Fundamentals of Soft Nanomaterials and Nanostructures

School of Materials Science and Engineering

MSE 4335/8803B Spring 2018
Klaus Bldg, room 2456
Tuesday, Thursday, 12.05-1.20 pm

Prerequisites: MSE 2001 or instructor consent

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) (20%), organization and dynamics (II) (20%), and properties and applications (III) (60%). Team research video presentations will explore very recent and modern applications.

Instructor: Prof. Vladimir V. Tsukruk. MSE; 3100M, Molecular Science @ Engineering Bldg; ph.: 46081, vladimir@mse.gatech.edu

Class composition and general duties

Teaching methods: In-class lectures, team discussions, mid-term exams, executive research summaries, and student team YouTube video research presentations.

Citizenship: occasional/random attendance list will be distributed and points will be added/subtracted from the final score (± 2%).

Module I
Soft Matter Fundamentals
Exam 1, Homework 1

Module II
Organization and Assembly of Soft Nanomaterials
Exam 2, Homework 2

Module III
Properties and Application of Soft Nanomaterials
Final exam: Research team video presentations

Exams: There will be two mid-term exams each of them closely related to a particular module. The final exam is a research video team presentation ranked by class-mated and instructors.

Final research team video presentations: Students will form research teams (4-5 students in a team), prepare a video for YouTube and will deliver a video presentation in class which is considered as the final exam grade. The topics will be selected and discussed in class and video ranking will be conducted by classmates along with instructor and TAs. Scripts will be graded separately.

Graduate students in addition to video presentation provide executive summary of critical review (2 pages) on research topic which is graded separately. Topic for critical review summary is the same as that for research video. Focus is on the state of the art in the field and critical issues to focus on. 2 pages of text: 1 spacing, 11 font. Additional 1-2 figs are allowed, <15 references.

Final grade distribution:

Exam 1	25%
Exam 2	30%
Research abstract, graduate students only	10%
Scripts, undergraduate students only	10%
Final exam: Research Presentation	35%
Attendance	± 2%
Total	**100%**

Grading scale:
A: 86-100%; B: 76-85%; C: 66-75%; D: <65%

Reference books:
A list of reference books will be provided in the beginning of class. Also references to recent relevant science and technology reviews, web-links, and papers will be provided/cited in classes.

Module I
Soft Matter Fundamentals

January 9	**Lecture 1**	Introduction in class organization and soft nanomaterials-**video 1/1 (Sml), student videos examples**
11	**2**	Chemical composition and structures, **video 1/2 ((Sml); 2/1 (Cln)**
16	**2**	Biopolymers and applications, **video preparation discussion**
18	**3**	Configuration, conformation, local/global flexibilities
23	**4**	Entropy, enthalpy, dynamics, and solutions
25	**5**	Thermal and mechanical properties. **Major concepts from Part 1**
30		**Exam 1**

Module II
Organization and Assembly of Soft Nanomaterials

February 1	**6**	Surface and interfacial organization-**video 2/3, 2/5 (Smr)**
6	**7**	Colloidal assemblies, **Topics/teams selection**
8	**8**	Nanoparticles and organic ligands 1-**video 1/5 (Sml)**
13	**9**	Molecular films and Polymer Brushes
15	**10**	Layer-by-layer assemblies, **Major concepts from Part 2**
20		**Exam 2**

Module III
Properties, Applications, and Trends in Soft Nanomaterials

22	**11**	Responsive soft nanomaterials-**video 2/6 (Smr)**
27	**12**	Hybrid nanoparticles applications-**video 1/4 (Sml)**
March 1	**13**	Soft membranes-**video 1/6 (Sml) video 2/6 (Cln)**
6	**14**	Nanomaterials, computational approaches -**video 2/4 (Smr); 1/4(Str), 1/5 (Str)**
8	**15**	Soft Lithography + **video discussion**
13	**16**	Controlled delivery, **video 1/4 (Sml), student video**
15	**17**	Biomimetic engineering-**video 2/2, 2/3, 2/7 (Smr); 1/7 (Str)**
20	**Break**	**Video**
22	**Break**	**Video**
27	**18**	Flexible electronics, **video 1/3, ¼, 1/5 (Sml)**
29	**19**	Wearable electronics self-healing
April 3	**20**	Organic photonics/electronics 1 - **video 2/8 (Smr)**
5	**21**	Organic photonics/electronics 2 **-video ¼, 1/5 (Sml)**
10	**22**	3D and 4D printing technologies
12	**23**	General trends and future prospective in soft nanomaterials GRA abstracts due; **video discussion**
17	**RV-Final Exam**	**Research Video Presentations, Teams 1-3**
19	**RV-Final Exam**	**Research Video Presentations, Teams 4-6**
24	**RV-Final Exam**	**Research Video Presentations, Teams 7-9**
26	**Reading**	
30	**11.30-2.20**	**Final exam-class results discussion**