ECE 220A/Materials 215A
SEMICONDUCTOR DEVICE PROCESSING
FALL 2008

Tu – Th. 12 – 1:50 pm, 1437 PHELPS
F 10-11[1]

Instructor:	Professor Evelyn L. Hu hu@ece.ucsb.edu; 893-2368 3448A Elings Hall (CNSI Building) Office hours: Monday & Wednesday, 1-2 pm, or by appointment
Textbook:	Stephen A. Campbell, *The Science and Engineering of Microelectronic Fabrication*, Oxford 2001; ISBN 0-19-513605-5 Supplementary notes and journal articles will be posted on the course website:
Course Website	http://www.ece.ucsb.edu/courses/ECE220/220A_F08Hu/default.html
TAs:	Samuel Beach: beach@umail.ucsb.edu Office hours to be arranged
Lab Supervisor:	Bob Hill: bob@ece.ucsb.edu Room 4110, Harold Frank

Course Description: This course is intended as an introduction to semiconductor fabrication technology: these are powerful techniques generated for semiconductor device fabrication, but have been widely useful in characterizing a wider range of materials (e.g. polymers, biomaterials) and devices.

The goals of the course are to gain a working knowledge of the basic building blocks of device fabrication. This includes: (1) a practical understanding of the principles and usage of *photolithography*, (2) understanding and utilizing techniques of metallization, wet etching, oxidation and diffusion, (3) integrating the building blocks to form micron-size structures and simple devices that will be *electrically characterized*

Prerequisites: No prior processing experience is required. You should, however, be familiar with the electronic properties of semiconductor materials. If you don't have this background, you can do additional reading in an introductory textbook such as B.G. Streetman, *Solid State Electronic Devices* (this is the textbook used for ECE 132).

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[1] We will not hold regular class meetings on Friday, but may reserve that time for make-up sessions, lab demonstrations or discussion sessions.

Course Requirements: An important goal of this class is for *you* to gain hands-on experience in device fabrication.

- Homeworks will involve very short in-lab processing or measurements with some analysis. These will be done individually. (50%)
- One large lab will fabricate and characterize a completed device, will require more planning of the processes and experiments, and will be done in groups of 4 or 5 people. (30%)
- The final exam will be open book and open notes, and is currently scheduled for Tuesday, December 9th, noon - 3pm. (20%). You may have a final project to be turned in, rather than a final exam.

Laboratory: There are no scheduled hours for the lab work; the teaching clean room will be available at most times with *key card access***, if two or more student are working together. For safety considerations, you will not be permitted to work alone.
** You can get a key card to enter the facilities by going to the 1st floor of *Harold Frank Hall*.

There will be **equipment demonstration sessions**, which are **required**, and will be necessary for you to attend if you are to carry out your lab. You will be working in groups of 4-5 students.

Lab safety is a critical issue. You will be working with acids, bases and organic solvents which can be hazardous if not handled properly. **You are required to attend a safety orientation session** before you will be allowed to enter into the lab. There are sessions provided by the University, or a series of tapes provided by ECE, and Martin Vandenbroek.

People working in the Research Cleanroom have been suspended or prohibited from working there for violating safety regulations. Following the correct procedures here will help to prevent that.

Further details about the lab project and the write-ups will be given out later.

ECE 220A/Mat 215A: TOPICS TO BE COVERED:

▪ Introduction to Integrated Processing: Gutenberg's Printing Press in Silicon	
▪ Optical Lithography: Placing the Design Onto the Material o Forming the optical image: o Imprinting the optical image: photoresists o Process sequence: clean interfaces, adhesion o Choices of optical tools o *Special topics: Nanoimprinting & Electron Beam Lithography*	*Chapter 7.1-7.4,* *Chapter 8* *Notes to be handed out*
▪ Physical Vapor Deposition of Thin Films: Integrating Materials and Functions o The vacuum environment o Growth of a thin film o Thermal evaporation techniques (and limitations) o Alternative approaches: sputter deposition o *Interfaces: the metal-semiconductor interface and <u>ohmic contacts</u>* o *Special topic: Molecular Beam Epitaxy and the growth of quantum dots*	*Chapters 10, 12* *Chapter 15.6-15.8 & notes* *Notes to be handed out*
▪ Diffusion: Defining the electronic character of the material at a local scale o The nature of diffusion o Fick's equations -> Diffusion Equations o Diffused profiles o Measuring the diffused junctions o *Special topic: ion implantation* o *Special topic: Impurity-induced disordering: a 3D bandgap engineering technique*	*Chapter 3* *Chapter 5* *Notes to be handed out*
▪ Oxidation: The most versatile of processes; more than rust o The mechanism o Deal-Grove Model o Characterizing the oxide o *Special topic: Atomic Force Microscope Oxidation of nanoscale features* o *Special topic: Selective oxidation of AlAs/GaAs structures*	*Chapter 4* *Notes to be handed out*
▪ Etching: preparing the surface, and sculpting the device o <u>Wet Etching</u>: The general principles, selectivity, anisotropy o <u>Dry Etching</u>: General principles, types, chemical vs. physical etching, selectivity, anisotropy, resolution o *Special topic: Photoelectrochemical wet etching*	*Chapter 11 & notes*