UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

# SYLLABUS DEL CORSO

# Macromolecular Strategies for Materials Synthesis

**2425-1-FSM01Q030-FSM01Q031M**

## 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.

## 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.

## Office hours

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

## Sustainable Development Goals

INDUSTRY, INNOVATION AND INFRASTRUCTURE | RESPONSIBLE CONSUMPTION AND PRODUCTION