UNIWERSYTET IM. ADAMA MICKIEWICZA W POZNANIU

Down- and up-conversion in nanomaterials

Educational subject description sheet

Basic information

Study programme
Fizyka (Physics of Advanced Materials for Energy Processing)

Speciality
-

Organizational unit
Faculty of Physics and Astronomy

Study level
Second-cycle programme

Study form
Full-time

Education profile
General academic

Didactic cycle
2024/25

Subject code
04FENS.21S.03238.24

Lecture languages
English

Course type
Elective

Block
specialty subjects

Subject coordinator	Tomasz Grzyb
Lecturer	Tomasz Grzyb

Period	**Activities and hours**	**Number of ECTS points**
Semester 1	• Lecture: 30, Graded credit	3

Goals

Code	Goal
C1	Introduction to spectroscopic properties of lanthanide ions and their f-f electronic transitions
C2	Description of down- and up-conversion processes, introduction to emission mechanisms
C3	Presentation of nanomaterials synthesis methods, with emphasis on designing the composition and structure
C4	Presentation of luminescence enhancements methods - particularly up-conversion in core/shell systems
C5	Demonstration of applications in biomedicine and energy conversion

Subject learning outcomes

Code	Outcomes in terms of	Learning outcomes	Examination methods
Knowledge – Student:			
W1	Know synthesis and functionalization methods of advanced nanostructures	FEN_K2_W01, FEN_K2_W02, FEN_K2_W04, FEN_K2_W05	Oral colloquium, Multimedia presentation
W2	Have a knowledge about spectroscopic properties of lanthanide ions	FEN_K2_W01, FEN_K2_W02, FEN_K2_W03, FEN_K2_W04, FEN_K2_W05	Oral colloquium, Multimedia presentation
W3	Understand the mechanisms responsible for the luminescence in lanthanide-doped nanomaterials	FEN_K2_W01, FEN_K2_W02, FEN_K2_W03, FEN_K2_W04, FEN_K2_W05	Oral colloquium, Multimedia presentation
W4	Know techniques necessary for characterization of nanomaterials	FEN_K2_W01, FEN_K2_W02, FEN_K2_W03, FEN_K2_W04, FEN_K2_W05	Oral colloquium, Multimedia presentation
W5	Know the necessary properties of nanomaterials required for applications in biomedicine, lighting and energy conversion	FEN_K2_W01, FEN_K2_W04, FEN_K2_W05	Oral colloquium, Multimedia presentation
Skills – Student:			
U1	is able to design materials containing lanthanide ions for energy conversion purposes	FEN_K2_U01, FEN_K2_U02, FEN_K2_U03, FEN_K2_U04, FEN_K2_U05	Oral colloquium, Multimedia presentation
U2	knows which techniques and why should be used for the analysis of photophysical properties of luminescent materials	FEN_K2_U01, FEN_K2_U02, FEN_K2_U03, FEN_K2_U04, FEN_K2_U05	Oral colloquium, Multimedia presentation
U3	will be able to predict the factors affecting the quality of the conversion of radiation into energy	FEN_K2_U01, FEN_K2_U02, FEN_K2_U03, FEN_K2_U04, FEN_K2_U05	Oral colloquium, Multimedia presentation
U4	can use literature sources	FEN_K2_U02, FEN_K2_U04, FEN_K2_U05	Oral colloquium, Multimedia presentation
Social competences – Student:			
K1	is aware of the importance of rare earth elements in science, modern technologies and energy conversion applications	FEN_K2_K01, FEN_K2_K02, FEN_K2_K03, FEN_K2_K04	Oral colloquium, Multimedia presentation
K2	can use the literature to gain current knowledge on a given topic	FEN_K2_K01, FEN_K2_K02, FEN_K2_K03	Oral colloquium, Multimedia presentation

Code	Outcomes in terms of	Learning outcomes	Examination methods
K3	has the ability to work in a team, discuss research problems and clearly present their results and conclusions	FEN_K2_K01, FEN_K2_K02, FEN_K2_K03	Oral colloquium, Multimedia presentation

Study content

No.	Course content	Subject learning outcomes	Activities
1.	Basics of lanthanides photo-physical properties	W1, W2, U1, U2, U3, U4, K1, K2, K3	Lecture
2.	Mechanisms of luminescence in lanthanide-doped nanomaterials	W1, W2, W3, U1, U2, U3, U4, K1, K2, K3	Lecture
3.	Down-conversion and down-shifting in nanomaterials containing lanthanide ions	W2, W3, U1, U2, U3, U4, K1, K2, K3	Lecture
4.	Up-conversion of nanomaterials containing lanthanide ions	W2, W3, U1, U2, U3, U4, K1, K2, K3	Lecture
5.	“Wet” chemical synthesis of lanthanide-doped nanomaterials: thermolysis and hydro(solvo)thermal strategies	W1, W3, W4, U1, U2, U3, U4, K1, K2, K3	Lecture
6.	Enhancement of emission properties of nanomaterials: core/shell nanoparticles	W1, W3, W4, U1, U2, U3, U4, K1, K2, K3	Lecture
7.	Functionalization and surface modification of nanoparticles	W1, W3, W4, U1, U2, U3, U4, K1, K2, K3	Lecture
8.	Spectroscopic and structural characterisation techniques of lanthanide-doped nanomaterials	W2, W3, W4, U1, U2, U3, U4, K1, K2, K3	Lecture
9.	Upconversion nanoparticles for biomedical applications	W5, U1, U2, U3, U4, K1, K2, K3	Lecture
10.	Upconversion nanoparticles for photovoltaic cells	W5, U1, U2, U3, U4, K1, K2, K3	Lecture

