COURSE DESCRIPTION CARD - SYLLABUS

Course name
Materials for Advanced Technology

Course

Field of study	Year/Semester
Technical Physics	3/5
Area of study (specialization)	Profile of study
	general academic
Level of study	Course offered in
First-cycle studies	polish
Form of study	Requirements
full-time	compulsory

Number of hours

Lecture	Laboratory classes	Other (e.g. online)
30	15	
Tutorials	Projects/seminars	
	15	

Number of credit points

5

Lecturers

Responsible for the course/lecturer:
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Responsible for the course/lecturer:
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Prerequisites

Knowledge of experimental physics and basic specialist knowledge of nanotechnology and functional materials. The ability to solve simple physical problems based on the possessed knowledge, the ability to obtain information from the indicated sources. Social competences: understanding the need to expand one's competences, readiness to cooperate as part of a team.

Course objective

1. Provide students with the knowledge of modern functional materials for molecular electronics, optoelectronics, sensors, photomedicine; familiarization with the properties of zero- two- and three-

dimensional structures in the nanometer scale, thin-film organic structures, metamaterials, fullerenes, carbon nanotubes, graphene, photonic crystals and materials for nonlinear optics.

2. Developing the ability to select modern materials for applications in electronics and optoelectronics. Ability to search for applications and develop technologies for producing innovative devices.

3. Shaping students' teamwork skills.

Course-related learning outcomes

Knowledge

As a result of the conducted classes, the student:

1. Has detailed knowledge of selected functional materials and requirements related to the properties of these materials used in many braches of optic technology - [K1_W012, K1_W13]

2. has extended knowledge of physical phenomena in the field of classical experimental physics [K1_W12]

3. knows the state of knowledge and is familiar with the latest trends in technology and materials science [K1_W12, K1_W13]

Skills

As a result of the course, the student should demonstrate skills in the following areas (the student will be able to):

1. can prepare a well-documented study on issues related to new functional materials and their applications in optoelectronics - [K1_U04]

2. can choose materials with appropriate physicochemical and design properties for laboratory and engineering applications for creating new electronic components - [K1_U18]

3. can, on the basis of literature, independently make a preliminary analysis of the results of laboratory measurements and draw conclusions [K1_U02]

4. is able to independently and efficiently present an oral presentation in Polish with well-documented and interpreted measurement results [K1_U04]

5. can choose materials with appropriate physicochemical and design properties for laboratory and engineering applications for creating new electronic components - [K_U14]

6. can explain the essence of measurement and measurement method on the basis of the indicated literature; shows particular commitment and independence at work and diligence in the development of results, looks for solutions in non-standard situations [K_U15].

Social competences

As a result of the course, the student will acquire the competences listed below. Completing the course means that:

1. understands the need and knows the possibilities of continuous training, improving professional, personal and social competences - [K1_K03].

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

final written examination/oral examination at the end of the semester

Programme content

Molecular monolayers at the interface. Phase boundary, surface excess, surface tension, surface pressure. Water-soluble and insoluble amphiphilic molecules; Gibbs and Langmuir (L) and Langmuir-Blodgett (LB) monolayers, SAM; properties of L and LB monolayers made of liquid crystals and fluorescent dyes.

Electromagnetic properties of metamaterials. Veselago hypothesis and phenomena related to the propagation of electromagnetic waves in metamaterials. Pendry materials with negative electric and magnetic permeability (networks formed by rectilinear conductors and ring resonators with a gap). Metamaterial prisms for the microwave range. Flat metamaterial structures for the terahertz range.

Characterization of crystalline materials with a perovskite structure by Raman spectroscopy. Crystallization process using the Czochralski method. Crystallographic structure of perovskite crystals. Elements of the representation theory. Positional symmetry analysis for selected spatial groups of perovskite crystals. Raman spectra of two- and three-component crystals SAT: LA and SAT: LA: CAT. Relationships between the change of spectral parameters of the bands registered in the Raman spectra of SAT: LA / SAT: LA: CAT crystals and the perovskite cell base lattice constant and the order parameters (long and short range ordering). Characterization of the orthorhombic Pbnm structure of La1-xSrxGa1-yMnyO3 crystals. Changes in the crystal structure of La1-xSrxGa1-yMnyO3 crystals in the phase transition. Fuel cells - applications. The principle of operation of a SOFC fuel cell. Perovskite crystals - applications in fuel cells.

Metal phthalocyanines and carbon materials. Types of polymorphic forms of thin layers of metallophthalocyanines deposited on solid substrates and their change with temperature. Change in energy gap and trap level with the thickness of the metal phthalocyanine layer. Absorption spectra of metallophthalocyanines and their characteristic absorption bands. Polymorphic forms of metallophthalocyanines characterized by Raman light scattering spectra. Types of carbon nanotubes, folding of graphene layers, chiral vector. Methods of obtaining micro and nanodiamond thin-film structures. Influence of gas concentration on the behavior of the diamond structure (sp3 / sp2 hybridization) and characterization of structures by Raman light scattering.

Teaching methods

Lecture supported by audiovisual means

Laboratory exercises: practical exercises, conducting experiments, modeling, discussion, team work.

Project: individual student project work, discussion.

Bibliography

Basic

1. G.T. Barnes, I.R. Gentle, Interfacial Science: an introduction, Oxford Univ. Press, second edit. 2011

2. S. A. Ramakrishna, T. M. Grzegorczyk, Physics and Applications of Negative Refractive Index Materials, CRC Press Taylor & Francis, Boca Raton, 2009.

3. C. Kittel, Intoroduction to Solid State Physics, John Wiley& Sons, Cambridge, 2014

Additional

Fundamentals

Breakdown of average student's workload

	Hours	ECTS
Total workload	90	5
Classes requiring direct contact with the teacher	60	3
Student's own work (literature studies, preparation for laboratory classes/tutorials, preparation for tests/exam, project preparation) [1]	30	2

[1] delete or add other activities as appropriate