COURSE DESCRIPTION CARD - SYLLABUS

Course name
Physicochemistry of polymers [S2TCh2-TP>FP]

Course

Field of study
Chemical Technology

Year/Semester
1/1

Area of study (specialization)
Polymer Technology

Profile of study
general academic

Level of study
second-cycle

Course offered in
polish

Form of study
full-time

Requirements
compulsory

Number of hours

Lecture
30

Laboratory classes
45

Other (e.g. online)
0

Tutorials
0

Projects/seminars
0

Number of credit points

6,00

Coordinators

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Lecturers

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Prerequisites

The student should have basic knowledge in the field polymer chemistry and organic chemistry. Student is able to search for information in scientific literature, databases and other properly chosen sources. In addition, student should be able to work in a chemical laboratory and operate basic research equipment.

Course objective

Providing knowledge related to the physicochemistry of polymers. Acquiring the ability to forecast macroscopic properties of polymeric materials based on their structure and phase transitions. Learning new research techniques used in polymer study.

Course-related learning outcomes

Knowledge:
1. The student has a well-established knowledge in the field of physicochemistry of polymers, allowing to solve complex technological problems related to the processing of polymer materials [K_W2]
2. The student has a well-established and expanded knowledge in the field of molecular and supermolecular structure of polymers as well as phase transitions occurring in polymers [K_W11]
3. The student knows modern methods of structure analysis, phase transitions and physicochemical properties of polymers and is able to find the relationship between structure and properties [K_W7]

Skills:
1. The student has expanded skills to analyze and solve problems related to the processing of polymer materials, using the theoretical basics of polymer physicochemistry as well as experimental methods to assess the structure and phase transitions occurring in plastics [K_U10]
2. The student has the skills necessary to work in an industrial environment and in research teams dealing with determining the structure of polymers and search relationships with properties of polymer materials [K_U18]
3. The student has the ability to critically evaluate the results of experimental works and is able to determine the direction of further research leading to solving problems in the field of physicochemical properties of polymers, as well as technological conditions during plastics processing [K_U21]

Social competences:
1. Student is aware of the limitations of their own knowledge and understanding of the need for further education in the field of physicochemistry of polymers [K_K1]
2. The student is able to cooperate in a team and is aware of the responsibility for own work and shared responsibility for the effects of team work [K_K4]
3. The student is able to think and act in a creative way as well as actively engage in solving the problems - [K_K6]

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Lectures:
Knowledge acquired in the lectures is verified in the form of an oral exam after the end of the lecture cycle. Exam issues will be sent to students via e-mail using the university e-mail system and will be forwarded before each lecture in order to emphasize the importance of the discussed program content. In the case of remote lectures - oral exam with the use of university infrastructure, which will be registered.
Laboratory:
The skills in the laboratory classes are verified on the basis of a test of theoretical issues, consisting of 3-5 questions. Theoretical issues for all exercises are passed on during the organizational meeting. Passing threshold: 50% of points. In addition, reports containing a description of the experiment and calculations are evaluated.

Programme content

1) Introduction to macromolecules and physicochemical of polymers.
2) Molecular and supermolecular structure of polymes. Intermolecular interaction in macromolecules. Isomerism and the stereochemistry of the polymers - conformation, configuration. 1st, 2nd and 3rd order structure of polymers- sequence of mers, geometric isomerism, chirality and tacticity, aggregation states. Two-phase micellar-fringed model, folded lamella model, degree of crystallinity. Relationship between supermolecular structure and rheological and mechanical properties of polymers.
3) Molecular weight of polymers: numeric average, weight average, viscosity average - definitions and meaning. Polydispersity. Calculation of molecular weight. Methods for determining molecular weights. Influence of molecular weight on the rheological properties and useful properties.

4) Polymers in condensed phase. Amorphous, semicrystalline, crosslinked polymers and polymer blends. Polymer networks, thermoelasticity. Polymer gels.
5) Amorphous state. Glass transition, models of glass transition. Glass transition temperature. Relationships between glass temperature and polymer structure, parameters affecting the glass temperature.
6) Crystal state, nucleation theories, kinetic of crystallization, Avrami model, Hoffman nucleation theory, polymer morphology, crystal structure and melting process.
7) Polymer solution: viscosity of polymer solution, relationships between viscosity and molecular weight, molecular theory of viscosity. Miscibility of polymers, thermodynamics of the dissolution process, theta temperature, Flory-Huggins theory, lattice model, solubility parameter, phase diagrams of polymer solutions.
8) Physical states and phase transitions of polymers. Viscoelasticity. Molecular interpretation of viscoelastic properties of solutions and polymer blends. Rouse theory and molecular reptation conception. Relaxation. Stress-strain relationships.
9) Polymer blends and polymer composites.
10) Research methods of structure and phase transitions of polymers. Thermal, spectroscopic, microscopy, and X-ray investigations.
As part of the laboratory classes, the following exercises are performed:
1. Shape of macromolecules in solution.
2. Characterisation of the supermolecular structure - X-ray diffraction method.
3. Analysis of phase transitions in polymers based on DSC method.
4. Testing PVC stabilization by the static method.
5. Analysis of polymer morphology in solid state by microscopic methods.
6. Investigations of rheological properties in polymer materials.

Teaching methods

1. Lecture: multimedia presentation
2. Laboratory: practical classes using chemical reagents and research equipment

Bibliography

Basic:
1. H. Galina, Fizykochemia polimerów, Wydawnictwo Politechniki Rzeszowskiej, Rzeszów, 1998.
2. W. Przygocki, A. Włochowicz, Fizyka polimerów, PWN, Warszawa, 2001.
3. Z. Florianczyk, S. Penczek, Chemia polimerów, tom. 1,2, Wydawnictwo Politechniki Warszawskiej, Warszawa, 1997.
4. W. Przygodzki, Metody fizyczne badań polimerów, PWN, Warszawa, 1990

Additional:
1. W. Przygocki, A. Włochowicz, Uporządkowanie makrocząsteczek w polimerach i włóknach, WNT, Warszawa 2006.
2. H. Sperling, Introduction to Physical Polymer Science, J.Wiley, New York, 1992

Breakdown of average student's workload

	Hours	ECTS
Total workload	150	6,00
Classes requiring direct contact with the teacher	79	3,00
Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation)	71	3,00