



## Subject card

Subject name and code	Composite materials in the energy and transport, PG_00033868						
Field of study	Nanotechnology						
Date of commencement of studies	October 2020	Academic year of realisation of subject			2022/2023		
Education level	first-cycle studies	Subject group					
Mode of study	Full-time studies	Mode of delivery			at the university		
Year of study	3	Language of instruction			Polish		
Semester of study	5	ECTS credits			1.0		
Learning profile	general academic profile	Assessment form			assessment		
Conducting unit	Department of Solid State Physics -> Faculty of Applied Physics and Mathematics						
Name and surname of lecturer (lecturers)	Subject supervisor	dr hab. inż. Beata Bochentyn					
	Teachers	dr hab. inż. Beata Bochentyn					
Lesson types and methods of instruction	Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
	Number of study hours	15.0	0.0	0.0	0.0	0.0	15
	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	15	0.0	0.0	15		
Subject objectives	<p>Presentation of the purpose and principles of composite materials fabrication.</p> <p>Presentation of different types of composites, their properties, fabrication methods, interactions between the components.</p> <p>Presentation of the methods of testing the structural and electrical properties of composite materials.</p> <p>Presenting examples of technological application of composites in transport and energy.</p>						
Learning outcomes	Course outcome	Subject outcome			Method of verification		
	K6_W07	The student knows the methods of fabricating composite materials, knows their properties and characterisation methods.			[SW1] Assessment of factual knowledge		
	K6_W06	The student is able to explain the properties of composite materials and the interactions between components based on their structure and transport phenomena occurring in the materials.			[SW1] Assessment of factual knowledge		

Subject contents	<p>1. Composites - definition, classification, examples</p> <p><i>Structural properties of composites - testing and characterization</i></p> <p>1. Composites of required structural properties - the most important features; methods for preparing  2. Methods of test for structural properties of composites: SEM, EDX, SPM, nanoindentation</p> <p><i>Electrical properties of composites - testing and characterization</i></p> <p>1. The materials with mixed electrical conductivity (ion, proton, electron)  2. Percolation theory  3. Methods of mixed electrical conductivity testing</p> <p><i>The division of composite materials, properties, manufacturing method, the interaction between the components</i></p> <p>1. Polymer matrix composites  2. Metal matrix composites  3. A ceramic matrix composites  4. Composites with carbon fibers matrix  5. Superconducting matrix composites</p> <p><i>Areas of technological application of composite materials (transport, energy)</i></p>								
Prerequisites and co-requisites	Knowledge of basic physics.								
Assessment methods and criteria	<table border="1" data-bbox="448 974 1487 1048"> <thead> <tr> <th data-bbox="448 974 798 1010">Subject passing criteria</th> <th data-bbox="801 974 1139 1010">Passing threshold</th> <th data-bbox="1142 974 1487 1010">Percentage of the final grade</th> </tr> </thead> <tbody> <tr> <td data-bbox="448 1014 798 1048">Written exam</td> <td data-bbox="801 1014 1139 1048">50.0%</td> <td data-bbox="1142 1014 1487 1048">100.0%</td> </tr> </tbody> </table>			Subject passing criteria	Passing threshold	Percentage of the final grade	Written exam	50.0%	100.0%
Subject passing criteria	Passing threshold	Percentage of the final grade							
Written exam	50.0%	100.0%							
Recommended reading	Basic literature	<p>1. Krishan K. Chawla, Composite materials. Science and engineering, Springer 2012</p> <p>2. A. Boczkowska, J. Kapuściński, Z. Lindemann, D. Witemberg-Perzyk, S. Wojciechowski, Kompozyty, Oficyna Wydawnicza Politechniki Wrocławskiej 2013</p>							

	Supplementary literature	<p>1. L. Nicolais, M. Meo, E. Milea, Composite materials. A vision for the future, Springer 2011</p> <p>2. I. Riess, Mixed ionic/electronic conductors - material properties and applications, Solid State Ionics 157 (2003) 117</p> <p>3. W. Bogusz, F. Krok, Elektrolity stałe. Właściwości elektryczne i sposoby ich pomiaru, Wydawnictwa Naukowo-Techniczne, Warszawa 1995</p> <p>4. Chunli Gong, Zhigang Xue, Sheng Wen, Yunsheng Ye, Xiaolin Xie, Advanced carbon materials/olivine LiFePO<sub>4</sub> composites cathode for lithium ion batteries, Journal of Power Sources 318 (2016) 93-112</p> <p>5. S. Ummartyotin, N. Bunnak, H. Manuspiya, A comprehensive review on modified clay based composite for energy based materials, Renewable and Sustainable Energy Reviews 61 (2016) 466472</p> <p>6. P. Zhang, X. Xiao, Z.W. Ma, A review of the composite phase change materials: Fabrication, characterization, mathematical modeling and application to performance enhancement, Applied Energy 165 (2016) 472510</p> <p>7. Other scientific papers</p>
	eResources addresses	<p>Adresy na platformie eNauczenie:</p> <p>Materiały kompozytowe w energetyce i transporcie - Moodle ID: 26925  <a href="https://enauczenie.pg.edu.pl/moodle/course/view.php?id=26925">https://enauczenie.pg.edu.pl/moodle/course/view.php?id=26925</a></p>
Example issues/ example questions/ tasks being completed	<p>1. Example of classification methods, and examples of composite materials belonging to each group  2. The principles of designing composites and the resulting properties of the composite materials (+ examples)  3. Percolation theory - basic issues  4. Methods of mixed electrical conductivity testing</p>	
Work placement	Not applicable	