Fall 2024

MSE 4330: Fundamentals of Nanomaterials and Nanostructures

MSE 6405: Advanced Nanomaterials

Tues/Thurs 3:30 pm - 4:45, Love 184

Instructor Antonio Facchetti

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Office Hours Wednesday: 3:00-4:00 PM (or by appointment)

Course Description

Overview: This course covers the fundamentals of nanomaterials, nanostructures and nanoscopic films, as well as their unique properties for a broad spectrum of applications in science and technology. It emphasizes the interplay of engineering, chemistry, surface science, and physics to elucidate the multi-disciplinary nature of nanoscale science and engineering. The selected topics are appropriate for students in materials science and engineering, chemistry, physics, chemical engineering, mechanical engineering, environmental engineering, biomedical engineering, and electrical engineering.

Details: This course will i) start with fundamental concepts of bonding in chemistry; ii) introduce physical chemistry and surface science to elucidate the fundamental aspects and unique properties of solid materials emerging at the nanoscale; iii) introduce both "top-down" and "bottom-up" approaches to the fabrication and synthesis of nanostructures, nanomaterials and nanoscopic films; iv) discuss general and advanced tools for characterizing the physical and chemical properties of nanomaterials; iv) review recent developments of nanomaterials for applications in electronics, optoelectronics, and energy for understanding the societal impact of nanotechnology.

Primary References

Introductory Nanoscience: Physical and Chemical Concepts, Masaru Kuno, Garland Science; the first edition (August 19, 2011) (Optional for Module I)

Nanostructures and Nanomaterials: Synthesis, Properties, and Applications, Guozhong Cao and Ying Wang, World Scientific, the 2nd edition (2011) (Optional, Modules II)

Nanochemistry: A Chemical Approach to Nanomaterials, Geoffrey Ozin and Andre Arsenaut, RSC Publishing 2005 (Optional, Module IV)

Class notes & background readings available on Canvas

Grading: The final grade in this course will be a weighted average of the following categories:

Exams	70% (Exam I, 30%; Exam II, 20%; Exam III, 20%)
Homework	20 %
Paper Review	10%

Below are the minimum weighted score grade ranges for the semester. Final weighted scores are rounded up from 0.5 to the nearest integer (i.e., a score of 69.5% would be rounded up to 70% and would be awarded a B grade).

A	≥85%
B	70-85%
C	60-69%
D	50-60%
F	<50%

A homework or exam may be curved (i.e., extra points added to everyone's score) at the instructor's discretion. The curve for an exam or quiz will be announced both in class and on Canvas when the assessment is graded and returned to the class.

Gradescope: Gradescope is an online assessment tool that is integrated in Canvas and allows for scoring of both electronic and handwritten answer submission. Your exams will be scanned and saved as a PDF document. This PDF will be scored electronically, and your results will be transmitted to you via Gradescope and Canvas. A specific guide for using gradescope with Canvas can be found at: https://help.gradescope.com/article/5d3ifaeqi4-student-canvas.

Homework: All homework must be entirely a student's own work. Discussion with other students on homework is encouraged but copying from one another will be considered academic misconduct.

Exams: There will be three closed book exams throughout the semester. No computers or phones allowed.

Paper Review: Each student will be given a scientific research article to comment in writing. Each paper must follow a template that will be discussed in class.

Website: Canvas will be used to post the course syllabus, lecture notes, recordings, homework, and homework solutions. You will also submit your assignments via Canvas. Important announcements posted on Canvas so please enable notifications and check it regularly.

Grade Accuracy: If you believe that an error was made in grading exams, you should write a short justification of your claim and attach it to the original assignment in question. Send an electronic copy of this justification and the originally graded assignment to Prof. Antonio Facchetti (afacchetti6@gatech.edu). The "statute of limitations" for such claims is 1 week after the test is returned.

Accommodations The Georgia Institute of Technology encourages qualified persons with disabilities to participate in its programs and activities. If you anticipate needing any type of

accommodation in this course or have questions about physical access, please tell the instructor as soon as possible.

