Workshop on polymers, synthesis, characterization and 3D printing

11.-13. Sept. 2023, Slovenj Gradec, Slovenia; Faculty of Polymer Technology

The workshop is aimed at students and researchers who work with polymers and want to gain a better insight into their structure, properties and processing. The workshop is organised within the framework of the EU-funded GrInShield project. Participation is free of charge, but registration is required.

Participation is possible both on-site and online, for both lectures and experimental work.

Registration:

You can register here! https://forms.office.com/e/4nqxK6kpBK

Program:

Monday, 11. 9. 2023

Time	Lecturer	Topic
8:30-8:45	B. Nardin	Welcome
8:45-9:00	S. Jovanović	Presentation of the Grinshield project
9:00-10:30	M. Huskić	Introduction to polymers
10:30-11:00	Coffee break	
11:00-12:30	I. Pulko	Polymer synthesis
12:30-14:00	Lunch	
14:00-17:00	Experimental work	Synthesis PA6, UV polymerisation, polymer membrane preparation

Tuesday, 12. 9. 2023

Time	Lecturer	Topic
9:00-9:45	M. Huskić	Determination of the molecular structure of polymers
9:45-10:30	S. Bolka	Mechanical and dynamic mechanical characterisation of polymers
10:30-11:00	Coffee break	
11:00-11:45	W. Friesenbichler	Rheology of Polymers and its Importance for Processing
11:45-12:30	M. Huskić	Thermal characterisation of polymers
12:30-14:00	Lunch	

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14:00-17:00	Experimental work	Determination of glass T_g and T_m by DSC, thermal stability by TGA and mechanical and thermomechanical properties by tensile test and DMA.

Wednesday, 13. 9. 2023

Time	Lecturer	Topic
9:00-10:30	M. Hriberšek	Overview of additive technologies
10:30-11:00	Coffee break	
11:00-11:45	J. Slapnik	Development of graphene oxide-modified photocurable resins for vat photopolymerization additive manufacturing
11:45-12:30	Experimental work	Demonstration of fabrication of test specimens from graphene oxide-modified resins using **DLP additive manufacturing**. **SLS technology** – preparation of the machine and start of 3D printing: Machine description, powder preparation, powder rolling, machine heating, import of 3D models into the program, parameter setting and start of 3D printing.
12:30-14:00	Lunch	
14:00-17:00	Experimental work	**SLS technology** – demonstration of the process of subsequent processing of produced specimens: Removal of specimens from the machine, rough cleaning with a brush and fine cleaning under elevated air pressure or sandblasting under high pressure (air + abrasive). Demonstration of **FDM technology** (filament or granulate) on TUMAKER.
17:00-17:15	Closing ceremony	

Brief description of topics:

Introduction to Polymers:

Definitions of monomers, oligomers, polymers and copolymers, degree of polymerisation, molecular masses and their distributions. Classifications of polymers. Thermoplastics, thermosets and elastomers. Polymer architecture (linear, branched, crosslinked, types of copolymers), amorphous and crystalline thermoplastic polymers, thermal transitions and their importance for the applications.

Polymer synthesis

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Chain (addition) polymerisation mechanisms and characteristics, steps of addition polymerisation (initiation, propagation, termination), types of chain polymerisations. Kinetics and thermodynamics of chain reactions.

Step growth (condensation) polymerisations- mechanisms, examples of appropriate monomers.

Determination of the molecular structure of polymers

A theoretical overview and practical applications of FTIR and NMR (1H and 13C) spectroscopy for polymers and copolymers characterisation. Molecular mass determination using SEC and SEC-MALS chromatography.

Thermal characterisation of polymers

Basic principles and practical examples of the thermal characterisation of polymers and copolymers by DSC and TGA will be presented. The influence of polymer structure on thermal properties will be discussed.

Mechanical and dynamic mechanical characterisation of polymers

Tensile and bending tests: basics, ISO methods, typical measurements (polymers, blends, composites, recycled polymers)

Dynamic mechanical analysis: basics, methods, typical measurements (polymers, blends, composites, recycled polymers)

Rheology of Polymers and its Importance for Processing

Understanding polymer processing and its optimization without profound knowledge of polymer rheology is nearly impossible. In this presentation, the characterization of rheological key figures such as viscosity, storage and loss moduli as well as viscoelasticity and its impact on simulation and processing will be demonstrated using the example of various practical parts being in production.

Overview of additive technologies

Definition of the additive manufacturing process. Comparison between additive manufacturing technologies and conventional production technologies. An overview and description of basic principles of the most commonly used additive manufacturing technologies (SLS, FDM, Polyjet...), list of used materials and connection with applications.

Development of graphene oxide-modified photocurable resins for vat photopolymerization additive manufacturing

This lecture will present vat photopolymerization additive manufacturing in more detail, including basic principles, different vat photopolymerization technologies and used materials. The development procedure of photocurable resins for vat photopolymerization with tunable properties based on acrylate chemistry will be presented. Finally, the use of graphene-based materials for the functionalisation of photocurable resins and potential applications of produced parts will be discussed.

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