ENMA 465 Microprocessing of Materials, Spring 2020

Dept of Materials Science and Engineering

Mon & Wed 3:30-4:45pm

Room 2324 technology classroom (google map)

Atlantic Bldg (ATL, Bldg 224)

Course Website on CANVAS: https://myelms.umd.edu/courses/1277156
Course materials will be shared through google drive at
https://drive.google.com/drive/folders/1vzFiJuBPVI_OUfFDMo2ul2MH6oJuMo0s
and be shared through your UMD account, either terpmail.umd.edu or just umd.edu.

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Guest Lecturer: Dr. David Stewart, steward@umd.edu Office: IREAP 0202, 301-405-0122	
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Synopsis

The goal of the course is to familiarize the students with basic as well as state of the art knowledge of technologically relevant topics in microprocessing and nanoprocessing as used in the semiconductor and related industries to fabricate ultrathin material layers, structures, and devices. Key processes are discussed in the context of their underlying physics and chemistry and how they influence the resulting materials properties. Concepts of process and device integration will be highlighted because fundamental interactions *between* process steps play a particularly important role in determining the performance of micron and nanometer sized structures. These sources of understanding provide a strong background for applications ranging from evolutionary semiconductor device technology to recent developments and opportunities in nanotechnology for energy, biotechnology, electronics, sensing, and other materials applications.

The basic framework of the course content comprises the set of deposition, patterning, etching, and planarization processes required to make small 3-dimensional devices. The students will develop skills in identifying, understanding, and exploiting basic mechanisms in microprocessing and gain a broad perspective on how this knowledge can be used industrial applications of microprocessing. The course will include laboratory sessions in the Maryland NanoCenter's FabLab clean room and an exercise in process and device design.

Course Objectives:

- Provide an overview of thin film microprocessing, from chemical and physical fundamentals at the microscopic level to applications in microelectronics, nanotechnology, and other areas.
- Identify and understand key concepts which transcend the various embodiments of microprocessing, so that students will be able to recognize the role of these concepts in diverse applications.

Processes:

Lectures will focus on topics generally covered in the textbook, but with somewhat different order and emphasis. Lecture notes will be distributed before class. Class time will emphasize student discussion arising from questions posed by instructor.

Homeworks are aimed at reinforcing the concepts in the course and as preparation for the exams. They will be assigned about every two weeks and must be submitted through Canvas. Homework solutions will be posted online after the homework due date. Homeworks will be graded on effort level, not on detailed technical responses. Students may work together on homeworks, and use the Discussion Board to do so, but no student should simply post their completed solutions for others to copy.

Exams will include a **midterm** and a **final exam** will be based on materials covered in lectures and reading assignments. The more complex equations will be provided with the exam, so student study should be aimed at understanding what the equations mean.

Canvas' Discussion Board will serve as a place for students to share ideas about the material and concepts in the lectures and in the homework.

Student teams of 4-6 students each will be formed early in the semester to organize both the FabLab exercise and the team's design project. For this purpose we will identify time slots during the week that all students on a team are available at that time. These times slots correspond to times that the lab exercise (below) will be done in FabLab and they will also represent times the team can work on its design exercise (below).

Lab exercise – microfabrication of cantilever devices. The course will include a ~4 week laboratory exercise where students will fabricate and then characterize microcantilever device structures. The class will be divided into groups of 5-6 students each, with each group assigned to a morning (9-12) or afternoon (12:30-3:30) session in FabLab. The lab exercises will be taught by FabLab staff. Students should pay attention and take notes during the lab so that they are prepared for questions on the lab exercise, either in homework, midterm, or final exam.

Design exercise – process and mask design. To complement the lab exercise, students will work in their lab teams to specify a sequence of process steps and a set of lithography mask designs that could be used to fabricate a functional device, e.g., a bottom-gate thin film transistor. Each team will report their progress several times in class and generate a written report due at the end of the semester.

Class participation will also be graded, recognizing individual discussion in class, contribution to the team project, and effort level in homework.

Grading	**Weight**
Final exam	25%
Midterm exam	20%
Team design project	25%
Homework	10%
Class participation	20%

Resources:

Slides used in lectures will be posted on the course google drive before each lecture period, representing a primary resource for the course. Materials on the google drive will be accessible by links from Canvas as well.

The textbook for the course - Franssila, Intro to Microfabrication - serves as a solid resource for the course material and for use in a fairly wide variety of career paths of interest to materials science and engineering student.

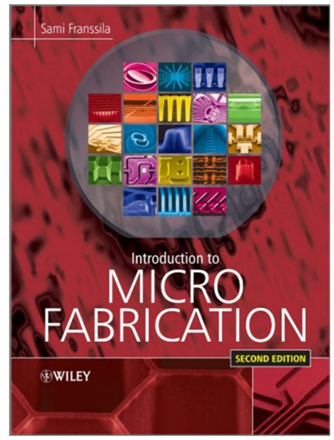
Required Textbook

Introduction to Microfabrication, 2nd edition, 2010
Sami Franssila
Wiley

You can purchase it in several formats, including:

- Hardcover
- Kindle e-book
- Apple i-book

I recommend the e-book version, allowing annotation and other functions as well as portability. I have purchased the ebook and downloaded it to Mac laptop and iPad successfully from Amazon, demonstrating that you can have copies in multiple places. I expect the Apple i-Book version will behave similarly.



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Additional reference books:

Fabrication Engineering at the Micro- and Nanoscale, Third Edition
Stephen A. Campbell
Oxford Press, paperback ($85.45 new at bookstore)
ISBN 978-0-1-9532017-6

Fundamentals of Semiconductor Fabrication (about $80)
Gary S. May and Simon M. Sze
Wiley 2004, ISBN 0-471-23279-3

Silicon VLSI Technology (Fundamentals, Practice and Modeling) by James D. Plummer, Michael D. Deal, and Peter B. Griffin

Introduction to Microelectronic Fabrication, 2nd edition
Richard C. Jaegar (1988)
Addison-Wesley Modular Series on Solid State Devices, ISBN 9780201444940