GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Methods of structural testing of nanomaterials, PG_00063348		
Field of study	Nanotechnology		
Date of commencement of studies	October 2024	Academic year of realisation of subject	2025/2026
Education level	first-cycle studies	Subject group	Obligatory subject group in the field of study 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	2	Language of instruction	Polish
Semester of study	4	ECTS credits	2.0
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 hab. inż. Agnieszka Witkowska	
	Teachers	dr hab. inż. Agnieszka Witkowska prof. dr hab. inż. Tomasz Klimczuk dr hab. inż. Jakub Karczewski	

Lesson types

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: 3155 Metody badań strukturalnych nanomateriałów
https://enauczanie.pg.edu.pl/2025/course/view.php?id=3155

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	2.0	18.0	50

Subject objectives

The aim of the course is to familiarize students with the possibilities offered by modern structural research methods, including a description of the measurement systems used and a presentation of data analysis techniques that enable the determination of structural parameters (at the macro-, micro-, and nanoscale, as well as at the atomic level) of the studied functional materials, including biomaterials.

Learning outcomes

Course outcome	Subject outcome	Method of verification
[K6_W09] Has knowledge of the structure and operation of scientific instruments, measuring and test equipment and in the field of planning and conducting a physical experiment and critical analysis of its results.	Students gain the knowledge of the construction and operation of diffraction, spectroscopic, and imaging devices for studying the micro- and nanostructure of materials. They understand how to plan and conduct appropriate experiments, as well as how to analyze data and interpret the results obtained using these research methods.	[SW1] Assessment of factual knowledge
[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).	The student has systematic knowledge of the physical and chemical fundamentals related to the research techniques discussed during the course and the properties of nanomaterials analyzed using them.	[SW1] Assessment of factual knowledge

<table>
<tr><td>Subject contents</td><td>Course content – lecture
Lecture:

1. Diffraction methods: introduction and diffraction techniques
- X-ray Diffraction
- Neutron Diffraction

2. Spectroscopic methods: introduction and theoretical foundations
- microwave and infrared molecular spectroscopy
- UV-Vis molecular spectroscopy
- Photoelectron Spectroscopy (PES) and Auger Electron Spectroscopy (AES)

3. Nanostructure imaging methods: introduction
- optical microscopy
- electron microscopy (SEM, TEM, STEM)
- scanning probe microscopes (STM, AFM)
- confocal microscopy</td></tr>
<tr><td>Prerequisites and co-requisites</td><td>Knowledge of the basics of physics, modern physics and crystallography</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>Written exam</td><td>51.0%</td><td>100.0%</td></tr>
</table></td></tr>
<tr><td>Recommended reading</td><td><table>
<tr><td>Basic literature</td><td>[1] D. S. Sivia, Elementary Scattering Theory For X-ray and Neutron Users, Oxford University Press (2014)

[2] H. M. Rietveld, A profile refinement method for nuclear and magnetic structures, Journal of Applied Crystallography (1969) vol. 2, 65-71

[3] J.M.Hollas, Modern Spectroscopy, John Wiley & Sons, Ltd. (2004)

[4] W. Zhou, Z. Lin Wang, "Scanning Microscopy for Nanotechnology: Techniques and Applications", Springer (2007)

[5] V. L. Mironov, "Fundamentals of Scanning Probe Microscopy", RAS (2014)</td></tr>
<tr><td>Supplementary literature</td><td>[1] Ch. Kittel, P. McEuen, Introduction to solid state physics, Wiley (2005)

[2] W. Moebs, S.J. Ling, J.S. Sanny, University Physics, OpenStax, Volume 2

[3] W. Moebs, S.J. Ling, J.S. Sanny, University Physics, OpenStax, Volume 3</td></tr>
<tr><td>eResources addresses</td><td></td></tr>
</table></td></tr>
<tr><td>Example issues/ example questions/ tasks being completed</td><td>1. X-ray and neutron diffraction - identify similarities and differences.
2. What is a spectrum? List and describe the parameters that characterize a spectral line.
3. Explain the concepts of transmittance, absorbance, and absorption coefficient. Define the relationships between them.
4. Explain why XPS is a surface-sensitive technique.
5. Electron microscopy - list the types of electron microscopes, compare them, and define their range of applications.
6. Discuss the operating principle and imaging modes of an atomic force microscope.</td></tr>
<tr><td>Practical activites within the subject</td><td>Not applicable</td></tr>
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