GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Physical Methods of Materials Investigation, PG_00039809		
Field of study	Materials Engineering, Materials Engineering, Materials Engineering, Materials Engineering		
Date of commencement of studies	October 2020	Academic year of realisation of subject	2022/2023
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	3	Language of instruction	Polish
Semester of study	5	ECTS credits	2.0
Learning profile	general academic profile	Assessment form	exam
Conducting unit	Department of Solid State Physics -> 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

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	1.0	19.0	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_W06	Student knows possibilities of the modern measuring techniques, student presents measuring possibilities related to diffraction and spectroscopy techniques, structure imaging and thermal properties of materials.	[SW1] Assessment of factual knowledge
K6_K01	The student is aware of the current technological advancement and progression in the development of research and measurement methods, thus he understands the need to constantly improve professional and personal competences. Being aware of their own limited possibilities of accessing and operating specialist equipment, the student knows when to refer to experts and how to plan the tasks performed by himself or others in these circumstances.	[SK2] Assessment of progress of work
K6_W02	On the basis of the acquired knowledge, the student indicates the possibilities of studying the macro- and micro-world, defines the limits of modern cognition and knows how to select research methods due to the type of the tested substance and the analyzed physico-chemical properties.	[SW1] Assessment of factual knowledge

<table>
<tr><td>Subject contents</td><td>1. Introduction - physical methods of material investigation and experiment planning.
2. Diffraction methods - theoretical basis:
- X-ray diffraction;
- Neutron diffraction;
- Electron diffraction.
3. Synchrotron, synchrotron radiation and its application.
4. 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).
5. Structure imaging methods:
- Electron microscopy;
- STM, AFM;
- Confocal microscopy.
6. Thermal analysis (DTA, DSC, TGA).
7. Adsorption methods: physical adsorption vs chemisorption, study of structural heterogeneity and pore size distribution.</td></tr>
<tr><td>Prerequisites and co-requisites</td><td>The basics knowledge of material engineering, physics, crystallography and general chemistry</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>Active participation in lectures</td><td>0.0%</td><td>15.0%</td></tr>
<tr><td>Writting exam</td><td>50.0%</td><td>85.0%</td></tr>
</table></td></tr>
<tr><td>Recommended reading</td><td><table>
<tr><td>Basic literature</td><td>[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)</td></tr>
<tr><td>Supplementary literature</td><td>[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 Spektroskopia 1: widma rotacyjne i oscylacyjne; Rozdz. 17 Spektroskopia 2: przejścia elektronowe, PWN (in polish)</td></tr>
<tr><td>eResources addresses</td><td>Adresy na platformie eNauczanie:
Fizyczne metody badań materiałów I - IM1 2022 - Moodle ID: 22570
https://enauczanie.pg.edu.pl/moodle/course/view.php?id=22570</td></tr>
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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. Describe how the bond length in the molecule can be determined from the microwave (rotational) spectrum (in a rigid rotator approximation). 7. Present the idea of the Raman phenomenon and discuss the shape of the Raman spectrum. 8. What is the origin of color of the transition metals complexes? 9. Explain why the XPS technique is a "surface sensitive" technique. 10. Discuss the differences between physical and chemical adsorption.
Work placement	Not applicable