Physics 564 – INTRODUCTION TO POLYMERS **August 2009**

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Piedmont Project – Incorporation of environmental sustainability and societal issues

This is a graduate level course open to physics and chemistry graduate students. As part of Emory's *Piedmont Project*, the course includes a project where the students report and present on a current research topic. The list of suggested topics for this project are geared to connect to current research trends and funding initiatives by the National Science Foundation (NSF) and the Department of Energy (DOE) on energy sustainability issues. Topics include energy related materials for use in batteries and solar cells, bio-based polymer composites, green chemistry practices, and polymer recycling. Students will identify the scientific questions and issues associated with developing technologies needed to solve our society's energy crisis. The goal is for students to see the connection between scientific research and its impact on society.

Course content: Polymer structures and conformations, polymer synthesis, molecular weight distribution and characterization; properties of polymer solutions, solubility and miscibility, polymer blends; properties of bulk polymers, glass and melt transitions, crystallization, rubber elasticity, viscous flow and viscoelasticity, time-temperature superposition; polymer dynamics, Rouse and reptation models. This course is intended to give students an overview of important concepts in polymer science, and highlight some of the current areas of research and how they relate to technological applications.

Audience: Advanced undergraduates in physics and chemistry, and graduate students.

Required Textbook: P.C. Hiemenz & T.P. Lodge, POLYMER CHEMISTRY, 2nd Edition, CRC Press (Taylor & Francis Group), 2007.

Course website: http://www.physics.emory.edu/faculty/roth/polymercourse/

Detailed Course Outline:

Lectures	Topics
4	Introduction to polymers and molecular weight distributions (Chap 1)
6	Polymerization (selections of Chaps 2-5)
5	Polymer Conformations (Chap 6)
5	Thermodynamics of polymer solutions and blends (Chap 7)
1	Light Scattering of Polymers (Chap 8)
1	MIDTERM
3	Dynamics of Dilute Polymer Solutions (Chap 9)
2	Polymer Networks and Rubber Elasticity (Chap 10)
3	Linear Viscoelasticity (Chap 11)
1	Presentations – Historical Papers
2.5	Glass Transition (Chap 12)
2.5	Crystallization (Chap 13)
2	Presentations – Current Topics in Polymer Research
1	Special Topic

Grading:

12%	Homework Assignments (6 in total)
15%	Midterm Test
28%	Final Exam (2 hrs)
15%	Review and Presentation of Historical Paper 10% for written review and 5% for presentation (see below for details)
30%	Report and Presentation on Current Research Topic 20% for report and 10% for presentation (see below for details)

Review and Presentation of Historical Paper (15% = 10% written + 5% presentation)

Each student will choose an important historical / landmark paper in polymers. They must do a literature search and write a short review placing the work into context. The review should address the following questions:

- What was the major finding of the paper?
- How did it advance the field?
- How has the paper been cited?
- Who are the authors and where was the work carried out?
- Is work in that area still ongoing or has it been resolved?

Written reviews should be no more than 2 pages double-spaced. Work exceeding this limit will not be graded. This is an opportunity for you to practice writing well constructed and concise sentences.

Presentations – Each student will give a short presentation (5 minutes in length) reviewing their paper to the class. You may use a maximum of 3 PowerPoint slides to illustrate key ideas or figures.

Selection of Historical Papers available on the course website:
http://www.physics.emory.edu/faculty/roth/polymercourse/historical.html
Or another paper selected by the student that meets the instructor's approval. No two students will review the same paper. Papers will be assigned on a first come, first serve basis. So choose early.

Report and Presentation on Current Research Topic
(30% = 20% written + 10% presentation)

Each student will select a current area of research in polymers and report / present on the following:

- Why are people studying this area? Emphasize motivation.
- What is the relevance to technological applications or society?
- What are the scientific issues? What are the outstanding questions people are trying to address?
- Historical timeline? How long have people been researching this topic? What have been the major breakthroughs?
- Explain the relevant science.
- What do you anticipate the future of this field to be?

Written report should be **no more than 5 pages double-spaced text**, not including abstract, references, or figures. Work exceeding this limit will not be graded.

- Cover page should include: Title, Name, Date, and Abstract (max 250 words)
- References: minimum of 7, with at least something current within the past 3 years
- Figures: Should be discussed within the body of the text, not just added into parentheses within the text.

Presentations – Each student will give a 10 minute presentation highlighting their report to the class. Presentations will be in class. We will try and reserve 1-2 minutes after each talk for questions.

Possible Suggestions for Current Research Topics:

- polymers for fuel cell applications
- polymers in solar cells
- polymers for organic light emitting diodes
- polymers for solid electrolyte batteries
- polymer recycling
- green chemistry (e.g., super-critical CO_2 processing)
- bio-based composites
- polymer nanocomposites
- polymer blend compatibility
- polymers in microelectronics
- controlled polymerization techniques
- …

Students are free to choose any current area of polymers that interests them provided it meets the instructor's approval. Again, no two students will report on the same topic**.** Topics will be assigned on a first come, first serve basis; so choose early. This is an opportunity for you to explore another research area besides your own; take advantage of it.