



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		

Subject contents	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.		
Prerequisites and co-requisites	The basics knowledge of material engineering, physics, crystallography and general chemistry		
Assessment methods and criteria	Subject passing criteria	Passing threshold	Percentage of the final grade
	Active participation in lectures	0.0%	15.0%
	Writing exam	50.0%	85.0%
Recommended reading	Basic literature	[1] A. Oleś, <i>Metody doświadczalne fizyki ciała stałego</i> , WNT (in polish) [2] J.Przedmojski, <i>Rentgenowskie metody badawcze w Inżynierii Materiałowej</i> , WNT (in polish) [3a] J. Sadlej, <i>Spektroskopia molekularna</i> , WNT, Warszawa (in polish) [3b] Z. Kęcki, <i>Podstawy spektroskopii molekularnej</i> , PWN, Warszawa (in polish) [4] A. Kisiel, <i>Synchrotron jako narzędzie: zastosowanie PS w spektroskopii ciała stałego</i> , SRNS 5(3) (2006) (in polish)	
	Supplementary literature	[5] Ch. Kittel, P. McEuen, <i>Introduction to solid state physics</i> (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, <i>Modern Spectroscopy</i> , John Wiley & Sons, Ltd. [8] P. Willmott, <i>An Introduction to Synchrotron Radiation: Techniques and Applications</i> , John Wiley & Sons, Ltd. [9] A. Barbacki (red.), <i>Mikroskopia elektronowa</i> , Wyd. Politechniki Poznańskiej (in polish) [10] P. Atkins, J.de Paula, <i>Chemia fizyczna</i> , Rozdz.16 <i>Spektroskopia 1: widma rotacyjne i oscylacyjne</i> ; Rozdz. 17 <i>Spektroskopia 2: przejścia elektronowe</i> , PWN (in polish)	
	eResources addresses	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	

Example issues/ example questions/ tasks being completed	<ol style="list-style-type: none"> 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° 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