MSE-362

Polymer science

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Cursus	Sem.	Type
Chemical Engineering	BA5	Opt.
Mechanical engineering	MA1, MA3	Opt.

Language of teaching	English
Credits	3
Session	Winter
Semester	Fall
Exam	Written
Workload	90h
Weeks	14
Hours	**3 weekly**
Courses	2 weekly
Exercises	1 weekly
Number of positions	

Summary

Introduction to polymer physics and the link between chemical structure and macroscopic properties, with emphasis on morphology and thermomechanical behaviour, polymer technology and manufacturing techniques, providing a basis for the rational selection of polymers in an industrial context.

Content

1. Physics and Mechanical Properties of Polymers

- **Introduction**: chain architecture and chemical structures of the most common synthetic polymers, synthetic methods, molar mass distribution, characterization methods.
- **Single Chain Properties**: ideal versus real polymer chains.
- **Polymer Mixtures**: solutions, polymer blends, block copolymers.
- **Structures of Polymers in the Condensed State**: cohesive energy, intermolecular interactions, amorphous, glassy, and semi-crystalline polymers.
- **Mechanical Properties**: rubber elasticity, viscoelasticity, entanglement, fracture, fatigue, impact resistance, plasticity, rubber toughening.

2. Polymer Technology and Processing

- **Major Polymer Classes**: commodity, engineered, and performance plastics, their syntheses and basic properties.
- **Introduction to Plastics and Additives**: processing rheology, solidification kinetics, structure-property relationships, degradation, biodegradation, recycling, production economics, environmental impact, and materials selection.
- **Thermoplastic and Thermoset Processing Techniques**: extrusion, injection molding, thermoforming, blow molding, coatings, foams, processing of "difficult" polymers, rubbers, and elastomers, part design.

Keywords

polymers, molar mass distribution, ideal chain, polymer blends, glass transition, melting temperature, microstructure and morphology, rubber elasticity, entanglement, viscoelasticity, rheology, orientation, yield, crazing, processing, materials selection.

Learning Prerequisites

Recommended courses

- general physics and analysis courses.
- organic chemistry.

Important concepts to start the course

Basics of calculus, organic chemistry, classical and statistical thermodynamics, mechanical properties.

Learning Outcomes

By the end of the course, the student must be able to:

- Solve simple problems in polymer physics.
- Predict polymer properties from their structures.
- Interpret polymer properties in terms of their structure.
- Explain the physical phenomena associated with polymers using fundamental concepts.
- Identify the most common commodity and engineering polymers.
- Describe the main plastic processing techniques and their applications.
- Propose materials and processing methods for specific applications.
- Assess / Evaluate the environmental impact and economic viability of different materials and processes.

Transversal skills

- Communicate effectively, being understood, including across different languages and cultures.
- Use a work methodology appropriate to the task.

Teaching methods

Ex cathedra, slides and blackboard, interactive exercises.

Expected student activities

Participation in lectures, completion of exercises, reading handouts, engaging in discussions with teacher and assistants.

Assessment methods

Written examination.

Resources

Bibliography

- Introduction to polymers / Young
- Traité des matériaux vol. 14: Matériaux polymères / Kausch

Ressources en bibliothèque

- Find the references at the Library

Moodle Link

- https://go.epfl.ch/MSE-362

Prerequisite for

Courses related to Soft Matter and Polymers.