POZNAN UNIVERSITY OF TECHNOLOGY

EUROPEAN CREDIT TRANSFER AND ACCUMULATION SYSTEM (ECTS)

COURSE DESCRIPTION CARD - SYLLABUS

Course name

Nanotechnology and functional materials [S1FT2>NiMF]

Course

Field of study

Technical Physics

Year/Semester

3/6

Area of study (specialization)

–

Profile of study

general academic

Level of study

first-cycle

Course offered in

Polish

Form of study

full-time

Requirements

compulsory

Number of hours

Lecture

30

Laboratory classes

0

Other

0

Tutorials

0

Projects/seminars

0

Number of credit points

2,00

Coordinators

dr hab. Tomasz Runka prof. PP
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Lecturers

Prerequisites

General knowledge of physics, mathematics at the level achieved after five semestrs of study in the field of technical physics. The ability to solve simple physical problems based on the acquired knowledge, the ability to obtain information from indicated sources. Understanding the necessity of self-training.

Course objective

1. To acquaint students with the characterization methods of functional materials, technology of their productuion and applications.

Course-related learning outcomes

Knowledge:

The student:

1. has knowledge related to selected issues of analysis of the properties of materials and processes on the nanoscale
2. knows the current state of advancement and is familiar with the latest development trends in the field of nanotechnology, optoelectronics, bioelectronics, quantum engineering and computer simulations of physical processes

Skills:
The student:
1. has the ability to self-educate, is able to obtain information from literature, databases and other sources, interpret it and draw conclusions, formulate and justify opinions
2. is able to select materials with appropriate physicochemical and structural properties for laboratory and engineering applications

Social competences:
The student:
1. understands the need and knows the possibilities of continuous learning - improving professional, personal and social competences; is aware of the need to seek the opinion of experts when solving engineering tasks beyond their own competence

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Method of assessment Assessment criteria
wrtitten exam: 3: 50.1%-70.0%
4: 70.1%-90.0%
5: from 90.1%

Programme content

The course focuses on advanced techniques for materials analysis, including the use of ultrasonic waves in medical and industrial applications. It also covers thermographic methods in material diagnostics and modern spectroscopic techniques for characterizing crystalline, layered, carbon-based, and organic materials. The curriculum addresses the fabrication and characterization of monolayers and functional layers, as well as the principles of operation of optical fibers and photonic crystals. Nonlinear material properties and "up-conversion" processes are also discussed. Additionally, the course includes probe microscopy, covering the basics and operational modes of AFM and STM microscopes and their various design variants.

Course topics

1. The use of ultrasonic waves for material analysis and in medical applications.
2. The use of thermal imaging methods in materials testing.
3. Modern spectroscopic methods and techniques used for the characterization and research of physical processes occurring in crystalline, layered, carbon and organic materials.
4. Methods of production and characterization of monolayers at the interface, swirled and cast layers with the use of functional materials.
5. Construction and operation of optical fibers and photonic crystals. Properties of nonlinear materials and up-conversion processes.
6. Scanning probe microscopy: fundamentals of operation and working modes of AFM and STM microscopes and their design variants.

Teaching methods

Conversational lecture: multimedia presentation, animations and simulation demonstrations, examples given on the blackboard, solving research problems.

Bibliography

Basic:
1. Materials from lectures (in Polish)
2. E. Dutkiewicz, Fizykochemia powierzchni, WNT, Warszawa, 1998.
3. A. Ulman, An introduction to ultrathin organic films, Academic Press, Boston 1991.
4. A. Śliwiński „Ultradźwięki i ich zastosowania”, WNT, Warszawa 2001.
5. B. Więcek, G. De Mey „Termowizja w podczerwieni, podstawy i zastosowania”, Wydawnictwo PAK, Warszawa 2011.
6. B. H. Stuart, Infrared Spectroscopy: Fundamentals and Applications, John Wiley & Sons, Ltd, 2004.

7. G. Turrell, J. Corset, Raman microscopy - Developments and Applications, Elsevier, 1996.
8. E. Meyer, H.J. Hug,R. Bennewitz, Scanning Probe Microscopy - The Lab on a Tip, Springer-Verlag, Berlin, 2003.
9. Roland Wiesendanger, Scanning Probe Microscopy and Spectroscopy: Methods and Applications, Cambridge University Press (2010).

Additional:
1. K. Olszewska, I. Jastrzębska, A. Łapiński, M. Górecki, R. Santillan, N. Farfan, T. Runka, Steroidal Molecular Rotors with 1,4-Diethynylphenylene Rotators: Experimental and Theoretical Investigations Toward Seeking Efficient Properties, The Journal of Physical Chemistry B 124 (2020) 9625-9635.
2. D. Kasprowicz, M. G. Brik, A. Majchrowski, E. Michalski, P. Głuchowski, Spectroscopic properties of KGd(WO4)2 single crystals doped with Er3+, Ho3+, Tm3+ and Yb3+ ions: Luminescence and micro-Raman investigations, J. Alloys Comp., 577 (2013) 687 - 692.
3. K. Jaroszewski, P. Gluchowski, M. G. Brik, T. Pedzinski, A. Majchrowski, M. Chrunik, E. Michalski, D. Kasprowicz, Bifunctional Bi2ZnOB2O6:Nd3+ single crystal for near infrared lasers: luminescencje and μ-Raman investigations, Cryst. Growth Des., 17 (2017) 3656−3664.
4. W. Dewo, V. Gorbenko, A. Markovskyi, Y. Zorenko, T. Runka, Photoconversion, Luminescence and vibrational properties of Mn and Mn, Ce doped Tb3Al5O12 garnet single crystalline films, J. Lumin. 254 (2023) 119481.
5. E. Piosik, A. Zaryczniak, K. Mylkie, M. Ziegler-Borowska, Probing of Interactions of Magnetite Nanoparticles Coated with Native and Aminated Starch with a DPPC Model Membrane, Int. J. Mol. Sci. 22 (2021)5939.
6. Skrypt pt. „Mikroskopia elektronowa” pod red. A. Barbackiego, rozdz. 9, R. Czajka. „Mikroskopia sond skanujących”, Wydawnictwo Politechniki Poznańskiej, Wydanie III, 2007.

Breakdown of average student's workload

	Hours	ECTS
Total workload	50	2,00
Classes requiring direct contact with the teacher	32	1,50
Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation)	18	0,50