UCL Université catholique de Louvain

LMAPR2019

2012-2013

Polymer Science and Engineering

5.0 credits	45.0 h + 15.0 h	1q

Teacher(s) :	Demoustier Sophie ; Jonas Alain (coordinator) ; Legras Roger ;
Language :	Anglais
Place of the course	Louvain-la-Neuve
Main themes :	The course is comprised of 4 parts : In the first one, students are introduced to the main notions regarding macromolecular chains and polymer materials, i.e., practical importance, classification, molar mass distribution, chain configurations and conformations, and chain models. The second and third parts are given in parallel and concentrate on the physical properties, and on the synthetic methods of polymers, respectively. A special emphasis is given to the relationships between polymerization methods, macromolecular structure, microscopic or chain properties, materials structure, and macroscopic or materials properties. More precisely, the second part is concerned with structure and properties of amorphous polymer materials (molecular structure, vitreous state, glass transition, visco-elasticity, rheology of molten polymers, physical ageing of glasses, etc.), of cross-linked materials (including rubber elasticity), and briefly of semi-crystalline polymers. The third part presents the two main methods of polymer synthesis, i.e., chain polymerization (radical polymerization, including controlled radical polymerization, coordination polymerization, ionic polymerizations, copolymerization) and step growth (polycondensation), followed by a short introduction to polymer degradation and stability. The final part, coinciding with 15 hours of practical training, consists of visits to industries active in the synthesis, processing or use of polymers. It aims at allowing students to grasp the practical importance of the concepts seen in the class.
Aims :	This is an introductory course to the physics and chemistry of polymers and macromolecules. After having followed the lectures, students are expected to be able : 1. to describe the properties and main transitions of polymer materials, and to explain them based on chain properties and dynamics; 2. to describe and explain the mechanisms of the main polymerization reactions, and to establish the relationship between synthetic methods and chain properties. Mastering these topics will place the student in a position to follow more specialized lectures in polymer science, especially to attend the classes of the "Polymer and Macromolecules" specialization of the engineering degree in chemistry and materials science. *The contribution of this Teaching Unit to the development and command of the skills and learning outcomes of the programme(s) can be accessed at the end of this sheet, in the section entitled “Programmes/courses offering this Teaching Unit”.*
Content :	Methods : Lectures including short exercises to be solved during or after the class, and containing examples from the industrial practice or from the research expertise of the teachers. Industrial visits. Content : 1. Introduction: importance and short history of polymers 2. The main classes of macromolecules 3. Configurations, conformations and modelling of linear chains 3.1. Configuration versus conformation: definitions 3.2. Configurations of macromolecular chains 3.3. Conformations of macromolecular chains 3.4. Secondary, tertiary and quaternary structures 4. Chains in disordered conformations: the amorphous state 4.1. Amorphous, crystalline and liquid crystalline states: definitions 4.2. The random coil of the amorphous state 4.3. Glassy and liquid "states" 4.4. From glass to liquid: the glass transition 5. Chains in conformations of lower energy: polymer crystals 5.1. Structure of semi-crystalline polymers: conformations of lower energy, crystal lamellae, spherulites 5.2. From crystal to liquid states: the melting of semi-crystalline polymers 5.3. Brief overview of the mechanical properties of semi-crystalline polymers 6. Cross-linked chains and rubbers 6.1. Introduction to rubbery materials 6.2. Retraction force of a stretched chain segment 6.3. Comparison to the pressure of a compressed perfect gas 6.4. Retraction force of a rubbery network 6.5. Physical cross-links (thermoplastic elastomers, semi-crystalline polymers, entanglements) 7. Polymer visco-elasticity 7.1. Relaxation and creep 7.2. Two important illustrations of polymer visco-elasticity: the physical ageing of glasses and the rheology of polymers 8. Introduction to polymer chemistry : general traits of polymerizaion reactions 8.1. Classification of polymerization reactions

	8.2. Polycondensation 8.3. Chain polymerization 9. Chain polymerization 9.1. Polymerizability, or influence of the nature of active centres on reactivity for radical and ionic polymerizations 9.2. Radical polymerization 9.3. Coordination polymerization 9.4. Ionic polymerizations (anionic, cationic) 9.5. Copolymerization 10. Step growth 10.1. General traits 10.2. Polycondensation of bi-functional monomers 10.3. Poly-functional monomers : network formation 10.4. Avergae molar mass, molar mass distribution, chain end control 10.5. Main reactions used in step growth 10.6. Kinetic aspects 10.7. Technical aspects 11. Reactivity and chemical modification of polymers 11.1. Reaction of polymers 11.2. Polymer degradation 11.3. Polymer stabilization
Other infos :	This course requires a good knowledge of thermodynamics, and of general physics and organic chemistry. Reference books and personal notes will be used by the teachers.
Cycle and year of study :	> Master [120] in Chemistry and Bio-industries > Master [120] in Physical Engineering > Master [120] in Biomedical Engineering > Master [120] in Chemical and Materials Engineering > Master [120] in Mechanical Engineering
Faculty or entity in charge:	FYKI