

ME 4766 Micro/Nano-Fabrication and Properties of Nanoscale Devices (Elective)

Catalog Description: ME 4766 Micro/Nano-Fabrication and Properties of Nanoscale Devices (3-0-3)

Prerequisites: ME 3322 Thermodynamics or AE 3450 Thermodynamics and Compressible Flow or MSE 3001 Chemical Thermodynamics of Materials or PHYS 3141 Thermodynamics

Fundamental properties at the nanoscale for photonics and sensors. Nanoscale fabrication methods including thin films, ion beam, lithography, electroplating, and example case studies in NEMS/MEMS and photonics.

Textbook: Zheng Cui, *Nanofabrication: Principles, Capabilities and Limits*, Springer, 2010.

References: Motoichi Ohtsu, *Nanophotonics and Nanofabrication*, Wiley/VCH, 2009.
Ivor Brodie and Julius J. Murray, *The Physics of Micro/Nano-Fabrication*, Academic Press, 2010.

Topics Covered:

1. Overview and introduction
2. Properties of nanostructure devices
3. Fundamentals and methods for solid-state nanofabrication
4. Nanodevice fabrication using focused ion beams and electron beams
5. Nanodevice fabrication using atomic layer deposition
6. Nanodevice fabrication by electroplating
7. Fabrication of nanoparticle-based sensing devices by directed self-assembly
8. Epitaxial self-assembly of semiconductor nanostructures through MBE and MOCVD
9. Other fabrication techniques for semiconductor nanostructures
10. Physics of semiconductor nanostructures
11. Nanodevice metrology and quality control
12. Term project presentations and discussion

Course Outcomes:

Outcome 1: To provide students with an introduction to the fundamentals and applications of mainly “top-down” fabricated nanoscale devices for photonics, NEMS/MEMS, and sensors.

- 1.1 The student will demonstrate an understanding of the basic concepts of top-down micro and nanofabrication techniques.
- 1.2 The student will demonstrate an understanding of the effects of scaling to the nanoscale on photonic, mechanical, and electrical properties of selected model materials covered in the class.
- 1.3 The students will demonstrate a basic understanding of electrochemical principles related to electroplating.

Outcome 2: To improve and expand the student’s skills in the techniques of micro/nano-fabrication.

- 2.1 The student will be able to solve problems related to film growth by physical and chemical vapor deposition.
- 2.2 The student will be able to calculate processing parameters for photolithography based on the properties of the resist and the wavelength of UV radiation.

- 2.3 The student will be able to correlate optical and electronic properties of nanostructures with structural parameters for the design of nanoscale devices.

Outcome 3: To provide student with the opportunity to integrate knowledge learned in this course.

- 3.1 Students will form teams to review a topic in micro/nano-fabrication, carry out a literature review, critically analyze results, and make a presentation to the class.

Correlation between Course Outcomes and Student Outcomes:

ME 4766											
	Mechanical Engineering Student Outcomes										
Course Outcomes	a	b	c	d	e	f	g	h	i	j	k
Course Outcome 1.1	X										
Course Outcome 1.2	X										
Course Outcome 1.3	X										
Course Outcome 2.1	X				X						
Course Outcome 2.2	X				X						
Course Outcome 2.3	X				X						
Course Outcome 3.1			X	X			X			X	X

GWW School of Mechanical Engineering Student Outcomes:

- (a) an ability to apply knowledge of mathematics, science and engineering
- (b) an ability to design and conduct experiments, as well as to analyze and interpret data
- (c) an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
- (d) an ability to function on multidisciplinary teams
- (e) an ability to identify, formulate, and solve engineering problems
- (f) an understanding of professional and ethical responsibility
- (g) an ability to communicate effectively
- (h) the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
- (i) a recognition of the need for, and an ability to engage in life-long learning
- (j) a knowledge of contemporary issues
- (k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice

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