# Functional nanomaterials and photocatalysis

Educational subject description sheet

## Basic information

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| **Study programme**<br>Fizyka (Physics of Advanced Materials for Energy Processing)<br>**Speciality**<br>-<br>**Organizational unit**<br>Faculty of Physics and Astronomy<br>**Study level**<br>Second-cycle programme<br>**Study form**<br>Full-time<br>**Education profile**<br>General academic | **Didactic cycle**<br>2024/25<br>**Subject code**<br>04FENS.21S.03239.24<br>**Lecture languages**<br>English<br>**Course type**<br>Elective<br>**Block**<br>specialty subjects |

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| **Subject coordinator** | Igor Iatsunskyi |
| **Lecturer** | Igor Iatsunskyi |

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

## