



## Subject card

Subject name and code	, PG_00058694						
Field of study	Materials Engineering, Materials Engineering						
Date of commencement of studies	February 2024	Academic year of realisation of subject			2024/2025		
Education level	second-cycle studies	Subject group			Obligatory subject group in the field of study Subject group related to scientific research in the field of study		
Mode of study	Full-time studies	Mode of delivery			at the university		
Year of study	1	Language of instruction			Polish		
Semester of study	2	ECTS credits			3.0		
Learning profile	general academic profile	Assessment form			assessment		
Conducting unit	Department of Polymers Technology -> Faculty of Chemistry						
Name and surname of lecturer (lecturers)	Subject supervisor	dr inż. Marcin Włoch					
	Teachers	dr inż. Marcin Włoch					
Lesson types and methods of instruction	Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
	Number of study hours	30.0	0.0	0.0	0.0	15.0	45
	E-learning hours included: 0.0						
Learning activity and number of study hours	Learning activity	Participation in didactic classes included in study plan	Participation in consultation hours		Self-study	SUM	
	Number of study hours	45	5.0		25.0	75	
Subject objectives	Knowledge of structure-property relationships in polymers and methods of their characterization						
Learning outcomes	Course outcome	Subject outcome			Method of verification		
	K7_U03	Student is able to design research tasks, which permit to determine properties of plastics and factors responsible for their failure			[SU3] Assessment of ability to use knowledge gained from the subject [SU5] Assessment of ability to present the results of task		
	K7_W06	The student knows the theoretical basis of functioning of research equipment appropriate for polymers testing			[SW1] Assessment of factual knowledge		
	K7_W02	The student knows experimental techniques (including spectroscopic, chromatographic and thermal analysis techniques) appropriate for polymeric materials			[SW1] Assessment of factual knowledge		
	K7_U04	The student is able to make a detailed analysis of the results from polymers testing			[SU1] Assessment of task fulfilment [SU5] Assessment of ability to present the results of task		

Subject contents	<p><b>Introduction:</b> Classification of polymers and their characterization. Crystalline and amorphous polymers. Physical states and viscoelastic properties of polymers. Average molecular weight and bimodal polymers. Characterization of plastics using spectroscopic (FTIR, NMR), chromatographic (HPLC, GPC), microscopic (SEM, TEM, AFM), thermal analysis (DSC, DMTA, TGA) and other techniques.</p> <p><b>Durability and degradation of plastics:</b> Classification of polymer degradation processes. Functional additives for plastics preventing their degradation (e.g. antioxidants, photostabilizers and flame retardants).</p> <p><b>Analysis of plastics failure:</b> Procedure, selection of testing techniques and analysis of obtained results. Analysis of exemplary plastics failures. Elements of monomers, polymers and functional additives toxicology.</p> <p><b>Physicochemistry of polymers surface:</b> Polymer surface structure. Methods of polymer surface testing and modification</p> <p><b>Tribology of polymers:</b> Mechanical-molecular theory of friction. Direct contact area during the friction of polymers. Mechanical and adhesive interactions. Influence of polymer structure and temperature on polymers friction coefficient. Physico-chemical phenomena occurring during polymer friction. Effects of lubricants. Modification of tribological properties of polymers. Triboelectric effect. Tribological wear.</p> <p><b>Recycling of plastics and environment protection:</b> Sources of plastics waste, recycling methods, domestic and European Union regulations. Microplastics in environment: formation, identification and consequences of their presence in the environment. Plastics obtained using bio-based substances. Biodegradable plastics.</p>											
Prerequisites and co-requisites	Basic knowledge in the area of chemistry and technology of polymers											
Assessment methods and criteria	<table border="1"> <thead> <tr> <th>Subject passing criteria</th> <th>Passing threshold</th> <th>Percentage of the final grade</th> </tr> </thead> <tbody> <tr> <td>written and oral works during seminar</td> <td>50.0%</td> <td>25.0%</td> </tr> <tr> <td>written tests (three in the term)</td> <td>50.0%</td> <td>75.0%</td> </tr> </tbody> </table>			Subject passing criteria	Passing threshold	Percentage of the final grade	written and oral works during seminar	50.0%	25.0%	written tests (three in the term)	50.0%	75.0%
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Recommended reading	<table border="1"> <tbody> <tr> <td>Basic literature</td> <td colspan="2">           (1) G.W. Ehrenstein, Ź. Brocka-Krzemińska: <i>Materiały polimerowe: Struktura, właściwości, zastosowanie</i>, PWN, Warszawa 2016            (2) J.F. Rabek: <i>Polimery i ich zastosowania interdyscyplinarne</i>, Tom 1 i 2, PWN, Warszawa 2021            (3) W. Szlezyngier, Z.K. Brzozowski: <i>Tworzywa sztuczne. Tom III: Środki pomocnicze i specjalne zastosowania polimerów</i>, Wydawnictwo Oświatowe FOSZE, Rzeszów 2013         </td> </tr> <tr> <td>Supplementary literature</td> <td colspan="2">           (1) J.F. Rabek: <i>Współczesna wiedza o polimerach. Tom 1: Budowa strukturalna polimerów i materiały badawcze</i>, PWN, Warszawa 2017            (2) J.F. Rabek: <i>Współczesna wiedza o polimerach. Tom 2: Polimery naturalne i syntetyczne, otrzymywanie i zastosowania</i>, PWN, Warszawa 2017         </td> </tr> <tr> <td>eResources addresses</td> <td colspan="2">Adresy na platformie eNauczanie:</td> </tr> </tbody> </table>			Basic literature	(1) G.W. Ehrenstein, Ź. Brocka-Krzemińska: <i>Materiały polimerowe: Struktura, właściwości, zastosowanie</i> , PWN, Warszawa 2016 (2) J.F. Rabek: <i>Polimery i ich zastosowania interdyscyplinarne</i> , Tom 1 i 2, PWN, Warszawa 2021 (3) W. Szlezyngier, Z.K. Brzozowski: <i>Tworzywa sztuczne. Tom III: Środki pomocnicze i specjalne zastosowania polimerów</i> , Wydawnictwo Oświatowe FOSZE, Rzeszów 2013		Supplementary literature	(1) J.F. Rabek: <i>Współczesna wiedza o polimerach. Tom 1: Budowa strukturalna polimerów i materiały badawcze</i> , PWN, Warszawa 2017 (2) J.F. Rabek: <i>Współczesna wiedza o polimerach. Tom 2: Polimery naturalne i syntetyczne, otrzymywanie i zastosowania</i> , PWN, Warszawa 2017		eResources addresses	Adresy na platformie eNauczanie:	
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Example issues/ example questions/ tasks being completed	<ol style="list-style-type: none"> <li>1. Factors responsible for polymers degradation</li> <li>2. Degradability of polyolefins, polyamides and polyesters.</li> <li>3. Mechanisms of action of degradation stabilizers and antioxidants.</li> <li>4. Factors and processes causing failure of plastic products.</li> <li>5. Methods of testing the tribological properties of plastic</li> </ol>											
Work placement	Not applicable											