Functional polymers

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Teaching Language: English

Supporting files: English

	Number of course slots (1h20)	Number of course slots (3h)
Magisterial	30	
Tutorials	9	
Practical		0

Description

- Establishing the structure / property / application relationships in applicative polymers.
- Understanding the design rules in functional polymers for various applications.

Outline

Part 1: Functional polymers by chemical modification

Introduction and objectives

Relationships between macromolecular architecture and reactivity

- Influence of functional groups
- Influence of tacticity
- Influence of the conformation and morphology
- Steric, electrostatic and hydrophobic effects

Main reactions for the modifications of polymers

- Isomerization
- Addition and chelation
- Substitution
- Elimination

Bridging reactions (grafting, branching, crosslinking)

- Alkyd resins
- Vulcanization of elastomers
- Crosslinking by peroxides or ionizing irradiation
- Grafted copolymers
- Compatibilization by grafting

Degradation and stabilization of polymers

Novel examples of modification reactions on polymers
- Derivatives of cellulose
- Derivatives of natural rubber
- Derivatives of polyolefins
- Derivatives of poly(styrene) and PVC
- Polymers as reactive or catalytic supports
- Carbon fibers
- Photo-resists
- Recent development in macromolecular engineering

Part 2: Functional polymers in selected applications

Examples of structure / property / application relationships
- Thermoregulation
- Information storage
- Energy generation
- Food packaging technology

Polymer Composites
- Technical matrices
- High performance matrices
- Fibers and reinforcement
- Fiber / matrix interface

Polymers and life science
- Polymers used in medicine
- Biodegradable polymers
- Surface modification
- Applications in life science

Part 3: Bio-sourced polymers

Introduction
- Oil production, main uses, some economic data
- Main polymer families and applications
- Polymer footprint and recyclability

Bioplastics

- Few data on bioplastics
- The renewable resources, the carbon cycle
- Concept of bio-refineries
- Bio-sourced vs biodegradability
- Legislative rules

Bio-based Plastics from natural polymers

- Natural rubber
- Starch-based polymers
- Cellulose-based polymers
- Lignin-based polymers

Bio alternative to fossil polymers

- Drop in Plastics (bioPE, bioPET, others)
- Succinic Acid platform (PBS)
- 1,3-propane diol (PTT), PBT
- Adipic acid (PBAT); azelaic acid (PBAZ)
- Acrylic acid (super absorbent polymers)
- Polyamide (PA-11 and others)
- Elastomers

New polymers with new sets of properties

- Lactic acid, PLA (synthesis and properties)
- Biosynthesis of PHAs (synthesis, recovery and properties)
- Furanic platform (PEF and others)
- Levulinc acid platform and derivatives thereof
- Isosorbide platform and polymers thereof
- Itaconic platform
- Vegetable oil platform: towards bio-based Polyols and other derivatives (PU and epoxy thermosets)
- Phenolic derivatives for bio-(semi)aromatic polymers
- Polymers from terpens and resinic acids

Conclusion

- Drivers for bio-based plastic development
- Main mature technologies
- Properties mapping
- Main domains of use of bio-based plastics
- Some perspectives

Part 4: Polymers in nanotechnologies

Polymer as photoresist for photolithography in microelectronic

- General principles
- UV nm resins
- Deep UV resins
- Towards extreme UV? Alternative approach

Design of semi-conducting (π-conjugated) polymers

- π-conjugated polymers?
- Synthesis techniques: oligomer route, oxidative coupling, organometallic coupling and precursor route
- Purification and characterization
- Architecture and molecular design

Examples of functional polymers for optoelectronic devices, information storage, energy

- Organic optoelectronic devices
- Ferroelectric /piezoelectric polymers
- Polymers as solid electrolytes in batteries for energy storage