Self Assembly and Nanotechnology (10.524)

Syllabus – Spring 2013, *UMass Lowell*

Instructor: Professor Zhiyong Gu
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Textbook: Not required.

Reference books: Evans and Wennerstrom, *The Colloidal Domain: Where Physics, Chemistry, Biology, and Technology Meet*, 2nd Ed., Wiley-VCH, New York, 1999

John A. Pelesko. *Self Assembly: The Science of Things That Put Themselves Together*, Chapman and Hall/CRC, 2007.

Goddard, III, Brenner, Lyshevski, and Iafrate, *Handbook of Nanoscience, Engineering, and Technology*, CRC Press, Boca Raton, FL, 2002.

Waser (Ed.), *Nanoelectronics and Information Technology*, 2nd Ed., Wiley-VCH Verlag GmbH & Co. KGaA, Weinheim, 2005

Time/Place: Lectures Wednesday 3:30 pm-6:00 pm in Kitson 302

Office Hours: Monday 11:00am-12:30pm, Weds. 11:00am-12:30pm, and by appointment (E-mail preferred)

Purpose: This course will introduce and discuss the emerging and evolving fields of self-assembly and nanotechnology. The goal is to provide and expose students with the vocabulary, concepts, fundamentals, creative ideas, and state-of-the-art techniques in both fields mentioned above. Students will have ample opportunities to learn both hand-on knowledge and advanced topics, exercise their creative thinking and train their personal communication skills through paper reading and critics, presentations, and report writing.

Course Outcomes: At the end of the course, students should be able to:

- Know the general concepts, fundamentals, and broad applications of self-assembly phenomena
- Learn basic self-assembling techniques and how to utilize these techniques in various applications
- Know the new materials, techniques, phenomena, frontiers and trends in the field of nanotechnology
- Learn and experience several advanced topics by invited lecturers from various backgrounds through discussions, questioning, and active interactions
- Learn and experience two laboratory sessions through discussions, questioning, and active interactions
- Learn and explore one advanced topic in the field of either self-assembly or nanotechnology by literature survey, paper readings, oral presentation and report writing.

General Requirements: Homeworks and other assignments must be submitted for grading. Late submissions will not be graded even though it can be submitted for evaluation. Make-up exams will not be given unless the student has an excused absence with appropriate paperwork. All electronic devices such as cell phones and laptops must be turned off in class. All electronic devices, e.g., cell phones, PDA's, and computers must be placed at the front of the classroom during exams. Identical solutions for assignments/exams will receive zero credit.

Availability outside of Class: We will try our best to help you learn and succeed. To make an appointment, send me an email with several time frames that you are able to meet, I will respond ASAP. You are also welcome to stop by my office; if I am not busy with other schedules, I will be happy to help you.

Grading System: Total: 100 Attendance and participation: 10%, Homework (including paper readings): 15%, Lab I report: 10%, Lab II Report: 10%, Midterm I: 10%, Midterm II: 10%, Project (advanced topics, 35%): abstract with short presentation (5%), literature review (10%), progress presentation and report (10%), final presentation and final report (15%)

Tentative Course Schedule

Week	**Date**	**Topic**
Week 1	Jan 23	Course Introduction; What, why, how? Applications & potentials of Nanotechnology and Nanobiotechnology
Week 2	Jan 30	Fundamentals and theories of self-assembly (Thermodynamics vs. Kinetics); Self-assembled structures (nano-, micro- and macro-scales); Methods and techniques for self-assembly; **literature search introduction**
Week 3	Feb 6	**Invited Lecture I:** "Measurements of Interfacial Forces" Speaker: Prof. Marina Ruths (Department of Chemistry) Self-assembled monolayers (SAMs); **Project abstract due date and discussion** (1 page)
Week 5	Feb 13	**Invited Lecture II and Lab Demo:** "Nanostructures and Biosensors" Lecturer and Lab Leader: Dr. Fan Gao (Department of Chemical Engineering)
Week 4	Feb 20	Biomolecular self-assembly (lipids, DNA, and proteins) Nanobiotechnology and Nanomedicine; **Midterm Exam I**
Week 6	Feb 27	Synthesis and fabrication of nanomaterials; Nanoscale characterization and measurements; **Project literature review due**
Week 7	Mar 6	Nanocomposite materials; Porous Nanostructures and Nanomaterials
Week 8	Mar 13	**Spring break**, no class! **Enjoy!**
Week 9	Mar 20	**Invited Lecture III and Lab Demo:** Nanowire Fabrication and Assembly Lecturer & lab leader: Dr. Fan Gao (Department of Chemical Engineering)
Week 10	Mar 27	**Project update presentation and discussion** (~4 min/person) **Progress report due**
Week 11	Apr 3	**Invited Lecture IV:** "Focused Ion Beam (FIB) and Its Applications" Speaker: Mr. Chris Santeufemio (Campus Materials Characterization Lab)
Week 12	Apr 10	Nanofluids and Microfluidics; **Midterm II**
Week 13	Apr 17	**Invited Lecture V and Lab Demo:** "Nanoimprint Lithography (NIL); Speaker: Mr. Junwei Su (Department of Mechanical Engineering)
Week 14	Apr 24	Nanoelectromechanical systems (NEMS)/MEMS; Nanoelectronics
Week 15	May 1	**Final presentations on advanced topics*** (~8 min/person)
Week 16	May 6-10	Final exam week (**Final Report Due on exam day; No final Exam!**)

* Each student will choose or be assigned an advanced topic in the field of either self-assembly or nanotechnology. It is advised that the topic be determined as early as possible so that you can start literature survey and paper reading ASAP.