GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Functional Nanomaterials, PG_00069336		
Field of study	Nanotechnology		
Date of commencement of studies	October 2025	Academic year of realisation of subject	2026/2027
Education level	first-cycle studies	Subject group	
Mode of study	Full-time studies	Mode of delivery	at the university
Year of study	2	Language of instruction	Polish
Semester of study	3	ECTS credits	5.0
Learning profile	general academic profile	Assessment form	exam
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	prof. dr hab. inż. Maria Gazda	
	Teachers	prof. dr hab. inż. Maria Gazda	

Lesson types

Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
Number of study hours	15.0	0.0	30.0	0.0	0.0	45

E-learning hours included: 0.0

eNauczanie source address: https://enauczanie.pg.edu.pl/2025/course/view.php?id=672

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	10.0	70.0	125

Subject objectives

Understanding the properties, structure and applications of functional nanomaterials; understanding the relationships between properties, structure, defects and size and nanostructure.

Learning outcomes

Course outcome	Subject outcome	Method of verification
[K6_U10] can forecast and assess potential negative biological and ecological effects of producing nanostructures on an industrial scale and their practical application.	Can predict and assess the potential negative biological and ecological effects of producing functional nanomaterials with selected electrical, optical, magnetic, etc. properties.	[SU3] Assessment of ability to use knowledge gained from the subject
[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).	Has systematic knowledge of the physical and chemical basis of obtaining functional nanomaterials with selected electrical, optical, magnetic, etc. properties.	[SW1] Assessment of factual knowledge
[K6_W01] has knowledge of materials science and understands its key role in the progress of civilization	Demonstrates knowledge of materials science, particularly regarding the influence of size and nanostructure on the functional properties of nanomaterials. Understands the relationship between materials science and civilizational development.	[SW1] Assessment of factual knowledge
[K6_U04] can plan and conduct experiments, critically analyze their results, draw conclusions and formulate opinions. Has laboratory experience.	Students can plan and conduct experiments involving the production and modification of selected nanomaterials, critically analyze their results, draw conclusions, and formulate opinions. They have experience in laboratory work related to the production and testing of nanomaterials.	[SU1] Assessment of task fulfilment

Subject contents	Course content – lecture **Lecture** Introduction: Nanomaterials and Nanostructures; a brief summary of the relationships between size and: crystalline structure, structural defects, melting point, specific heat, thermal expansion, optical and dielectric properties, etc. Nanomaterials and nanostructures with specific functions resulting from their properties: electrical (conductive, superconducting, semiconducting, insulators); optical (nanomaterials in optics and photonics); magnetic (nanomaterials in information recording and storage); other (nanomaterials in energy storage and conservation); **Laboratory** The materials and nanomaterials produced and studied in the laboratory are oxides. The exercises are divided into two thematic groups: 1) production, modification, and study of a oxide superconductor (YBCO). Students use solid-state reaction methods, using, among others, using a ball mill (reactants in the form of nanopowders); students investigate phase composition (XRD), crystallite and nanocrystallite size (Scherrer method), crystal grain size (SEM), and superconducting properties (levitation, critical temperature); 2) preparation of nanopowders of oxides such as ZnO, CeO2, TiO2, and others. They use co-precipitation methods; each group prepares at least two oxides. 3) The laboratory concludes with a joint comparison, discussion, and summary of the results. 4) Laboratory reports are structured like scientific publications.
Prerequisites and co-requisites	no

Assessment methods and criteria

Subject passing criteria	Passing threshold	Percentage of the final grade
laboratory assesement	52.0%	50.0%
written exam regarding lecture	52.0%	50.0%

Recommended reading

Basic literature	Nanomaterials, Vollath
Supplementary literature	Any scientific literature, e.g. Journal RSC "Materials Advances"
eResources addresses	Basic https://enauczanie.pg.edu.pl/2025/course/view.php?id=672 - Kurs "Nanomateriały funkcjonalne"

Example issues/ example questions/ tasks being completed

1. The best examples of functional nanostructures are elements used to record information. Physical phenomena related to nanoscale that are important in this field include giant magnetoresistance and tunneling magnetoresistance. Briefly describe them and explain their relationship to information recording.
2. List the defects present in nanomaterials. How does size affect the concentration of individual defects (with a brief explanation)?
3. How does size affect the elastic properties, strength, melting point, and heat capacity of materials (with a brief explanation)?
4. Explain why:
The heat capacity of a nanomaterial is greater than that of its micro-sized counterpart.
The dislocation concentration in a nanometal is lower than that of its micro-sized counterpart.
The optical properties of a nanometal are different than those of its micro-sized counterpart.
5. The lectures discussed "functional materials and nanomaterials" containing Cu/Si/some other. List them and describe the properties of one of them.
6. The lectures discussed "functional materials and nanomaterials" in the form of oxides. Name them and describe the properties of one of them.
7. What properties should a superconductor have to form the winding of an electromagnet generating a magnetic field with B = 15 T?
8. Properties of superconductors.
9. Compare type I and type II superconductors. Why do only type II superconductors have practical applications?
10. What properties change (how?) as a result of doping semiconductors?
11. Compare the properties of intrinsic and doped semiconductors.
12. How does size affect the electrical and optical properties of a semiconductor?
13. How does size affect the electrical and optical properties of an insulator?
14. How does size affect the electrical and optical properties of a metal?
15. Optical properties of metals/semiconductors/insulators. 16. Superparamagnetism - what is it and why is it a barrier to miniaturization?
17. Non-magnetic methods of storing information.
18. How does a dielectric interact with an electric field?
19. Ferroelectrics and ferromagnets are characterized by a hysteresis loop. Where does the hysteresis loop come from? Draw an example loop, marking and labeling the characteristic points.

Practical activites within the subject	Not applicable