GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	, PG_00052077		
Field of study	Nanotechnology		
Date of commencement of studies	October 2020	Academic year of realisation of subject	2021/2022
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	Instytut Nanotechnologii i Inżynierii Materiałowej -> Faculty of Applied Physics and Mathematics		
Name and surname of lecturer (lecturers)	Subject supervisor	dr hab. inż. Agnieszka Witkowska	
	Teachers	dr hab. inż. Agnieszka Witkowska	

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

Adresy na platformie eNauczanie:

Fizyczne metody badań materiałów I - NT1 2022 - Moodle ID: 21149
https://enauczanie.pg.edu.pl/moodle/course/view.php?id=21149

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 present the possibilities of modern measurement techniques, along with a description of appropriate measurement systems, methods of analysis of results leading to the determination of structure parameters (macro-, micro- and nanoscopic, as well as at the atomic level) of the studied materials, determination of the chemical composition and physico-chemical and thermal properties.

Learning outcomes

Course outcome	Subject outcome	Method of verification
K6_U02	Student has an extended theoretical knowledge in the field of research methods and techniques used in nanotechnology and materials engineering. He is able to choose an appropriate experimental method to solve a given research problem.	[SU2] Assessment of ability to analyse information [SU3] Assessment of ability to use knowledge gained from the subject
K6_W07	Student acquires a wide knowledge in the field of methods of analyzing the physical properties of materials and nanomaterials. Learns both the theoretical principles (main phenomena, laws and relations) as well as technical and application aspects of the research methods under discussion.	[SW1] Assessment of factual knowledge
K6_W10	Student is able to analyze the research problem, select a research method and plan a physical experiment in order to solve this problem. Is aware of the limitations related to the use of certain experimental methods.	[SW1] Assessment of factual knowledge

Subject contents	1. Introduction; 2. Diffraction methods - theoretical basis: - X-ray diffraction; - Neutron diffraction; - Electron diffraction. 3. EM radiation sources; 4. Detectors of ionizing radiation; 5. Synchrotron, synchrotron radiation and its application. 6. Spectroscopic methods - introduction and theoretical basis: - Molecular spectroscopy (microwave, IR, Raman, UV-Vis); - Photoelectron spectroscopy (PES) and Auger electron spectroscopy (AES); - X-ray absorption spectroscopy (XAS). 7. Structure imaging methods: - Electron microscopy (SEM, TEM, STEM); - Scaning probe microscopy (STM, AFM); - Confocal microscopy. 6. Thermal analysis (DTA, DSC, TGA). 7. Methods of testing material porosity (mercury porosimetry, gas porosimetry, micro-CT)
Prerequisites and co-requisites	The basics knowledge of physics, crystallography, general chemistry and materials engineering,

Assessment methods and criteria

Subject passing criteria	Passing threshold	Percentage of the final grade
Active participation in lectures	0.0%	15.0%
Writting exam	50.0%	85.0%

Recommended reading

Basic literature	[1] A. Oleś, *Metody doświadczalne fizyki ciała stałego*, WNT (in polish) [2] J.Przedmojski, *Rentgenowskie metody badawcze w Inżynierii Materiałowej*, WNT (in polish) [3a] J. Sadlej, *Spektroskopia molekularna*, WNT, Warszawa (in polish) [3b] Z. Kęcki, *Podstawy spektroskopii molekularnej*, PWN, Warszawa (in polish) [4] A. Kisiel, *Synchrotron jako narzędzie: zastosowanie PS w spektroskopii ciała stałego*, SRNS 5(3) (2006) (in polish)
Supplementary literature	[5] Ch. Kittel, P. McEuen, *Introduction to solid state physics* (9th Ed.), New Jersey: Wiley [6a] W. Moebs, S.J. Ling, J.S. Sanny, University Physics, OpenStax, Volume 2 [6b] W. Moebs, S.J. Ling, J.S. Sanny, University Physics, OpenStax, Volume 3 [7] J.M. Hollas, *Modern Spectroscopy*, John Wiley & Sons, Ltd. [8] P. Willmott, *An Introduction to Synchrotron Radiation: Techniques and Applications*, John Wiley & Sons, Ltd. [9] A. Barbacki (red.), *Mikroskopia elektronowa*, Wyd. Politechniki Poznańskiej (in polish) [10] P. Atkins, J.de Paula, *Chemia fizyczna*, Rozdz.16 S*pektroskopia 1: widma rotacyjne i oscylacyjne*; Rozdz. 17 *Spektroskopia 2: przejścia elektronowe*, PWN (in polish)
eResources addresses	Fizyczne metody badań materiałów I - NT1 2022 - Moodle ID: 21149 https://enauczanie.pg.edu.pl/moodle/course/view.php?id=21149

Example issues/ example questions/ tasks being completed	1. List and briefly characterize detectors of ionizing radiation. 2. Silicon crystallizes in a simple cubic system. A neutron diffraction experiment with a 10-meter detector and angle = 45^{o} reveals that the neutrons reflected from the family of planes (111) have a time of flight of 11200 microseconds. Find the lattice constant of a silicon unit cell? 3. What is a synchrotron and how does it work? Describe the basic properties of synchrotron radiation. 4. What is a spectrum? Give and discuss the parameters that characterize the spectral line. 5. Explain the terms transmittance, absorbance and absorption coefficient. Give the relationship between them. 6. Present the idea of the Raman phenomenon and discuss the shape of the Raman spectrum. 7. Explain why the XPS technique is a "surface sensitive" technique. 8. Electron microscopy - list the types of electron microscopes, compare them and define the scope of applications. 9. Determine what thermal analysis is and what the types are. 10. Discuss the differences between physical and chemical adsorption.
Work placement	Not applicable