Physical Chemistry of Polymer Solutions

Course coordinator: Jean-François Le Meins lemeins@enscbp.fr

European credits ECTS: 6

Teaching Language: English

Supporting files: English

	Number of course slots (1h20)	Number of course slots (4h)
Magisterial	20	
Tutorials	7	
Practical		4

Description

- Acquiring the basic concepts of polymer solution thermodynamics
- Knowing the characteristic physicochemical variables (size, mass, geometry) and essential properties (viscosity, osmotic pressure, solubility…). Being able to use the experimental techniques allowing to measure these properties (tonometry, osmometry, viscosimetry, light scattering)

Outline

Part 1: Flory-Huggins theory – Scaling laws

Introduction

Thermodynamics of simple mixtures

- Gibbs energy – chemical potential
- Ideal solutions, entropy calculation
- The regular solution model
- Excess parameters.
- Solubility and demixtion predictions using the χ parameter
- Hildebrand approach

Flory Huggins theory (Polymer solution)

- Flory's questions
- Flory's hypothesis

- Flory expression for the Gibbs energy and the chemical potential
- Solubility prediction and phase diagrams
- Osmotic pressure

Conformations of isolated chains

- Ideal chain model
- Real chain model: Flory calculation

Various concentration regimes and their scaling laws

- Dilute and semi dilute regime
- Scaling law in semi dilute solutions

Part 2: Characterization of polymer solutions

Introduction: Differences with "small" molecules

Limits of the Flory theory

- Krigbaum approach: notion of excluded volume

Characterization methods for polymers or colloidal solutions
Thermodynamical methods:

- Osmometry – mass, solvent quality. Scaling laws predictions
- Tonometry
- Ebulliometry,
- Cryoscopy
- Advantages and limits of these techniques

Hydrodynamical methods:

- Size exclusion chromatography,
  Connection with polymer solution thermodynamics
  Numbers of plateau, efficiency of the columns separation ability.
- Viscosimetry
  Dilute regime: Einstein relation, intrinsic viscosity. Semi-dilute regime: viscosity – concentration variation

Light scattering

- General expression of the scattered intensity, contrast
- Static light scattering: R_G, M_W, second Virial coefficient A_2.
- Dynamic light scattering: R_H
- Examples

Perspectives and applications