COURSE DESCRIPTION CARD - SYLLABUS

Course name
Advanced methods of research the structure and properties of materials [S2IMat1>ZMBSiWM]

Course

Field of study
Materials Engineering

Year/Semester
1/1

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
15

Other (e.g. online)
0

Tutorials
0

Projects/seminars
0

Number of credit points

3,00

Coordinators

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Lecturers

Prerequisites

Students should have a basic knowledge of materials science and physics. They should also have the ability to think logically and to obtain information from various sources as well as be ready to cooperate within a team. In addition, they should understand the need to learn and acquire new knowledge

Course objective

Providing to students information about advanced methods of studying the structure and properties of materials.

Course-related learning outcomes

Knowledge:
1) students have knowledge of scanning probe microscopy - [k_w01, k_w03, k_w10].
2) students have knowledge of the methods of the materials surface and structure characterization using a beam of electrons, neutrons, photons and ions - [k_w01, k_w03, k_w10].
3) students have knowledge of the methods mechanical properties characterization with the use of nanoindentation - [k_w03, k_w10].

Skills:
1) students can apply advanced microscopic methods for materials characterization - [k_u01, k_u03, k_u08, k_u09, k_u10, k_u19].
2) students are able to characterize the properties of materials determined with the use of advanced methods of surface characterization - [k_u01, k_u03, k_u08, k_u09, k_u10, k_u19].
3) students are able to plan in the research process the use of advanced methods of the materials surface characterization - [k_u01, k_u03, k_u08, k_u09, k_u10, k_u19].

Social competences:
1) students can work together in a team - [k_k03].
2) students are aware of the role of checking the quality of materials in the modern economy and for society - [k_k02].

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

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1) Knowledge acquired during the lectures is verified at the final test lasting 45 minutes. There are two credit deadlines in the semester to which every student is entitled. In addition, students can improve their grades in additional session. Final test consists of 3-5 questions. The pass threshold is 50% of the points.
2) Skills acquired as part of the laboratory classes are checked on an ongoing basis during each class in the form of an oral or written answer to the questions asked and assessed on the basis of reports from each laboratory exercise. Each laboratory exercise requires a positive evaluation. At the end of the semester, after completing compulsory exercises, there is a possibility to pass a corrective exam of selected exercises.

Programme content

Lecture:
1. Theoretical background of SPM microscopy - construction and operation modes of the microscopes, STM, AFM, LFM, MFM, NSOM, EFM, FMM, SCM methods.
2. Applications of SPM in the areas of technology, medicine and biotechnology, surface modification - lithography and building of nanostructures.
3. 3DAP atomic probe tomography - principle of operation and application.
4. Interaction of particles with the surface of solids; methods of surface characterization based on its bombardment with a beam of electrons, ions and photons - principle of operation, application.
5. Methods of nanoindentation - structure and principle of operation, methods of mechanical properties characterization by making an indents, scratching or hitting the surface with an indenter, examples of applications.
6. Method for determining the size of nanoparticles based on the phenomenon of light scattering.
7. High-resolution methods of chemical analysis.
8. Computed microtomography in technical applications.
Laboratory classes:
1. Application of AFM in metallographic samples examination.
2. Computer analysis of images taken from AFM, STM and MFM microscopes.
3. Hardness and critical stress intensity factor measurements using a computer controlled hardness tester.
4. Analysis of the structure and phase composition of materials using the XRD crystallographic database.
5. Hydrogen absorption/desorption analysis and electrode loading/discharging.
6. Examples of SEM / EDS applications in industry.
7. Hardness measurements at low loads.

Teaching methods

1) Lecture: multimedia presentation, illustrated with examples on the board.
2) Laboratory exercises: performance of tasks given by the teacher - practical exercises.

Bibliography

Basic

1. A. Oleś, Metody doświadczalne fizyki ciała stałego, WNT, Warszawa 1998
2. A. Szaynok, S. Kuźmiński, Podstawy fizyki powierzchni półprzewodników, WNT, Warszawa 2000
3. M. Subotowicz - Metody doświadczalne w fizyce ciała stałego, UMCS, Lublin 1976
4. R.W. Kelsall, I.W. Hamley, M. Georghegan, Nanotechnologie, PWN, Warszawa 2008
Additional
1. J. Jakubowicz, Obróbka powierzchniowa biomateriałów tytanowych, WPP, Poznań 2019
2. C. Kittel, Wstęp do fizyki ciała stałego
3. http://www.tmmicro.com/tech/index.htm
4. http://www.tmmicro.com/links/spmlinks.htm
5. M. Jurczyk, Nanomateriały, wybrane zagadnienia, WPP 2001

Breakdown of average student's workload

	Hours	ECTS
Total workload	50	3,00
Classes requiring direct contact with the teacher	30	2,00
Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation)	20	1,00