MS 350 – Spring 2009

Nanostructured Materials: Design, Synthesis, and Processing

Instructor: Prof. Andrea Armani, Dept. of Chemical Engineering and Materials Science, VHE 712, (213) 740-4428, armani@usc.edu

Class Hours: M/W/F, 11:00-11:50am, VHE 206

Office Hours: TBA

Textbook/Reference material:

NanoChemistry, by G. Ozin and A. Arsenault

Additional reference materials will be posted periodically on Blackboard. These readings are intended to complement the text book material and cover additional concepts in more detail.

Grading:

Homework	25%
Papers (2)	15/15%
Midterm	20%
Final	25%

Expectations/Information for Assignments, Exams and Papers:

Homework assignments:

These will generally consist of 2-5 problems and will be given on a bi-weekly basis [2-3 hrs/week]. In addition, students are expected to complete additional reading assignments prior to class [2hrs/week].

Late homework assignments will not be accepted without a written note from a doctor.

Exams:

The midterm and final exam will consist of 3-5 problems, structured to allow the entire exam to be completed in a single class period. The final exam will cover material from the entire semester. A sheet of crucial equations and mathematical formulas will be attached to the exams.

Papers:

Nanotechnology is most accurately reflected in modern literature. Therefore, each student will choose and write a paper on a topic in nanotechnology. The topics for each paper written during the semester must be distinct. Sample paper(s) will be posted on Blackboard.

This exercise is also intended to teach scientific writing and analysis, which is very different from writing papers for a literature or history course. One and a half weeks before the paper is due, students will blindly exchange papers, mimicking a "peer-review" process. You will have 6 days to perform the review of your classmate's paper. Your final paper grade is based on 1) your peer review or how thorough of a review you performed on your classmate's paper (5%) and 2) your own final paper (10%). Additional handouts will be given to aid in the peer-review process and in the writing process.

Specific information about paper topic selection as well as guidelines for formatting, style, length, etc. will be provided. Everyone is strongly advised to have their paper topics approved before beginning to write their paper.

Course Vision:

This course is designed to discuss Nanotechnology from the bottom up. In that sense, we will first discuss the building blocks of nanotechnology, or structures like nanocrystals, polymers and nanowires/tubes, and their fundamental properties (optical, electrical, mechanical, etc). From there, we will use these individual structures to build more complex devices using methods ranging from self-assembly to lithography.

Tentative Course Outline:

Building blocks of Nanotechnology

- Nanoparticles
  - Gold nanoparticle synthesis
    - *Optical characterization methods*
    - *Characteristics (absorption, fluorescence)*
    - *Purification Methods*
    - *Analysis methods (uniformity size)*
  - Silver nanoparticle synthesis
    - *Characteristics (absorption, fluorescence)*
- Nanocrystals
  - CdSe nanocrystal Synthesis
    - *Optical characterization methods*
    - *Characteristics (absorption, fluorescence)*
    - *Purification Methods*
    - *Analysis (uniformity size)*
  - Silicon nanocrystal Synthesis
    - *Electrical characterization methods*
    - *Characteristics (conductivity)*
- Polymers
  - Conductive polymer synthesis
    - *Electrical characteristics (conductivity)*
  - Electro-optic polymers
    - *Optical characteristics (loss, EO coefficient, refractive index)*

    - Elastomers (PDMS)
        - *Mechanical characterization methods*
        - *Mechanical characteristics (deformation)*
- Nanotubes/wire
    - Synthesis – single wall vs. multi wall
        - Mechanical properties
        - Electrical characteristics

Introduction of fabrication processes

- Self Assembly
    - DNA
    - Polymers
- Lithography
    - E-beam vs. Photolithography
    - Pattern transfer methods
        - *Etching (wet, dry)*
        - *Metallization*
- Soft Lithography
- Dip-Pen Lithography

Devices/applications *(selected topics from list will be discussed)*

- Sensors
    - Introduction to sensors
    - Nanowire conductivity sensor
    - Nanocrystal FRET sensor
    - Polymer “optical nose” sensor
- Microfluidics
    - Introduction to microfluidics
    - Nanocrystal single molecule imaging
    - PCR on-chip
- Solar Energy
    - Introduction to solar energy
    - Nanowire solar cell
    - Polymer solar cell
    - Silicon nanocrystal solar cell
- Therapeutics
    - Introduction to nanoparticle-based therapies
    - Nanowire-based cancer therapy
    - Gold nanoparticles HIV therapy
    - Nanoparticle-based drug delivery method
- Integrated microdevices
    - Introduction to microdevices
    - Polymer self-assembly
    - Microlaser (nanocrystal)

Statement of Students with Disabilities:

And student requesting academic accommodations based on a disability is required to register with Disability Services and Programs (DSP) each semester. A letter of verification for approved accommodations can be obtained from DSP. Please be sure the letter is delivered to me (or the TA) as early in the semester as possible. DSP is located in STU 301 and is open 8:30am – 5:00pm, Monday through Friday. The phone number for DSP is (213) 740-0776.