



UNIVERSITÀ  
DEGLI STUDI DI MILANO-BICOCCA

## SYLLABUS DEL CORSO

### Chemistry & Technology of Polymers & Industrial Applications

2324-1-FSM01Q010

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#### Aims

The aim of the course is to explore the preparation and transformation processes of several classes of polymers with particular attention to functional polymers. Traditional and recent methods and technological processes to improve their chemical, physical and mechanical properties, as well as the underlying scientific basis, linking the macroscopic properties to fundamental concepts in polymer science will be covered. Most relevant principles and concepts will be introduced along with case studies of actual industrial process.

#### Contents

The course encompasses advanced technological processes in the synthesis and transformation of polymers, including new methods of polymer synthesis, introduction to hybrid materials with particular emphasis to preparation and characterization of polymer materials endowed with heterogeneous interfaces and new functional properties.

#### Detailed program

- General Concepts

Classification and polymeric sectors: commodities, specialities and engineering polymers

Polymers as materials: intermolecular interactions and cross-links and their influence on impact and heat resistance properties

Self-assembly of polymer chains and optical properties

Formation of polymeric networks

High performance polymers: aromatic amides and esters (the case studies of Kevlar, Nomex), polyether ether

ketone

Polymers of industrial interest: polyurethanes and their properties

Fluoropolymers: structures and properties

Advanced polymer synthesis in the solid state and in the confined state: replica phenomena and fabrication of innovative polymeric architectures

Polymeric aerogels: synthesis, properties and applications

Relevant polymeric composites for industrial applications: integration of hybrid materials, such as modified clays, into polymers for improving mechanical and optical properties

Principles for the formation of foams: properties and applications

Synthesis and applications of high performance fibers and textiles

Characterization of the extended interfaces by advanced methods

- Industrial applications and case studies

Polymer melt processing: extrusion, injection molding, blow molding, and film casting. Focus on the extrusion process and its applications.

Processing parameters, including pretreatment, and consequences on the final properties.

Advanced technological processes with the final aim to improve the functional properties of polymers. Curing and post-treatment: polymer annealing and welding.

Principles of reactive extrusion, and the use of maleimide to compatibilize polyolefins.

Types of extruders, masterbatches and their insertion in polymer manufacturing.

Polymer solution processing: fiber spinning and coating. Electrospinning.

Polymers for biomedical applications. Polymers for contact lenses, description of the synthetic and manufacturing methods for rigid and for soft contact lenses.

The lamination process for the preparation of multilayer packaging material, illustrating the issues of adhesion between different polymers and with other substrates.

Multilayered polymer tubing, the issue of gas diffusion in polymers, focus on the preparation of polyvinylalcohol.

Polymer recycling, including the compatibilization of mixed polymer waste using developed multi-block compatibilizers. Depolymerization.

Biopolymers from agricultural sources and their transformation. The many modifications of cellulose (nitrocellulose, cellulose acetate, ect.). Polymer films from treated agrowaste.

Elastomers for the automotive industry, the vulcanization process, main topics of polymer network degradation, stability, and recycling. Open issues in recycling, thermoplastic elastomers, physical and reversible crosslinking.

Self-assembly of polymeric chains for drug delivery, cellular scaffolding, and other nanomedical applications, and for the preparation of patterned surfaces for electronics.

Self-healing polymers. Polymer blends (example, HIPS).

The course includes seminars by experts in the field of polymer chemistry and will be integrated by visits to polymer companies of the area.

The student is requested to propose a subject of his/her interest in the field to be presented to the class

## Prerequisites

- Good knowledge of macromolecular chemistry, including the main types of polymerization reactions (step-growth, chain-growth).
- Basic knowledge of thermodynamics including the concepts of phase transitions in polymers including glass transition and melting.
- Basic knowledge of the mechanical properties of polymers.

## Teaching form

Lectures , seminars on specific topics, seminar of experts in the field and visits to industrial research laboratories.

## Textbook and teaching resource

1. Introduction to Physical Polymer Science, L. H. Sperling. Wiley-Interscience (2006).
2. Polymer Chemistry. S. Koltzenburg, M. Maskos, O. Nuyken. Springer (2017).
3. Hybrid Materials: Synthesis, Characterization, and Applications. Editor: G. Kickelbick. Wiley-VCH (2007). ISBN: 978-3-527-31299-3
4. Lecture Notes.

## Semester

1st year, 2nd semester.

## Assessment method

Oral Exam:

Evaluation of the acquired knowledge during the course and presentation of a chosen topic in the field of materials chemistry and technology. The structure of commonplace polymers and the basic concepts in polymer science can also be required.

## Office hours

By appointment.

## Sustainable Development Goals

INDUSTRY, INNOVATION AND INFRASTRUCTURE

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