EECS 598-002 Special Topics
Nano-photonics and Nano-scale Fabrication

Winter 2006; Instructor: P.C. Ku

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Lectures: TTh: 1:30 pm – 3:30 pm
Room: 3433 EECS
Office hours: TTh 3:45 pm - 5 pm or by appointment.
Grading (4 credit hours): Homework (5-6 times; 50%) and term paper + presentation (50%).
Prerequisites: EECS 334 or EECS 423 or EECS 434 or Graduate Standing
Course website: http://www.eecs.umich.edu/~peicheng/course/EECS598_06_Winter/index.htm
Required textbooks: None. Lecture notes will be posted on-line on the course website.
Recommended textbooks:
1. Nanophotonics by P.N. Prasad (on AAE reserve)
2. Optics of Nanostructured Materials by V. A. Markel and T. F. George (on AAE reserve)
3. Introduction to Nanoscale Science and Technology by M. Di Ventra et al (on AAE reserve)

Sure you know iPod gets *nano*! But do you know that photonics gets *nano-er*? We will review key topics in nano-photonics as well as the enabling fabrication technologies including both top-down and bottom-up approaches. It's an all-encompassing field that has applications in a diverse range of fields from information technology, IC manufacturing, material science, to life science and health care. Whether you are a serious researcher or simply would like to know why the sky is blue or the sunset is red, we welcome you!

Miniaturization (aka Moore's Laws) is one of the key driving forces contributing to the growth and prosperity of the "silicon era" in the past few decades. Shrinking the device feature size not only allows us to pack more transistors in one chip but also lowers the power consumption and improves the overall performance. With the device feature reaching the "nano" scale, device interface, surface, size and defects all become important and new physics can be observed. Some of these pose great challenges for us in keeping up with the Moore's Laws but some can become advantages for novel devices that were not achievable in the "pre-nano" era. One example is the laser diode which has been widely used in our daily life in CD/DVD players, internets, supermarket barcode scanners and etc. A laser diode converts the electrical current into a coherent light ray by recombining the electrons and holes in a nano-scale active region in which the energy states are quantized. Without the "nano" active region, a laser diode would not be efficient enough to be practical.

In this course, we will review key topics in nano-photonics and the related nano-fabrication technologies. Nano-photonics is the topic that studies either the photonics in nanoscale structures or the use of photonics in them. It has impacts on a range of fields from information technology, IC manufacturing, material science to health care. We plan to discuss the following topics.

A. Overview
    1. Is *nano* a hype or the future?
B. Nano-photonics
    1. Basics (basic properties of light and concepts of photons)
    2. Scaling in optics
    3. Light-matter interaction
    4. Dielectric optics
        A. Dispersion engineering (guiding, slow light, fast light, …)
        B. Photonic crystals
    5. Metal optics (plasmonics)
C. Nano-fabrication
    1. Overview. How do we put the right material at the right place with the right size and shape?
    2. Top-down approach
        i. Patterning (litho/etch)
        ii. Thin-film (deposition, damascene)
    3. Bottom-up approach
        i. self-assembly and chemical synthesis
D. Student term paper presentation