GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Electrical Properties of Materials and Nanomaterials, PG_00069706		
Field of study	Nanotechnology		
Date of commencement of studies	October 2024	Academic year of realisation of subject	2026/2027
Education level	first-cycle studies	Subject group	Optional subject group 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	3	Language of instruction	Polish
Semester of study	5	ECTS credits	2.0
Learning profile	general academic profile	Assessment form	exam
Conducting unit	Division of New Functional Materials For Energy Conversion -> Institute of Nanotechnology and Materials Engineering -> Faculty of Applied Physics and Mathematics -> Wydziały Politechniki Gdańskiej		
Name and surname of lecturer (lecturers)	Subject supervisor	dr hab. inż. Beata Bochentyn	
	Teachers		

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	3.0	32.0	50

Subject objectives

The course aims to present the purpose and principles of creating composite materials, presenting various types of composites, their properties, manufacturing methods, interactions between components, and computational methods for determining the parameters of the resulting materials. Students will also learn methods for testing the structural and electrical properties of composite materials and become familiar with technological examples of composite applications in transportation and energy.

Learning outcomes

Course outcome	Subject outcome	Method of verification
[K6_W01] has knowledge of materials science and understands its key role in the progress of civilization	Can 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
[K6_K05] can present effects of their own work, provide information in a clear manner, communicate and self-evaluate, and give constructive feedback on the work of others.	Is able to find a solution to a given problem and present it in a clear, understandable and accessible way for the listener/reader.	[SK5] Assessment of ability to solve problems that arise in practice [SK4] Assessment of communication skills, including language correctness
[K6_U06] can accurately present technological and scientific problems, related to the production and application of nanostructures, to specialists in related fields, and initiate and coordinate interdisciplinary cooperation.	Can convey substantive knowledge about the properties and applications of composite materials in written and/or oral form. Shares knowledge in a clear and understandable manner. Responds to problem-solving questions.	[SU3] Assessment of ability to use knowledge gained from the subject

Subject contents	1. Composites - definition, classification, examples *Structural properties of composites - testing and characterization* 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 *Electrical properties of composites - testing and characterization* 1. The materials with mixed electrical conductivity (ion, proton, electron) 2. Percolation theory 3. Methods of mixed electrical conductivity testing *The division of composite materials, properties, manufacturing method, the interaction between the components* 1. Polymer matrix composites 2. Metal matrix composites 3. A ceramic matrix composites 4. Composites with carbon fibers matrix 5. Superconducting matrix composites *Areas of technological application of composite materials (transport, energy)*
Prerequisites and co-requisites	Knowledge of basic physics.

Assessment methods and criteria

Subject passing criteria	Passing threshold	Percentage of the final grade
Final exam	50.0%	100.0%

Recommended reading

Basic literature

1. Mahesh Bhong, Tasneem K.H. Khan, Kiran Devade, B. Vijay Krishna, Sreekanth Sura, H.K. Eftikhaar, H. Pal Thethi, Nakul Gupta, Review of composite materials and applications, Materials Today: Proceedings, 2023, https://doi.org/10.1016/j.matpr.2023.10.026
2. Puran Singh, V. Raghavender, Sudhir Joshi, Nikale Pooja Vasant, Ankita Awasthi, Amandeep Nagpal, Alaa jasim Abd al-saheb, Composite material: A review over current development and automotive application, Materials Today: Proceedings, 2023, https://doi.org/10.1016/j.matpr.2023.11.012
3. Huang, X.; Su, S.; Xu, Z.; Miao, Q.; Li, W.; Wang, L. Advanced Composite Materials for Structure Strengthening and Resilience Improvement. *Buildings* **2023**, *13*, 2406. https://doi.org/10.3390/buildings13102406
4. **Materials science and engineering** : an **introduction, 10th Edition** / by William D. Callister, David G. Rethwisch, Chapter 16 Compostites, dostęp online: https://ftp.idu.ac.id/wp-content/uploads/ebook/tdg/TEKNOLOGI%20REKAYASA%20MATERIAL%20PERTAHANAN/Materials%20Science%20and%20Engineering%20An%20Introducti%20Callister,%20Jr.,%20David%20G.%20Rethwish%20(z-lib.org).pdf
5. Krishan K. Chawla, Composite materials. Science and engineering, Springer 2012
6. Boczkowska, J. Kapuściński, Z. Lindemann, D. Witemberg-Perzyk, S. Wojciechowski, Kompozyty, Oficyna Wydawnicza Politechniki Wrocławskiej 2013

	Supplementary literature	1. L. Nicolais, M. Meo, E. Milea, Composite materials. A vision for the future, Springer 2011 2. I. Riess, Mixed ionicelectronic conductors - material properties and applications, Solid State Ionics 157 (2003) 117 3. W. Bogusz, F.Krok, Elektrolity stałe. Właściwości elektryczne i sposoby ich pomiaru, Wydawnictwa Naukowo-Techniczne, Warszawa 1995 4. Chunli Gong, Zhigang Xue, Sheng Wen, Yunsheng Ye, Xiaolin Xie, Advanced carbon materials/olivine $LiFePO_4$ composites cathode for lithium ion batteries, Journal of Power Sources 318 (2016) 93-112 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 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 7. Inne anglojęzyczne publikacje naukowe
	eResources addresses	
Example issues/ example questions/ tasks being completed	1. Example of classification methods, and examples of composite materials belonging to each group2. 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	
Work placement	Not applicable	

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