UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

COURSE SYLLABUS

Applications-Polymeric Materials

2223-2-E2701Q067-E2701Q068M

Aims

GENERAL INTRODUCTION to "CHIMICA MACROMOLECOLARE CON LABORATORIO" Course (2122-2-E2701Q067)

The course takes place throughout the year and represents a formative accompaniment that leads the student to the ability to know, prepare and treat macromolecular materials at a fundamental level. It is divided into two sections: the first unit (Macromolecole con Laboratorio) is constituted by a theoretical part, which frames the fundamental concepts of the science of polymers and the methods of synthesis (4 CFU), followed in the second semester by the laboratory, which transmits direct and experimental knowledge of macromolecules and their synthesis (4 CFU); in the second unit (Applicazioni-materiali Polimerici) the properties of the polymers will be defined by specifying the property / structure relationships (6 CFU). At the end of the year, thanks also to references to application realities, the student will gain wide-ranging knowledge that will allow them to become familiar with the sector of polymeric materials.

AIMS OF "APPLICAZIONI-MATERIALI POLIMERICI" UNIT (2223-2-E2701Q067-E2701Q068M)

The aims of the course is to familiarize students with relevant comcepts in polymer chemistry like characterization of polymers and molecular weight distributions; thermodynamics of polymer solutions; the crystalline and amorphous states; rubber elasticity; structure-property relationships. Special topics in polymer materials like block copolymers and natural polymers will be also introduced.

Contents

Thermodynamics of polymer solutions. Flory-Huggings theory. Chain conformation in solution: flexible and rigid polymers. Concept of random coil and radius of gyration. Polymeric mixtures and phase diagrams. Characterization of polymeric mixtures. Block copolymers synthesis and properties. Emulsion Polymerization. The amorphous state of polymers. Glass transition. The crystalline state of polymers: lamellae, spherulites, fibers. Semi-crystalline

polymers: polyethylene, iso- and syndiotactic polypropylene. Crystalline liquid polymers. Cross-linked polymers and rubber elasticity. Mechanical behavior of polymers. Viscoelasticity and rheology of polymers: creep measurements, relaxation times. Polysaccharides and protein based materials

Detailed program

Conformations of Polymers, end-to-end distance, length of persistence, semi-flexible chains and rigid chains, radius of gyration, dendrimers, branched polymers

Thermodynamics of polymer solutions, entropy and mixing enthalpy, Flory-Huggings theory, parameter ?

Osmotic pressure of a polyme solution, osmometry, Flory Huggins theory for osmotic pressure, parameter B, comcept of ? solvent

Phase diagram of polymer solutions, binodal, spinodal and critical point (LCST and UCST)

Block copolymers and self-assembly in bulk and in solution

Dynamics of polymeric solutions, friction and viscosity, Newtonian and Non-Newtonian fluids, Stokes's law, viscosity of diluted polymeric solutions, Mark-Houwink's equation, diffusion and Stokes-Einstein relationship, emulsion polymerization

Gel Permeation Chromatography

Emulsion Polymerization

Correlation between polymer chain structure and glass transition temperature (Tg)

Elasticity of rubber, vulcanization of natural rubber, mechanical properties, thermodynamics of elasticity.

Mechanical properties: creep, relaxation, rubbery plateau, Maxwell element, Voigt element

Mechanical dynamic analysis, temperature sweep, frequency sweep. Time temperature superposition

The amorphous state of polymers: theoretical models of glass transition, free volume theory, Flory-Fox equation,

Semicrystalline polymers, helical conformation, thermodynamics of crystallization, lamellae, spherulites,

Polymeric materials based on carbohydrates, cellulose, hemicellulose, cellulose acetate, starch, agar

Polymeric materials based on proteins, wool, silk, keratin, collagen

Prerequisites

Basic knowledge of polymer chemistry: definition of polymer, average molecular weight, simple polymerization methods

Teaching form

Lectures in classroom in italian language. In the case of incoming students, the course will be delivered in English.

Textbook and teaching resource

Textbooks

"Polymer Chemistry” (Second Edition) P.C. Hiemenz, T.P. Lodge, CRC Press.

“Introduction to Physical Polymer Science” (Fourth Edition), L.H. Sperling, Wiley”

Powerpoint presntation containing the lessons

Semester

Second semester

Assessment method

The exam consists of an oral exam in which the topics presented in the lessons are discussed. In addition to learning the fundamentals presented in the course, the student's skills and aptitudes are also assessed to adapt the theoretical foundations of polymer chemistry to particular operational and practical conditions (for example the differences in mechanical properties between a rubber and a thermoplastic, or the molecular origin of the elasticity of the rubber); the exhibition capacity and adequacy of the student's language is evaluated.

Two intermediate tests are also carried out (with the resolution of exercises and the answer to questions) at half of the course and at the end of the course; each test includes 10 questions and exercises; students who obtain a positive result in both the tests (for each exercise or question are assigned from 0 to 10 points, the achievement of 50 points is considered positive) can take a reduced oral exam, in which the questions and the exercises of the two intermediate tests are discussed.

Office hours

On tuedsay from 2:00 to 4:00 in instructor's office

Sustainable Development Goals

RESPONSIBLE CONSUMPTION AND PRODUCTION