MCEE 505/605 Lithography Materials and Processes

Instructor: Dale Ewbank
Contact: 475-4941, Dale.Ewbank@rit.edu

Student Requirements

Students required to take this course:
Course is required for Microelectronic Engineering students in their fourth year. The Graduate level version of this course MCEE-605 is required for students seeking a Master of Science in Microelectronic Engineering or a Master of Engineering in Microelectronic Manufacturing Engineering.

Students who might elect to take the course: Students who are interested in image capture related to lithography for research and manufacturing.

Goals of the course

(1) To build on the understanding of waves developed in Electromagnetic Fields by examining the interaction of light with atoms, which leads to scattering.
(2) To utilize this understanding of scattering to examine the fundamental phenomena of reflection, refraction, and polarization.
(3) To study phenomena such as interference, and coherence to gain an understanding of the limitations imposed on optical processes.
(4) To provide an understanding of polymer chemistry related to photoresist materials.
(5) To explore the chemistry of photoresist materials.
(6) To provide an understanding of process requirements for photoresist materials.
(7) To develop models of a photolithographic process and allow for simulation

Course description

Course number: MCEE-505  Lithography Materials and Processes

Catalog Description: Microlithography Materials and Processes covers the chemical aspects of microlithography and resist processes as well as an introduction to the principles of optics in which reflection, refraction, transmission, and absorption are explained as a result of interaction between the excitation field and the medium. Topics include Fresnel Coefficients, imagery due to refraction at a single surface, simple lenses, and ray tracing techniques. The fundamentals of polymer technology will be addressed and the chemistry of various resist platforms including novolac, styrene, and acrylate systems will be covered. Double patterning materials will also be studied. Topics include the principles of photoresist materials, including polymer synthesis, photochemistry, processing technologies and methods of process optimization. Also advanced lithographic techniques and materials, including multi-layer techniques for BARC, double patterning, TARC, and next generation materials and processes are applied to optical lithography.
**Prerequisite(s):** CHMG-131  
**Co-requisite(s):** none  
**Class 3, Lab 3, Credit 3 (Fall Semester)**

### Resources

**Text:**  


**Suggested but not required:**  

**Software:** PROLITH by KLA-Tencor

### Topics:

**Course Lecture Topics:**  
1. Introduction and overview of photoresist materials and processes.  
2. Wave Motion  
3. Electromagnetic theory, photons, and light  
4. Propagation of light  
5. Geometrical optics  
6. Polymer chemistry for microlithographic materials  
7. Chemistry of conventional photoresist  
8. Chemically amplified systems  
9. Resist processing  
10. Multi-layer techniques and Double Patterning  
11. Antireflective Coatings  
12. Next generation optical lithography  
13. Optical lithography modeling

**Laboratory Topics:**  
1. Safety and Notebooks  
2. Malus’ Law  
3. Reflection, refraction and transmission  
4. Introduction to simple lenses  
5. Stepper, Wafertrack, and Resist processing  
6. Resist Sensitivity and Contrast  
7. Nanoimprint  
8. Absorbance in photoresist  
9. Development rate measurement  
10. Swing curves
11. Multilayer processes
12 Double patterning

Laboratory requirements:
This course makes use of the very unique Semiconductor & Microsystems Fabrication Laboratory within the KGCOE, i.e. “the cleanroom”. The laboratory also uses software resources (Prolith) on the EME server.

Evaluation Methods MCEE-505:
Homework 30%
Laboratory 25%
1st exam 15%
2nd exam 15%
Final 15%

Evaluation Methods MCEE-605:
Homework 28%
Laboratory 23%
1st exam 13%
2nd exam 13%
Final 13%
Graduate Research Project 10%

Course Policy on Academic Honesty

KGCOE HONOR PRINCIPLES: RIT Engineering faculty, staff and students are truthful and honorable, and do not tolerate lying, cheating, stealing, or plagiarism.

All members of our community are expected to abide by these principles and to embrace the spirit they represent. We each have a responsibility to address any unethical behavior we observe; either through direct discussion with the offending party, or by discussion with an appropriate faculty or staff member. Allowing unethical behavior to continue unchallenged is not acceptable.

Rochester Institute of Technology does not condone any form of academic dishonesty. Academic Dishonesty falls into three basic areas: cheating, duplicate submission and plagiarism (refer to http://www.rit.edu/kgcoe/advising/handbook.pdf pages 19-20 for more information).

Throughout this course the following specific conditions exist in regards to academic honesty:

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<thead>
<tr>
<th>Course Element</th>
<th>Specific Conditions</th>
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<tr>
<td>Homework: Graded and Ungraded</td>
<td>Student collaboration is encouraged. However, the final product that is turned in must be your own work. All homework sets must be completely documented in regards to references used (books other than the course textbook, web sites, etc.) and assistance obtained from individuals other than the course instructor. Proper documentation would include source, date, and extent of</td>
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<td>Information gained through that source.</td>
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<td>Exams</td>
<td>Individual exercise; collaboration of any kind is disallowed</td>
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<tr>
<td>Laboratory Assignments</td>
<td>All team members expected to participate fully; one submission required from each student</td>
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Any act of Academic Dishonesty will incur the following consequences. After notifying and presenting the student with evidence of such misconduct, the instructor has the full prerogative to assign a lower grade, including an “F” for the offense itself or for the entire course. If after careful review of the evidence, the instructor decides that the student’s actions are indeed misconduct and warrant a penalty, the instructor will add a letter to the student’s file in his or her home department (copy to the student, Department Head and the Dean) documenting the offense. Depending on the seriousness of the offense, the student may also be brought before the Academic Conduct Committee of the College in which the offense occurred, and may face academic suspension or dismissal from the Institute. The student has the right to appeal any disciplinary action as described in section D17.0 “Academic Conduct and Appeals Procedures” and D18.0 “RIT Student Conduct Process” of the Institute Policies and Procedures Manual.