

Fundamentals of Soft Nanomaterials and Nanostructures

School of Materials Science and Engineering

MSE 4335/8803B
Klaus Bldg, room 2447

Tuesday, Thursday, 12.05-1.30 pm

Prerequisites: MSE 2001 or instructor consensus

Course Overview

The purpose of this course is to discuss fundamentals and the types of soft (polymer, organic, and biological) nanomaterials and corresponding hybrid nanostructures that have been discovered and synthesized for prospective applications in nanotechnology such as flexible nanostructures, soft nanoparticles, hybrid nanomaterials, soft lithography, colloidal assemblies, self-assembled organic structures, and biological complexes.

Course Description

The multi-disciplinary aspect of nanotechnology crosses the traditional disciplines of physics, chemistry, biology and materials engineering. Fundamental principles, physical phenomena, synthesis protocols and physical/chemical properties of soft nanomaterials will be discussed with particular emphasis on organic, polymeric, biological, and hybrid (organic-inorganic) assemblies at a length scale ranging from 1 nm to 1000 nm. The course will be composed of three closely related modules with emphasis on: soft matter fundamentals (I), organization and dynamics (II), and properties and applications (III).

Instructor: Prof. Vladimir V. Tsukruk. MSE School
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Class composition

Teaching method: In-class lectures and student presentations.

Module I

Soft Matter Fundamentals

Exam 1

Module II

Organization and Assembly of Soft Nanomaterials

Exam 2

Module III

Properties and Application of Soft Nanomaterials

Research papers reports

Exams: There will be two mid-term exams and a research presentation scheduled during the semester, each of them closely related to a particular module. Each exam contributes 1/3 towards the final grade.

Final research presentation: Students will form teams (2-3 students in a team) and will deliver an oral presentation which contributes 1/3 toward the final grade. These critical reviews will be based on one paper selected from a list of published seminal articles in soft nanomaterials provided by the instructor. Graduate students in addition to individual presentations provide executive summary of critical review (2 pages) on research presentation.

Final grades:

Exam 1	33.3%
Exam 2	33.3%
Final Research Paper	33.3%
Total	100%

1% bonus point for class activity and completed teaching evaluation

Reference books:

Reference books will be provided in the beginning of class. Also recent relevant science and technology reviews and papers will be cited during the course

CALENDAR

Module I Soft Matter Fundamentals

January 8	Lecture 1	Introduction in soft nanomaterials-general principles
10	2	Introduction -general principles and chemical structures
15	3	Configuration, conformation, local/global flexibilities
17	4	Entropy, enthalpy, & multi-length scale dynamics
22	5	Solutions and solid states of soft matters
24	6	Thermal and mechanical properties
29	7	Surfaces and interfaces at confined states 1. Module Review
31		Exam 1

Module II Organization and Assembly of Soft Nanomaterials

February 5	Lecture 8	Surface and interfacial organization 2
7	9	Colloidal assemblies
12	10	Nanoparticles and organic ligands 1
14	11	Nanoparticles and organic ligands 2
19	12	Molecular films Papers/teams selection
21	13	Layer-by-layer assemblies
26	14	Polymer Brushes; Module Review
28		Exam 2

Module III Properties and Application of Soft Nanomaterials

March 5	Lecture 15	Responsive soft nanomaterials
7	16	Hybrid nanoparticles applications
12	17	Microcapsules and bio/synthetic membranes
14	18	Block-copolymers and reinforced nanomaterials
19	Break	
21	Break	
26	19	Soft membranes
28	20	Soft lithography
April 4	21	SPM Lithography
2	22	Controlled delivery
4	23	Biomimetic engineering
9	24	Flexible electronics
11	25	Organic photonics/electronics 1
16	26	Organic photonics/electronics 2
18		Research Papers
23		Research Papers
26		Research Papers