>) by providing appropriate documentation. Once registered, students will receive an accommodation letter which must be presented to the instructor when requesting accommodation. Students with disabilities should follow this procedure as early as possible in the semester.

Course Evaluation

Students are expected to provide professional and respectful feedback on the quality of instruction in this course by completing course evaluations online via GatorEvals. Guidance on how to give feedback in a professional and respectful manner is available at <https://gatorevals.aa.ufl.edu/students/>. Students will be notified when the evaluation period opens, and can complete evaluations through the email they receive from GatorEvals, in their Canvas course menu under GatorEvals, or via <https://ufl.bluera.com/ufl/>. Summaries of course evaluation results are available to students at <https://gatorevals.aa.ufl.edu/public-results/>.

University Honesty Policy

UF students are bound by The Honor Pledge which states, “We, the members of the University of Florida community, pledge to hold ourselves and our peers to the highest standards of honor and integrity by abiding by the Honor Code. On all work submitted for credit by students at the University of Florida, the following pledge is either required or implied: “On my honor, I have neither given nor received unauthorized aid in doing this assignment.” The Honor Code (<https://www.dso.ufl.edu/sccr/process/student-conduct-honor-code/>) specifies a number of behaviors that are in violation of this code and the possible sanctions. Furthermore, you are obligated

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to report any condition that facilitates academic misconduct to appropriate personnel. If you have any questions or concerns, please consult with the instructor or TAs in this class.

Commitment to a Safe and Inclusive Learning Environment

The Herbert Wertheim College of Engineering values broad diversity within our community and is committed to individual and group empowerment, inclusion, and the elimination of discrimination. It is expected that every person in this class will treat one another with dignity and respect regardless of gender, sexuality, disability, age, socioeconomic status, ethnicity, race, and culture.

If you feel like your performance in class is being impacted by discrimination or harassment of any kind, please contact your instructor or any of the following:

- Your academic advisor or Graduate Program Coordinator
- Robin Bielling, Director of Human Resources, 352-392-0903, rbielling@eng.ufl.edu
- Curtis Taylor, Associate Dean of Student Affairs, 352-392-2177, taylor@eng.ufl.edu
- Toshikazu Nishida, Associate Dean of Academic Affairs, 352-392-0943, nishida@eng.ufl.edu

Software Use

All faculty, staff, and students 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.

Student Privacy

There are federal laws protecting your privacy with regards to grades earned in courses and on individual assignments. For more information, please see: <http://registrar.ufl.edu/catalog0910/policies/regulationferpa.html>

Campus Resources:

Health and Wellness

U Matter, We Care:

Your well-being is important to the University of Florida. The U Matter, We Care initiative is committed to creating a culture of care on our campus by encouraging members of our community to look out for one another and to reach out for help if a member of our community is in need. If you or a friend is in distress, please contact umatter@ufl.edu so that the U Matter, We Care Team can reach out to the student in distress. A nighttime and weekend crisis counselor is available by phone at 352-392-1575. The U Matter, We Care Team can help connect students to the many other helping resources available including, but not limited to, Victim Advocates, Housing staff, and the Counseling and Wellness Center. Please remember that asking for help is a sign of strength. In case of emergency, call 9-1-1.

Counseling and Wellness Center: <http://www.counseling.ufl.edu/cwc>, and 392-1575; and the University Police Department: 392-1111 or 9-1-1 for emergencies.

Sexual Discrimination, Harassment, Assault, or Violence

If you or a friend has been subjected to sexual discrimination, sexual harassment, sexual assault, or violence contact the **Office of Title IX Compliance**, located at Yon Hall Room 427, 1908 Stadium Road, (352) 273-1094, title-ix@ufl.edu

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Sexual Assault Recovery Services (SARS)

Student Health Care Center, 392-1161.

University Police Department at 392-1111 (or 9-1-1 for emergencies), or <http://www.police.ufl.edu/>.

Academic Resources

E-learning technical support, 352-392-4357 (select option 2) or e-mail to Learning-support@ufl.edu.
<https://lss.at.ufl.edu/help.shtml>.

Career Resource Center, Reitz Union, 392-1601. Career assistance and counseling.
<https://www.crc.ufl.edu/>.

Library Support, <http://cms.uflib.ufl.edu/ask>. Various ways to receive assistance with respect to using the libraries or finding resources.

Teaching Center, Broward Hall, 392-2010 or 392-6420. General study skills and tutoring.
<https://teachingcenter.ufl.edu/>.

Writing Studio, 302 Tigert Hall, 846-1138. Help brainstorming, formatting, and writing papers.
<https://writing.ufl.edu/writing-studio/>.

Student Complaints Campus: https://www.dso.ufl.edu/documents/UF_Complaints_policy.pdf.

On-Line Students Complaints: <http://www.distance.ufl.edu/student-complaint-process>.