

**Course:** Chemical Engineering for Micro and Nano Technology. (M/W 5:30 pm to 7:00 pm)

**General Description:** Nanotechnology is the field of fabrication, characterization and manipulation of extremely small objects (dimensions on the micron to nanometer length scale). Microscale objects, because of their small size are expected to be at the frontier of technological innovation for the next decade. This course will include a description of the materials used in microtechnology, methods employed to fabricate nanoscale objects, techniques involved in characterizing and exploiting the properties of small structures, and examples of how this technology is revolutionizing the areas of Electronics and Medicine.

**Detailed Description:** The course will cover the following topics:

- 1) **Materials used in Microtechnology** (How to pick the right material): An overview of the physical (mechanical, electrical) and chemical properties of different classes of solid materials such as metals, semiconductors, insulators and polymers will be presented. This section will include a few examples of size effects of properties observed in thin films, colloids and nanocrystals.
- 2) **Methods of Conventional Fabrication** (How to build a micro or nano scale structure): There will be a description of techniques used in conventional microfabrication including thin film deposition (e.g. CVD, PVD), lithography, chemical etching and electrodeposition. The student will be given a tool kit for fabricating a wide variety of structures on the micron to nano scale.
- 3) **Analytical Techniques**: (How to characterize what you've built). Analytical techniques such as Electron Microscopy, Electron and X-ray Diffraction, Ellipsometry, Photoelectron, Optical and Ion spectroscopy and Probe Microscopy that are used routinely to characterize small structures, small volumes and thin films will be described.
- 4) **Emerging unconventional methods** (Alternatives): Fabrication methods developed in the last 10 years such as soft-lithography and self-assembly will be reviewed. The emphasis will be on looking towards biology for inspiration to fabricate structures in three dimensions.

5) **Applications** (How to use what you've built to revolutionize the world) : Examples of applications in Micro and Nano technology including Microelectronics, Microfluidics, Micro Electro Mechanical Systems (MEMS) and Molecular Electronics will be described.

**Grading:** The final grade will be based on 5 x (10 point) homeworks on each of the subheadings above, a 25 point written take home exam and a 25 point oral presentation for 15 minutes. Grading will be relative.

**Books:** A good text book is: Fundamentals of Microfabrication by Marc J Madou. However for each sub-header additional reading books will be required.

**Additional Reading Material:**

*Introduction to Solid State Physics:* C. Kittel

*Introduction to Materials Science for Engineers* (5th Edition): James F. Shackelford

*Intermolecular and Surface Forces:* Jacob Israelachvili

*Nano- and Micro-Electromechanical Systems: Fundamentals of Nano- and Microengineering*  
by Sergey Edward Lyshevski

*The MEMS Handbook:* M. Gad-EI-Hak (Editor)

*Semiconductor Devices, Physics and Technology:* Simon Sze

*Microfluidics and BioMems Applications:* Francis Tay

+ Lots of resources ONLINE.