



Subject card

Subject name and code	, PG_00069394						
Field of study	Materials Engineering, Materials Engineering						
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		1.0		
Learning profile	general academic profile		Assessment form		assessment		
Conducting unit	Institute of Nanotechnology and Materials Engineering -> Faculty of Applied Physics and Mathematics -> Faculties of Gdańsk University of Technology						
Name and surname of lecturer (lecturers)	Subject supervisor		dr inż. Leszek Wicikowski				
	Teachers		dr inż. Leszek Wicikowski				
Lesson types	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						
	eNauczanie source addresses: Moodle ID: 1327 Materiały amorficzne https://enauczanie.pg.edu.pl/2025/course/view.php?id=1327						
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		1.0		9.0	25
Subject objectives	The aim of the course is to familiarize students with basic information on: the structure and properties of amorphous materials, methods of their production, characterization techniques, main areas of application in materials science and modern technologies.						
Learning outcomes	Course outcome		Subject outcome		Method of verification		
	[K6_W04] Knows selected aspects of construction and operation of scientific equipment in materials engineering.		Understands the basic design and operating principles of scientific equipment used to investigate the structure, phase transformations, and thermal and optical properties of amorphous materials.		[SW1] Assessment of factual knowledge		
	[K6_W06] Knows selected methods, techniques, tools and materials used in solving simple engineering problems within the scope of materials engineering.		Is familiar with selected methods for the fabrication, modification, and characterization of amorphous materials, as well as the principles of selecting these materials for basic engineering applications.		[SW1] Assessment of factual knowledge		
	[K6_W03] Has knowledge of materials science and can relate the properties of materials with their structure and composition, knows the theoretical description of phenomena occurring in materials subjected to external factors.		Explains the relationships between the chemical composition, structure, and physicochemical properties of amorphous materials. Describes and explains physical phenomena occurring in amorphous materials under the influence of external factors, particularly structural transformations, relaxation, and crystallization.		[SW1] Assessment of factual knowledge		

Subject contents	Course content – lecture Course Content (Lecture 15 h) 1. Definition of amorphous materials, examples, technological significance. 2. Amorphous structure short- and medium-range order. 3. Glass transition, basic thermodynamics of glass. 4. Methods for manufacturing amorphous materials: rapid cooling, sol-gel, vapor deposition, sputtering. 5. Inorganic glasses composition, optical and mechanical properties. 6. Amorphous metals preparation, magnetic and mechanical properties. 7. Amorphous polymers and thin films. 8. Basic research techniques (XRD, DSC, spectroscopy). 9. Applications of amorphous materials in electronics, optoelectronics, and biomaterials. 10. Prospects for the development of amorphous materials. Teaching Methods • Lecture with multimedia presentation. • Problem-solving discussion. • Case study (application examples).		
Prerequisites and co-requisites			
Assessment methods and criteria	Subject passing criteria	Passing threshold	Percentage of the final grade
	Final test	50.0%	100.0%
Recommended reading	Basic literature	1. A. Varshneya, Fundamentals of Inorganic Glasses 2. J. Zarzycki, Glasses and the Vitreous State. 3. A. Inoue, Amorphous Materials and Metallic Glasses.	
	Supplementary literature	1. D.R. Uhlmann, N.J. Kreidl, Glass: Science and Technology. 2. A. Makino, T. Bitoh, Soft Magnetic Amorphous and Nanocrystalline Alloys. 3. Aktualna literatura naukowa	
	eResources addresses		
Example issues/ example questions/ tasks being completed	Sample Test Questions and Short Answers 1. Explain the difference between crystalline and amorphous structures. 2. What is the glass transition? 3. Name three methods for obtaining amorphous materials. 4. Why does rapid cooling favor the formation of the amorphous phase? 5. Give examples of applications for amorphous metals. 6. What technique can be used to confirm the absence of long-range order in a material? 7. What is the difference between "short-range order" and "long-range order"? 8. Which of the following materials can be amorphous: SiO, Al, Fe, polystyrene? 9. Why is glass metastable? 10. Indicate the main advantage of metallic glass in mechanical applications. Open/Descriptive Questions 1. Discuss the conditions for glass formation according to D. Turnbull's concept. 2. Explain how the cooling rate affects the ability to avoid crystallization. 3. Compare the mechanical properties of silica glass and metallic glass. 4. Describe the glass transition process how do specific volume and enthalpy change as a function of temperature? 5. Explain the role of glass-forming oxides and modifiers in inorganic glasses. 6. Discuss the differences in amorphization methods: rapid cooling vs. vacuum vapor deposition. 7. What are the limitations of characterization techniques for amorphous materials compared to crystals? Calculation/Problem-Solving 1. A material crystallizes at a cooling rate of less than 10⁴ K/s. What minimum cooling rate should be used to obtain glass if the crystallization temperature is 600 K and the melting point is 200 K? (Estimate relaxation time and discuss). 2. The DSC curve of the glass sample shows T_g = 450°C, T_x = 520°C. Calculate the thermal stability parameter S = T_x - T_g. What does this mean, and can the material be considered thermally stable? 3. Draw and discuss the free enthalpy G as a function of temperature for the crystalline and amorphous phases. Where does the difference occur and what significance does this have for the metastability of the glass? 4. Explain why sharp reflections are not observed in the diffraction pattern of an amorphous material, but rather a broad peak. How can this indicate the lack of long-range order? Examples of Project/Discussion Tasks 1. Suggest a potential application of an amorphous material in electronics and justify the method used to obtain it. 2. Compare the advantages and disadvantages of amorphous metals compared to conventional structural steels. 3. Prepare a short paper: "Modern Glasses for Optoelectronics Examples and Development Prospects."		
Practical activities within the subject	Not applicable		

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