Additional information

Activities	Teaching and learning methods and activities
Lecture	Lecture with a multimedia presentation of selected issues, Conversation lecture, Case study

Activities	Credit conditions
Lecture	Presentation discussing chosen subject. Oral colloquium. The final grade wil be based on he quality of the presentation (maximum 3 points) and quality of answered questions (maximum 2 points). Grading scale with percentage distribution applied: - very good (very good; 5.0): achieving the assumed learning outcomes by the student at the minimum level of 95%, - good plus (+db; 4.5): achieving the assumed learning outcomes by the student in the range of 85.0% - 94.9%, - good (db; 4.0): achieving the assumed learning outcomes by the student in the range of 75% - 84.9%, - sufficient plus (+dst; 3.5) achieving the assumed learning outcomes by the student in the range of 65% - 74.9%, - satisfactory (dst; 3.0): achieving the assumed learning outcomes by the student in the range of 55% - 64.9%, - unsatisfactory (ndst; 2.0): the student fails to achieve the assumed learning outcomes, the result is below 55%

Literature

Obligatory

1. S. Cotton, “Lanthanide and Actinide Chemistry”, Wiley, 2006.
2. O.S. Wolfbeis, “Springer Series on Fluorescence – Lanthanide Luminescence”, Springer, 2011

Optional

1. F. Zhang, “Photon Upconversion Nanomaterials”, Springer, 2015.
2. C. Altavilla, “Upconverting Nanomaterials: Perspectives, synthesis and Applications”, CRC Press 2017

Calculation of ECTS points

Activities	Activity hours*
Lecture	30
Preparation for classes	10
Reading the indicated literature	15
Preparation of a multimedia presentation	20
Student workload	**Hours** 75
Number of ECTS points	**ECTS** 3

* academic hour = 45 minutes

Efekty uczenia się dla kierunku

Kod	Treść
FEN_K2_K01	The graduate is ready to critically evaluate own knowledge and received content
FEN_K2_K02	The graduate is ready to recognize the importance of knowledge in solving cognitive and practical problems and seeking expert opinion (also from other scientific disciplines) to overcome difficulties during independent problem solving
FEN_K2_K03	The graduate is ready to fulfill social obligations, inspire and organize activities for the benefit of the social environment and initiate activities in the public interest
FEN_K2_K04	The graduate is ready to think and act in an entrepreneurial manner
FEN_K2_U01	The graduate can use their knowledge to formulate and solve complex and unusual problems in the field of physical sciences; select and apply appropriate methods and tools necessary to solve a given problem (including advanced IT techniques), as well as adapt existing methods and tools or develop completely new ones
FEN_K2_U02	The graduate can find the necessary information in the professional literature, databases and other sources, in particular in scientific journals basic to physics, and perform critical analysis, synthesis and creative interpretation of the collected information
FEN_K2_U03	The graduate can formulate and test hypotheses related to simple research problems in physics (plan and perform observations, experiments, theoretical calculations or computer simulations and critically evaluate and discuss the results obtained)
FEN_K2_U04	The graduate can prepare, for various audiences, oral presentations and written studies presenting specialized topics in the field of physical sciences in a communicative way, as well as debate on such topics
FEN_K2_U05	The graduate can use English in accordance with the requirements set out for level B2+ of the Common European Framework of Reference for Languages, as well as specialist English terminology in the field of physical sciences
FEN_K2_W01	The graduate knows and understands in-depth selected facts, phenomena, concepts and theories specific to physics and complex relationships between them (constituting advanced general knowledge in the field of physical sciences and representing both key and other selected issues in the field of advanced detailed knowledge in this discipline)
FEN_K2_W02	The graduate knows and understands in-depth selected research methods and tools as well as mathematical models used in physics
FEN_K2_W03	The graduate knows and understands in-depth selected computational methods and information technology tools and techniques used to solve complex problems in physics
FEN_K2_W04	The graduate knows and understands main development trends in the discipline of physical sciences
FEN_K2_W05	The graduate knows and understands the role of physical sciences in the context of fundamental dilemmas and challenges of modern civilization