



Nanoscale Functional Materials

Course description sheet

Basic information

Field of study AGH UST International Courses Major All Organisational unit AGH University Database of Electives Study level University database of electives Form of study Full-time studies Profile General academic		Didactic cycle 2026/2027 Course code UBPOJOS.A200000.06551.26 Lecture languages English Mandatoriness Elective Block General Modules Course related to scientific research Yes USOS code 693-INT-xS-116	
Course coordinator	Angelika Kmita		
Lecturer	Angelika Kmita, Dorota Lachowicz, Joanna Stępień, Andrii Naumov, Vitaliy Bilovol, Katarzyna Berent		
Period Summer semester	Method of verification of the learning outcomes Exam Activities and hours Lectures: 15 Workshop classes: 15		Number of ECTS credits 4

Goals

C1	Students acquire knowledge on the functional properties of nanoscale materials as well as on techniques of their production and characterization.
C2	Students acquire experience in preparation and execution of the production of nanoscale materials - films, composites, nanoparticles and/or nanostructures.
C3	Students familiarize with methods of characterization and modeling of properties of nanoscale materials.
C4	Students' capability to teamwork is developed during workshop classes.

Course's learning outcomes

Code	Outcomes in terms of	Learning outcomes prescribed to a field of study	Methods of verification
Knowledge - Student knows and understands:			
W1	Students acquire knowledge on the functional properties of nanoscale materials as well as on selected techniques of their production and characterization.		Activity during classes, Participation in a discussion, Examination
Skills - Student can:			
U1	Students shall acquire experience in preparation and physio-chemical characterization of nanoscale functional materials - films, composites, nanoparticles and/or nanostructures.		Report, Involvement in teamwork, Preparation and conduct of scientific research
Social competences - Student is ready to:			
K1	The ability to teamwork is developed during workshop, especially with respect to coordination of the team, knowledge exchange and reporting.		Activity during classes, Participation in a discussion
K2	Active participation in the discussions during lectures and workshop classes shall develop skills related to effective exchange of ideas and learning via discussion.		Activity during classes, Participation in a discussion, Report, Involvement in teamwork, Preparation and conduct of scientific research

Program content ensuring the achievement of the learning outcomes prescribed to the module

A course shall familiarize students with functional properties of nanoscale materials, including selected techniques of their fabrication and physio-chemical characterization.

Student workload

Activity form	Average amount of hours* needed to complete each activity form
Lectures	15

Workshop classes	15
Preparation for classes	15
Participation in classes / practical placement	30
Preparation of project, presentation, essay, report	15
Realization of independently performed tasks	15
Examination or final test/colloquium	2
Contact hours	3
Student workload	Hours 110
Workload involving teacher	Hours 30

* hour means 45 minutes

Program content

No.	Program content	Course's learning outcomes	Activities
1.	The course is focused on the functional properties of materials and their modification in the nanoscale materials. Introduction to electronic, sensing, magnetic, and mechanic properties of inorganic and organic materials (e.g. alloys, ceramics, crystals, composites) is followed by description of the state-of-the-art methods of synthesis of nanomaterials (quantum dots, nanoparticles, nanowires, nanoplates, etc.) and/or nanostructurization (focussed beam and UV lithography, nanoprinting, etc.). A review of experimental techniques used for the characterization of nanoscale materials and their functional properties is given as well.	W1, K2	Lectures
2.	During workshop classes students (working in small groups) participate in the preparation of selected nanoscale functional materials (eg. films, composites, nanoparticles, magnetic aerogels) and their analysis by means of eg. microscopy, spectroscopy, thermogravimetry, PPMS etc. All activities will be performed under the supervision of scientists in charge of selected laboratories at ACMiN AGH and/or at collaborating units (e.g. National Centre of Synchrotron Radiation SOLARIS in Krakow).	W1, U1, K1, K2	Workshop classes

Extended information/Additional elements

Teaching methods and techniques :

Lectures, Discussion, Case study, Group work

Activities	Methods of verification	Credit conditions
Lectures	Activity during classes, Participation in a discussion, Examination	
Workshop	Activity during classes, Participation in a discussion, Report, Involvement in teamwork, Preparation and conduct of scientific research	

Method of determining the final grade

The final grade is calculated as weighted average:

- oral exam (35%),
- report from workshop classes (35%),
- preparation to and activity/discussion during workshop classes (30%).

Prerequisites and additional requirements

Basic course in solid state physics and/or materials chemistry.

Rules of participation in given classes, indicating whether student presence at the lecture is obligatory

Attendance to 80% of lectures is expected. Participation in workshop classes is obligatory.

Literature

Obligatory

1. Ashutosh Tiwari, Lokman Uzun (Eds.), Advanced Functional Materials, Wiley 2015.
2. Mark J. Schulz, Ajit D. Kelkar, Mannur J. Sundaresan (Eds.), Nanoengineering of Structural, Functional and Smart Materials, CRC Press 2006.

Optional

1. Ashutosh Tiwari, Yogendra Kumar Mishra, Hisatoshi Kobayashi, Anthony P. F. Turner (Eds.), Intelligent Nanomaterials, Wiley 2016.
2. <https://onlinelibrary.wiley.com/doi/full/10.1002/cphc.201200444>

Scientific research and publications

Publications

1. Angelika Kmita, Jan Żukrowski, Juliusz Kuciakowski et al.: Effect of thermal treatment at inert atmosphere on structural and magnetic properties of non-stoichiometric zinc ferrite nanoparticles, Metallurgical and Materials Transactions A 52, 1632 (2021), <https://doi.org/10.1007/s11661-021-06154-3>.
2. Shengjie Peng, Peng Li: Nanomaterials and Nanotechnology: Basic, Preparation and Applications. Springer, 2024 (Book)
3. Juliusz Kuciakowski, Angelika Kmita, Dorota Lachowicz et al.: Selective magnetometry of superparamagnetic iron oxide nanoparticles in liquids Nanoscale, 2020, 12, 16420–16426, <https://doi.org/10.1039/d0nr02866e>
4. Tabrej Khan et al., Nanomaterials: The Building Blocks of Modern Technology: Synthesis, Properties and Applications, Springer, 2023 (Book)
5. Dorota Lachowicz, Angelika Kmita, Roma Wirecka et al.: Aerogels based on cationically modified chitosan and poly(vinyl alcohol) for efficient capturing of viruses” Carbohydrate Polymers 312 (2023) 120756. <https://doi.org/10.1016/j.carbpol.2023.120756>
6. Angelika Kmita, Dorota Lachowicz, Jan Żukrowski et al.: One-Step Synthesis of Long Term Stable Superparamagnetic Colloid of Zinc Ferrite Nanorods in Water” Materials 12 (2019) 1048, <https://doi.org/10.3390/ma12071048>