UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

COURSE SYLLABUS

Macromolecular Strategies for Materials Synthesis

2526-1-FSM02Q030-FSM02Q03003

Aims

The macroscopic properties of polymeric materials strongly depend on the chemical nature and on the physical and chemical treatments, starting from the synthetic approach, and on the presence in the material of suitable additives. The course aims to introduce the fundamental strategies for the realization of polymeric materials and how to modulate the macroscopic properties (thermal and mechanical) by varying the architecture of the polymer chains. Particular emphasis will be given to property-structure relationships in amorphous and semi-crystalline polymers.

Knowledge and understanding
At the end of the course the student will have acquired knowledge on:
• main conventional synthesis methods
• latest generation of synthetic strategies for the production of innovative polymers
• property-structure relationships in amorphous and semi-crystalline polymers.

Applying knowledge and understanding
At the end of the course the student will be able to describe the main synthetic approaches to modulate the properties of polymers for scientific and applicative uses.

Making judgments
The student will be able to orient himself in the field of polymers both in terms of chemical structure, conventional and innovative synthesis methods, and in terms of properties of polymeric materials.

Communication skills
The student will be able to express the topics covered during the course with language skills suitable for polymer science.

Learning skills
The student will be able to apply the knowledge acquired during the course to understand the topics dealt with in the scientific and patent literature in the field of innovative polymeric materials.

Contents

The course focuses on the relevant aspects of polymer science in terms of macromolecular architecture; main synthetic tools to control polymer structure and topology, molecular mass and distribution; and property-structure relationships.
The solution and bulk-phase properties of polymers will be described by means of some characterization methods, highlighting the impact of the polymer microstructure on the performance of the materials. Special topics on liquid crystal polymers, thermosetting resins and sustainable polymers will also be addressed.

Detailed program

- Various classes of polymers and their chemical structure, including cross-linked polymers, copolymers, blends and polymeric composites.
- Synthetic tools to precisely control macromolecular structure including chain composition, microstructure, functionality, and topology.
- Thermoplastic polymers, thermosetting polymers, elastomers, and termoplastic elastomers.
- Aggregation states in polymers.
- Main properties and transitions of amorphous and semicrystalline polymers and their dependence on the main parameters, such as molecular mass and distribution.
- Impact of stereochemistry and degree of order on thermal and mechanical properties of polymers
- Fundamental structure-property-performance relationships in polymeric materials.
- Copolymers: synthesis methods, structures and interfaces
- Synthesis of three-dimensional polymers and dendrimes
- Polyolefins and Spheripol process for polymer growth with morphology retention.
- Sustainable polymers: polymers from renewable sources, biodegradable and biocompatible (the case study of PLA)
- Polymers in the liquid crystalline state.
- Self-healing polymers.
- Thermoset resins and polymeric composites.
- Macromolecular characterization methods in solution and in the solid state.

Prerequisites

Fundamental knowledge of chemistry, in particular organic chemistry and polymer chemistry.

Teaching form

The lessons will be delivered in English.
24 two-hour lectures, in person, Delivered Didactics.

Textbook and teaching resource

- Notes provided by the professor (power point presentations to support teaching activities)
- Polymers, Walton, D. J., Lorimer, J. P. (2001). Oxford Chemistry Primers, Oxford University Press.
- Polymer Chemistry Koltzenburg, S.; Maskos, M.; Nuyken, O. ; Springer: Berlin, Germany, 2017.
- Principle of Polymerization, (4th edition) G. Odian, 2004 John Wiley & Sons, Inc.
- Polymer Chemistry" (Second Edition) P.C. Hiemenz, T.P. Lodge, CRC Press, 2017.
- Articles from the scientific literature.

Semester

1st year, 1st semester.

Assessment method

ORAL INTERVIEW ON THE TOPICS COVERED DURING THE COURSE AND ON IN-DEPTH TOPICS
The oral exam consists of the evaluation of the knowledge acquired by the student in the field of polymer science, with particular attention to the synthesis, structure and properties of polymers. The autonomy of analysis and judgment, and the ability of exposure will be evaluated using the following criteria:
18-20/30: preparation on a small number of topics covered during the course, with limited capacity for discussion and analysis; not always correct presentation skills and vocabulary, with limited capacity for critical processing.
21-23/30: partial preparation on the subjects covered during the course, limited ability to self-analysis; use of correct vocabulary although not entirely accurate and clear; uncertain presentation skills.
24-27/30: preparation on a wide range of topics covered during the course, ability to develop self-argument and critical analysis; Ability to apply general knowledge to the specific context of polymer science and link topics studied to concrete cases; use of correct vocabulary and competence in the use of scientific language.
28-30/30L: complete and comprehensive preparation on all the subjects covered during the course; autonomy of analysis and critical judgment of the topics addressed in class; ability to link the topics studied to concrete cases and different scientific contexts; Full mastery of scientific vocabulary and rigorous presentation skills, clear and articulate; excellent ability to argue and reflect.

Office hours

By appointment. (silvia.bracco@unimib.it)

Sustainable Development Goals

INDUSTRY, INNOVATION AND INFRASTRUCTURE | RESPONSIBLE CONSUMPTION AND PRODUCTION