Polymer Physics: Structure-Properties relationship

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European credits ECTS: 5

Teaching Language: English

Supporting files: Spanish and English

	Number of course slots (1h20)	**Number of course slots (4h)**
Magisterial	30	
Tutorials	4	
Practical		4+12

Description

- To get knowledge on the theory and applications of the viscoelasticity, to study the structure-properties relationships in polymers and polymer based materials
- To be able to understand and apply normalized methods for the study of the mechanical behavior and the dielectric and thermal properties of polymeric materials and multiphase polymeric systems.
- To know how to use autonomously scientific instruments used in the physical characterization of polymeric materials.

Outline

Part 1: The viscoelastic nature of polymers

1.1 Theory and applications of linear and non-linear viscoelasticity

- Basic models and experimental techniques
- Why is important viscoelasticity in polymer physics
- Polymer chains dynamics and the three viscoelastic regions
- Non-linear viscoelasticity and practical implications of rheology

1.2 Studies of the rubbery and terminal (flow) viscoelastic regions

- Crystalline and glassy states: The glassy to rubbery state transition and the free

volume
- Dynamic viscoelasticity as a main tool to investigate rubbery and terminal regions
- Reduction to only two viscoelastic regions in crosslinked polymers and polymer composites
- The role of microestructure and chain architecture in the rubbery and terminal regions

1.3 A rheological analysis of the terminal region: The flow of polymers in the liquid state
- Non-newtonian (shear thinning) viscosity: chains entanglement-disentaglement process
- Non linear viscoelasticity in flow: Elastic fluids
- Effect of temperature and pressure on the viscosity
- Practical cases in the framework of the correlation "Molecular parameters-Rheology-Processing"

Part 2: Solid state: advanced methods to study the mechanical properties of mono- and multi-phase polymer systems.

2.1 Composite materials
- Definition and classification
- Structure
- Matrices
- Fibers

2.2 Fiber/polymeric matrix interface
- Adhesion theories
- Glass fiber/polymer interface: coupling agents
- Other fiber/matrix interfaces

2.3 Mechanical properties of composites
- Geometrical aspects
- Stiffness
- Strength
- Other properties: impact strength and work of fracture, fatigue.

2.4 Fracture
- Concepts of stress and strain
- Introduction to fracture
- Fracture in elastic systems
- Fracture in systems with energy dissipation
- Application of concepts of fracture mechanics in fatigue tests

Part 3: Solid state: dielectric and thermal behavior of polymeric materials

3.1. Electrical properties of polymeric materials

3.1.1 The dielectric response and broadband dielectric spectroscopy.
- Response functions
- Specific Relaxation Processes: local processes, the α-relaxation, the normal mode, relaxation of partially crystalline materials.

3.1.2 Semiconducting polymers
- Conjugated polymers (generalities)
- Electrooptic activity
- Applications: Organic solar cells and field effect transistors

3.2. Thermal behaviour of polymer materials