MSE 4775: Polymer Science and Engineering I

Credit hours and contact hours: 3-0-0-3

Instructor: Zhiqun Lin

Textbook: Joel Fried, *Polymer Science and Technology*, Prentice Hall, 3rd Edition, 2014.

Specific course information

Catalog description: An introduction to the chemistry, structure, and formation of polymers, physical states and transitions, physical and mechanical properties of polymer fluids and solids.

Prerequisites: MSE 2001 Principles & Applications of Engineering Materials and CHEM 2312 Organic Chemistry II or CHEM 1315 Survey of Organic Chemistry and CHEM 3411 Physical Chemistry I or ME 3322 Thermodynamics or MSE 3001 Chemical Thermodynamics in Materials

Course: Required

Specific goals for the course

Outcomes of instruction:

1. Be familiar with chemical structure and chemical formulas of common polymeric materials.
2. Distinguish different polymerization reactions and mechanisms.
3. Predict conversion and molecular weight resulting from polymerization reactions.
4. Estimate the thermodynamic interaction and miscibility of polymer solution and polymer blend.
5. Characterize molecular weight and molecular weight distribution in terms of common parameters.
6. Analyze date from measurement techniques to obtain molecular weight of polymers.
7. Identify the physical states and transition temperatures of polymers.
8. Predict how molecular weight affects thermal and mechanical properties of polymer solid and melt.
9. Describe the viscoelastic behavior of polymers and construct basic viscoelastic models.
10. Use available information on polymers to predict the response to applied stress and strain.

Student Outcomes:

(1) An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.

Topics covered:

1. Introduction to 4775; Review on Organic Functional Groups
2. Introduction to Polymers
3. Molecular Weight (MW) and MW Distribution
4. Step-Growth Polymerization
5. Chain Growth Polymerization: Free Radical Polymerization; Ionic Polymerization (Anionic and Cationic); Coordination Polymerization
6. Polymer Conformation
7. Thermodynamics of Polymer Solution
8. Thermodynamics of Polymer Blends
9. Kinetics of Polymer Blends
10. Measurements of Molecular Weight and Size
11. Glass Transition of Polymers
12. Morphology and Crystallization in Semicrystalline Polymers
13. Mechanical and Rheological Properties of Polymers

Correlation between Outcomes of Instruction and Student Outcomes:

Outcomes of Instruction	Student Outcomes						
	1	**2**	**3**	**4**	**5**	**6**	**7**
1. Be familiar with chemical structure and chemical formulas of common polymeric materials	X						
2. Distinguish different polymerization reactions and mechanisms.	X						
3. Predict conversion and molecular weight resulting from polymerization reactions.	X						
4. Estimate the thermodynamic interaction and miscibility of polymer solution and polymer blend.	X						
5. Characterize molecular weight and molecular weight distribution in terms of common parameters.	X						
6. Analyze date from measurement techniques to obtain molecular weight of polymers.	X						
7. Identify the physical states and transition temperatures of polymers.	X						
8. Predict how molecular weight affects thermal and mechanical properties of polymer solid and melt.	X						

9. Describe the viscoelastic behavior of polymers and construct basic viscoelastic models.	X						
10. Use available information on polymers to predict the response to applied stress and strain.	X						

School of Materials Science and Engineering Student Outcomes:

(1) An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.
(2) An ability to apply engineering design to produce solutions that meet specified needs with consideration for public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.
(3) An ability to communicate effectively with a range of audiences.
(4) An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.
(5) An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives.
(6) An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.
(7) An ability to acquire and apply new knowledge as needed, using appropriate learning strategies.