COURSE DESCRIPTION CARD - SYLLABUS

Course name
Synchrotron radiation in solid state spectroscopy [S2FT2>PSwSCS]

Course

Field of study
Technical Physics

Year/Semester
2/3

Area of study (specialization)
–

Profile of study
general academic

Level of study
second-cycle

Course offered in
Polish

Form of study
full-time

Requirements
compulsory

Number of hours

Lecture
15

Laboratory classes
0

Other
0

Tutorials
0

Projects/seminars
0

Number of credit points

1,00

Coordinators

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Lecturers

Prerequisites

Knowledge of physics and chemistry at the bachelor's level. In particular, knowledge about: quantum mechanics (Schrödinger's equation, atomic orbitals, and energy quantization), solid state physics (structure of solids, energy band theory, understanding of crystal structure and its influence on material properties) and the basics of spectroscopy (principles of absorption, emission and scattering of radiation by matter).). In addition, the student understands the need to expand his knowledge of modern measurement techniques and has the ability to obtain additional information from the indicated references.

Course objective

The purpose of the lecture is to introduce students to the fundamentals of synchrotron radiation physics, including its properties, generation methods, and the construction of radiation sources. Moreover, selected solid-state spectroscopy techniques using synchrotron radiation, with particular emphasis on electron spectroscopy techniques will be discussed. The course also aims to familiarize students with the latest scientific developments and potential applications of synchrotron radiation in various fields of life sciences.

Course-related learning outcomes

Knowledge:

1. The student possesses knowledge of the physics of synchrotron radiation. He understands the phenomenon of generating this type of radiation and can identify its most important properties.
2. The student has a detailed knowledge of the construction and principle of operation of synchrotrons.
3. The student understands the fundamentals of the interaction of electromagnetic radiation with matter at the atomic, as well as molecular level (including photoelectric, absorption and emission phenomena).
4. The student has a general knowledge of standard spectroscopic analysis techniques that use synchrotron radiation.

Skills:
1. The student is able to describe the process of generation of a synchrotron radiation.
2. The student knows how to select appropriate spectroscopic research techniques which use synchrotron radiation to analyze specific physical properties of the materials under study.
3. The student can provide a preliminary interpretation of the results of the study of the structure of matter, which were obtained with the use of synchrotron radiation.

Social competences:
1. The student is aware that the dynamic development of measurement techniques using synchrotron radiation requires him on his own to expand his knowledge in this field.
2. The student understands that the unique properties of the synchrotron radiation can result in breakthroughs in disciplines other than physics, which can contribute to the development of innovative technologies relevant to society.

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

In terms of the methods used to verify the achieved learning outcomes, the following grading thresholds are applied: 50.1-60% - satisfactory; 60.1-70% - satisfactory plus; 70.1-80% - good; 80.1-90% - good plus; from 90.1% - very good.
The grade is based on an individual written assignment and/or the assessment of an oral response.

Programme content

1. To learn the physical basis and characteristics of synchrotron radiation.
2. To understand the basics of synchrotron operation and generation of synchrotron radiation.
3. To discuss the types of interaction of electromagnetic radiation with matter.
4.To learn about selected spectroscopic research techniques using synchrotron radiation.
5. To learn about the possibility of using synchrotron radiation in the study of the stru cture of advanced materials.

Course topics

1. Basics of synchrotron radiation
• Mechanism of generation of synchrotron radiation and its characteristics
• History and development of synchrotrons
• Construction and principle of operation of synchrotrons
2. Principles of interaction of radiation with matter
• Absorption and emission of X-rays
• Theoretical basis of electron spectroscopy
3. Photoemission spectroscopy and angle-resolved photoemission spectroscopy
• Photoelectric phenomenon, principle of conservation of angular momentum
• Analysis of XPS spectra: interpretation of electron binding levels,
• ARPES (Angle-Resolved Photoemission Spectroscopy) technique.
4. X-ray Absorption Spectroscopy (XAS).
• Principles of XAS: electron transitions
• Applications in structural and chemical studies
5. Magnetic dichroism spectroscopy and microscopy
• XMCD and XLMD techniques
• PEEM as a tool for XMCD and XLMD studies with spatial resolution.
6. Synchrotron spectroscopic methods in materials research

• Applications of synchrotron radiation in the study of the structure of matter in solid state ph ysics, chemistry, biology and nanotechnology
• Examples of applications from the scientific literature
7. Overview of modern synchrotron centers
• Presentation of the main synchrotron centers in the world
• Examples of experiments performed at synchrotrons
• Presentation of application procedures for measurements at such centers

Teaching methods

Lectures with the use of modern multimedia methods, including, but not limited to: presentations, animations, educational films, and computer simulations. Lectures are interactive, meaning there is an opportunity to ask questions, for discussion, and considerations of current issues.

Bibliography

Basic:
1. B.J. Kowalski and W. Paszkowicz, editors , Promieniowanie synchrotronowe w fizyce i chemii ciała stałego: wybrane zagadnienia, Adam Mickiewicz University Press 2024.
2. S. Mobilio, F. Boscherini, and C. Meneghini, editors , Synchrotron radiation, Berlin, Heidelberg 2015.

Additional:
1. S. Hüfner, Photoelectron spectroscopy, Berlin, Heidelberg 2003.

Breakdown of average student's workload

	Hours	ECTS
Total workload	25	1,00
Classes requiring direct contact with the teacher	15	0,50
Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation)	10	0,50