GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Nanostructures in Glasses and Amorphous Materials, PG_00069707		
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	3.0
Learning profile	general academic profile	Assessment form	exam
Conducting unit	Institute of Nanotechnology and Materials Engineering -> Faculty of Applied Physics and Mathematics -> Wydziały Politechniki Gdańskiej		
Name and surname of lecturer (lecturers)	Subject supervisor	dr inż. Leszek Wicikowski	
	Teachers		

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	0.0	30

E-learning hours included: 0.0

eNauczanie source addresses:

Moodle ID: 1543 Nanostruktury w szkłach i materiałach amorficznych
https://enauczanie.pg.edu.pl/2025/course/view.php?id=1543

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	30	4.0	41.0	75

Subject objectives

The aim of this course is to introduce students to the fundamentals of physics and chemistry of amorphous materials, particularly glasses, and their applications in nanotechnology. Students will gain knowledge of the mechanisms of nanostructure formation in glasses and amorphous materials, their physical, optical, and mechanical properties, as well as manufacturing and research methods.

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 track the latest advances in nanotechnology can relate the nanostructure of materials to their properties	[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.	Understands the need to update knowledge on new materials and technologies. Can work independently to analyze physical phenomena in amorphous materials.	[SK5] Assessment of ability to solve problems that arise in practice
[K6_W07] has systematic knowledge of the physical and chemical principles of nanotechnology (methods of obtaining nanostructures, types of nanostructures, their properties, basic research methods).	Knows the structure and properties of amorphous materials and glasses. Understands the processes of nanostructure formation in glasses and amorphous materials. Knows methods for studying nanostructures and their physical and optical properties.	[SW1] Assessment of factual knowledge

<table>
<tr><td>Subject contents</td><td>1. Introduction definition of amorphous materials and glasses, basic differences from crystalline materials.
2. Structure of glasses and amorphous solids structural models, bonding networks, defects.
3. Methods for manufacturing glasses and amorphous materials cooling, sol-gel, vapor deposition, melting methods.
4. Nanostructures in glass colloids, nanocrystallites, nanoporosity.
5. Mechanisms of nanostructure formation phase separation, controlled crystallization, ionic and laser modifications.
6. Optical properties of nanostructures in glass luminescence, optical nonlinearity, plasmonic properties.
7. Mechanical and thermal properties of nanostructures in glass and amorphous solids.
8. Methods of studying nanostructures optical spectroscopy, electron and atomic force microscopy, X-ray techniques.
9. Application examples photonics, optoelectronics, sensors, biomedicine.
10. Development prospects new materials and research directions.</td></tr>
<tr><td>Prerequisites and co-requisites</td><td></td></tr>
<tr><td>Assessment methods and criteria</td><td><table><tr><th>Subject passing criteria</th><th>Passing threshold</th><th>Percentage of the final grade</th></tr><tr><td>Exam</td><td>50.0%</td><td>100.0%</td></tr></table></td></tr>
<tr><td>Recommended reading</td><td><table><tr><td>Basic literature</td><td>1. A. Makishima, Properties and Structure of Glass, Springer.
2. J. Zarzycki, Glasses and the Vitreous State, Cambridge University Press.
3. C. S. Ray, D. E. Day, Nanostructured Glasses.</td></tr><tr><td>Supplementary literature</td><td>1. Publications from the Journal of Non-Crystalline Solids and Journal of Materials Science
2. Lecture materials provided by the lecturer.</td></tr><tr><td>eResources addresses</td><td></td></tr></table></td></tr>
<tr><td>Example issues/ example questions/ tasks being completed</td><td>Theoretical questions (open-ended, descriptive):
1. Compare the structures of crystalline and amorphous materials. What are the main differences in their physical properties?
2. Explain the concept of "glass transition temperature" and its importance in glass formation processes.
3. Discuss the mechanisms of nanostructure formation in glass as a result of phase separation.
4. What are the main optical properties of nanostructures in glass and what do they result from?
5. Describe methods for modifying glass using rare-earth ions.
6. Explain the phenomenon of luminescence in glassy nanostructures.
7. What spectroscopic techniques can be used to study nanostructures in glass? Provide examples and their capabilities.
8. How does the sol-gel process enable the production of nanostructured amorphous materials?
9. Present examples of applications of nanostructures in glass in photonics and optoelectronics.
10. What are the promising directions of research on nanostructures in amorphous materials?
Problem-solving and analytical questions:
1. Propose a method for producing glass with silver nanoparticles exhibiting plasmonic properties. What process parameters will be crucial?
2. How will the thermal conductivity of the glass change after introducing a nanoporous structure? Justify your answer.
3. You have a sample of glass containing semiconductor nanocrystals. What research methods will allow you to determine their size and distribution?
4. Explain why nanostructures in glass can improve its mechanical properties.
5. Compare the potential applications of nanostructures in glass and nanostructures in crystalline ceramic materials.</td></tr>
<tr><td>Work placement</td><td>Not applicable</td></tr>
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