

## **ECE 730 T24: Fabrication in the nanoscale: principles, technology and applications**

### Overview:

The research in nanoscale science and technology has seen a very fast growth in the past years. The cornerstone for this exciting growth is the ability to create nanoscale patterns, which is the object of the current course. The course will cover all major nano-lithography technologies capable of generating or duplicating sub-100nm patterns, including lithographies based on photons, charged beams, scanning probes, replication and self assembly. Within each lithographic technique, the students will learn its working principle, related materials and instrument, process and limit. This course is complementary to ECE 631 (Microelectronic Processing Technology), but takes fabrication and associated theory into nanoscale.

Prerequisite (optional): ECE 631 or equivalent.

Course outline: (total 36 hours)

1. Overview of nanofabrication. (3 hours)  
Lithographies, thin film deposition techniques, pattern transfer methods.
2. High resolution photon-based lithography. (4h)  
Deep UV lithography with resolution enhancement technology, near field lithography, interference lithography, two-photon lithography.
3. Extreme UV (soft x-ray) lithography and x-ray lithography. (5h)
4. Electron beam lithography. (5h)  
Electron optics, electron-matter interaction, proximity effect, resists, multi-beam lithography.
5. Nano-patterning by focused ion beam (FIB). (5h)  
Ion source/optics, ion-matter interaction, FIB etching, focused ion/electron beam induced deposition.
6. Nanoimprint lithography (NIL). (4h)  
Thermal NIL, UV-curable NIL, resist, alignment, mold fabrication.
7. Nano-patterning by scanning probes. (5h)  
Scanning probe overview, AFM oxidation, dip-pen lithography, near field exposure of resist, STM manipulation of atoms.
8. Soft lithography and self assembly. (5h)  
Micro-contact printing, nano-transfer printing.  
Anodized aluminum oxide, nano-sphere lithography, block copolymer self assembly.

### Course materials:

1. Lecture slides and notes.
2. Nanofabrication: principles, capabilities and limits, written by Zheng Cui, Springer 2008. (required)
3. Nanofabrication: fundamentals and applications, edited by Ampere A. Tseng, World Scientific 2008. (reference book)

