Nanoscale Functional Materials

Course description sheet

Basic information

Field of study AGH UST International Courses **Major** All **Organisational unit** Generic subjects **Study level** any level **Form of study** Full-time studies **Profile** General academic	**Didactic cycle** 2023/2024 **Course code** POGJOS.A200000O.4191a8bab9103ac91300e51568f4c27f.23 **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, Marcin Sikora, Aleksandra Szkudlarek, Dorota Lachowicz, Sylwia Klejna, Vitaliy Bilovol

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 (quantuum dots, nanoparticles, nanowires, nanoplates, etc.) and/or nanostructurizarion (focussed beam and UV litography, 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, nanosctuctures) and their analysis by means of microscopy, spectroscopy, thermogravimetry, numerical simulations, etc. All the activities will be performed under supervision of scientists in charge of selected laboratories at ACMiN AGH	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 chamistry.

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

Attendence 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. K.E. Hnida, A. Żywczak, M. Sikora, M. Marciszko, M. Przybylski, Room-Temperature Ferromagnetism in InSb-Mn Nanowires. Nano Lett. 19, 7144 (2019), https://doi.org/10.1021/acs.nanolett.9b02690.
2. A. Szkudlarek, K.E. Hnida-Gut, K. Kollbek, M. Marzec, K. Pitala, M. Sikora, Cobalt-platinum nanomotors for local gas generation. Nanotechnology 31, 07LT01 (2020), https://doi.org/10.1088/1361-6528/ab53bd.
3. Angelika Kmita, Jan Żukrowski, Juliusz Kuciakowski, Marianna Marciszko-Wiąckowska, Antoni Żywczak, Dorota Lachowicz, Marta Gajewska and Marcin Sikora, 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.
4. Juliusz Kuciakowski, Joanna Stępień, Jan Żukrowski, Dorota Lachowicz, Antoni Żywczak, Marta Gajewska, Marek Przybylski, Simone Pollastri, Luca Olivi, Marcin Sikora, and Angelika Kmita: Thermal Decomposition Pathways of ZnxFe3–xO4 Nanoparticles in Different Atmospheres. ACS Ind. Eng. Chem. Res. 2022, 61, 34, 12532–12544.