CHE 560 Fundamentals of Polymer Science, Spring 2023

Time: Fri 3:00pm – 5:30pm Location: Edwin 329

Instructor: Prof. Pinar Akcora, Department of Chemical Engineering & Materials Science
pakcora@stevens.edu, Office: McLean 415, Tel: (201) 216-5060. **Office Hours: Th 12:00pm – 1:30pm**

Course Objective: This course focuses on the polymerization kinetics; thermodynamics of polymer solutions; networks and gels. Neutron scattering techniques to understand structure-property relationships are introduced.

Grading Percentages: Mid-term 30%, Project 35%, Final Exam 30%, Homework 5%

Textbook: "Polymer Synthesis", Paul Rempp, Edward W. Merrill, Huthig & Wepf, New York, ISBN: 3-85739114-6.

"Fundamental Principles of Polymeric Materials", Stephen L. Rosen, Wiley Interscience, ISBN: 0-471-57515-9.

Course Topics:

Introduction to Polymers: Molecular structure of polymers (Merrill: Ch1, Rosen: Ch 2, 3, 4)

Molecular weight distributions, light scattering theory (Rosen: Ch6)

Formation of Polymers: Mechanism and Kinetics of

1. Step-growth polymerization (Merrill: Ch2, Rosen: Ch9)
   1.1. Network formation by step-growth polymerization
   1.2. Molecular weight distribution of polycondensates
2. Free radical addition polymerization (Merrill: Ch3, 5, Rosen: Ch9)
   2.1. Free radical copolymerization (Merrill: Ch4)
3. Anionic polymerization (Merrill: Ch5)
4. Cationic polymerization (Merrill: Ch6)
   MidTerm Exam
5. Non-radical polymerization
6. Block and graft copolymerization (Merrill: Ch10)

Thermodynamics of polymer solution

Emulsion and suspension polymerization (Merrill: Ch12)

Heterogeneous polymerization, interfacial reactions (Merrill: Ch13)

Networks and gels

Scattering theory and applications to polymer

Polymer Design Project Presentations

Assignment: Students will submit homework individually. Group work is not allowed. Assignments should be turned in the beginning of the class on due dates. Late assignments are not accepted.

PROJECT: Designing Functional Polymeric Materials for Functional Devices

The purpose of the project is to learn, investigate and propose polymeric or polymer-based composite materials for a specific engineering application. The project focuses on the material design aspect. You will use what you learned in class, implement, understand and then present on how these fundamental properties and polymerization mechanisms and processing will enable the new structures and designs of polymer products. For example, in class we will learn about the properties of building units (monomers) such as stiffness, crystallinity, amorphous, flexibility, nucleophilicity etc. You will learn the working principles and needs of an application and discuss what kind of polymerization you will use to polymerize the monomer for end use properties.

You will conduct literature search in Scopus or Web of Science to understand the properties required for that specific application. Then search on what systems have been used for those properties. You can re-modify, post-process, functionalize, graft or change the chemistry in the process of making and fabricating your polymeric device.

Some example questions that may help you to design a polymeric product/device are listed below:

Do you need block copolymers or polymer blends where you can combine the properties of the two different homopolymers? Do you need semi-crystalline polymers? Do you need the good mechanical properties of gels? Do you need physical or chemical crosslinking in gels? Do you need biocompatibility? Do you need charge hopping along the backbone of the chains? Do you need good optical properties? Do you need the additional properties of inorganic nanoparticles or ions? Do polymers or their composites function at specific conditions? How do you process them? Do the properties change during the processing conditions?

Your ideas should have good physical and chemical basis. The novelty of your idea in designing a polymeric material is an important criteria in grading of a project. You will write a 10-pages report using the following format. References are excluded from the 10-pages.

Font size: 11; Line spacing: 1.5 lines; Margins: Left: 1", Right: 1"

Powerpoint Presentation time: 20 min.

Grading policy for Project: 10% presentation; 20% profound project idea of a good chemical and physical basis with well-presented literature background; 5% format of the project report.