UCL Université catholique de Louvain

LCHM2261A

2014-2015

Polymer Chemistry and Physico-Chemistry

3.0 credits	22.5 h + 7.5 h

Teacher(s) :	
Language :	Français
Place of the course	Louvain-la-Neuve
Main themes :	First part: After recalling the basics of chain polymerization methods, the different synthetic strategies existing today will be systematically studied (anionic, cationic, standard radical, controlled radical and coordinative polymerization methods). The scope and limitations of each method will be systematically discussed. Mechanistic and kinetic features will be then studied for each polymerization method. Special emphasis will be finally put on the control of macromolecular architectures. Second part: After defining the characteristic features of polymer in solution, the Flory and Huggins' thermodynamic theory of polymer solutions will be studied. Afterwards, the Flory and Kringbaum's theory will be developed in order to describe the thermodynamics of very diluted polymer solution. The out of equilibrium behaviour, and more precisely the hydrodynamic properties, will be finally addressed. All these topics will not be necessarily covered each year.
Aims :	This course aims for providing a profound understanding of chain polymerization methods as well as physico-chemical properties of polymers in solutions. The course is divided into two parts covering these two features. At this end of the course, the students are expected to deeply understand and explain the following items: For the first part " Chain polymerization methods ": - The state of the art in chain polymerization methods. - The concepts of controlled and living polymerizations as well as their impact on the polymer characteristic features (molar mass, polydispersity index, architecture) - The technological issues related to chain polymerization. - Furthermore, the students will be able to use the above mentioned concepts to propose relevant synthetic methodologies for case studies and in the frame of laboratory works. For the second part " Polymers in solution ": - The fundamentals of the behaviour of polymers in solution and of the concepts of miscibility and phse separation. - The determination of physico-chemical features such as molar masses, chain architectures, interaction parameters, solubility, second virial coefficient, excluded volume as well as geometrical features such as the radius of gyration. - Furthermore, the students will be able to use the above mentioned concepts to solve problems in the frame of case studies and laboratory works. *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 :	First part " Chain polymerization methods " 1. Introduction 1.1 Chain polymerizations 1.2 Living and controlled chain polymerizations 2. Anionic polymerization 2.1 General features 2.2 Initiating systems 2.3 Mechanistic features 2.4 Examples of macromolecular architectures 2.5 Special anionic polymerization methods (group transfer polymerization, metal-free anionic polymerization, ligated anionic polymerization) 3. Cationic polymerization 3.1 General features 3.2 Initiating systems 3.3 Mechanistic features 3.4 Cationic polymerization of heterocycles

	3.5 Factors allowing a living character 3.6 Examples of macromolecular architectures 4. Classical radical polymerization 4.1 Mechanistic and kinetic features 4.2 Control of molar mass (" dead-end " method) 4.3 Control of end-groups (telomerization) 4.4 The " Iniferter " method 4.5 Technology of radical polymerization 5. Controlled radical polymerization 5.1 General features 5.2 Control by nitroxides radicals (NMP) 5.3 Control by atom transfer (ATRP) 5.4 Control by reversible chain transfer (RAFT) 5.5 Control by organo-tellurium (TERP) 6. Coordinative polymerization 6.1 Ziegler-Natta catalysts 6.2 Phillips catalysts 6.3 Metallocene catalysts and tacticity control 6.4 Ring-opening metathesis polymerization 6.5 Coordinative ring-opening polymerization of aliphatic esters Second part " Polymers in solution " 7. Solubilisation and characteristic features of polymers in solution 7.1 Solubilisation without degradation 7.2 Definitions of the physico-chemical concepts of interest 7.3 Thermodynamic concepts (free energy of mixing,) 8. Flory and Huggins thermodynamic theory of polymer solutions 8.1 Regular solutions 8.2 Determination of the free energy of mixing 8.3 Limitations 8.4 Application to miscibility and phase separation concepts (phase diagram) 9. Flory and Krigbaum thermodynamic theory of diluted polymer solutions 9.1 The concept of excluded volume 9.2 Thermodynamic calculations 9.3 Application to membrane osmometry and tonometry 9.4 Application to light scattering 10. Out of equilibrium polymer solutions (hydrodynamic properties) 10.1 Viscosimetry 10.2 Size exclusion chromatography Methods: Lectures eventually completed by invited seminars and/or seminars prepared by the students themselves.
Other infos :	Background: CHM1361 or any other equivalent course). Documents: Written notes and reference books will be made available for the students. The course could be partly or totally delivered by an invited lecturer.
Cycle and year of study :	> Master [120] in Chemistry
Faculty or entity in charge:	CHIM