Missed Tests Make-up exams/tests will only be permitted when absences are due to legitimate reasons such as illness, religious observance, or other events recognized by the Institute as a valid excuse. In any case, you must contact the instructor in advance of the quiz via email to schedule a make-up quiz and provide documentation from the Institute through the Dean of Students. If you miss an exam/quiz without either a certified medical excuse or prior instructor approval, you will earn zero credit for that exam.

Academic Integrity Students should refer to the Institute's policy on academic integrity found in the code of conduct (http://www.policylibrary.gatech.edu/student-affairs/code-conduct). It is the instructor's understanding and expectation that students neither give nor receive any unauthorized aid on exams or quizzes, including the use of unauthorized notes or other information on an electronic device. While group discussion is encouraged on homework assignments, individuals must submit their own assignments. Authorized aid on homework assignments includes discussing the interpretation of the problems, sharing ideas or approaches for solving the problems, and explaining the concepts and possible solutions involved in the problems. All cases of academic misconduct will be submitted to Office of Student Integrity.

Student Expectations 1. Electronic devices (tablets, cell phones, calculators, etc.) are allowed during lectures if they do not distract you from learning. All of these devices are banned during exams. 2. During all course interactions (online or in person), students are expected to act in a professional manner that is courteous to the instructor and their fellow classmates.

Instructor's Commitment You can expect your instructor to be courteous, punctual, well-organized, and prepared for lecture and other class activities; to answer questions clearly; to be available during office hours or to notify you beforehand if she is unable to keep them; to provide a suitable guest lecturer if she is traveling; and to grade uniformly and objectively all tests and assignments.

Class Recordings Classes may not be recorded by students without the express consent of the instructor unless it is pursuant to an accommodation granted by the Office of Disability services. Class recordings, lectures, presentations, and other materials posted on Canvas are for the sole purpose of educating the students currently enrolled in the course. Students may not record or share the materials or recordings, including screen capturing or automated bots, unless the instructor gives permission.

Tentative Schedule

	Lectures	Dates	HW/ Assignment	Tentative topics
Week-1	Lecture-1	20-Aug		Introduction and Course Overview
	Lecture-2	22-Aug		Electronic Structure and Bonding
Week-2	Lecture-3	27-Aug		Structure of Solids
	Lecture-4	29-Aug		Solid Surface and Surface Energy
Week-3	Lecture-5	3-Sep	HW1	Solid Surface and Adsorption
	Lecture-6	5-Sep		Band Structure and Electronic Materials
Week-4	Lecture-7	10-Sep		Lengh Scale in Semiconductors and Metals
	Lecture-8	12-Sep		Review/In-class Problems
Week-5	Exam-I	17-Sep		Exam-I
	Lecture-9	19-Sep		Nanomaterials Fabrication -- Top-down Approaches
Week-6	Lecture-10	24-Sep		Nanomaterials Fabrication -- Top-down Approaches
	Lecture-11	26-Sep		Nanomaterials Fabrication -- Bottom-up Approaches
Week-7	Lecture-12	1-Oct		Nanomaterials Fabrication -- Bottom-up Approaches
	Lecture-13	3-Oct		Nanomaterials Fabrication -- Bottom-up Approaches
Week-8	Review/In-class Problems	8-Oct		Review/In-class Problems
	Exam-II	10-Oct		Exam-II
Week-9	Academic and administrative holiday	15-Oct		
	Lecture-14	17-Oct		Nanomaterial Characterization
Week-10	Lecture-15	22-Oct		Light Microscopy
	Lecture-16	24-Oct	HW2	SEM and TEM
Week-11	Lecture-17	29-Oct		Carbon Nanomaterials
	Lecture-18	31-Oct		Metal and Metal Oxide Nanomaterials
Week-12	Lecture-19	5-Nov		Lab Demo - Groups 1-2 // Self-assembled Nanomaterials - Groups 3-4
	Lecture-20	7-Nov		Lab Demo - Groups 3-4 // Self-assembled Nanomaterials - Groups 1-2
Week-13	Exam-III	12-Nov		Review/In-class Problems
	Lecture-21	14-Nov		Exam-III
Week-14	Lecture-22	19-Nov		Applications to Electronics
	Lecture-23	21-Nov		Applications to Energy
Week-15	Lecture-24	26-Nov		Paper Discussion
	Academic and administrative holiday	28-Nov		
Week-16	Paper due	6-Dec	Paper	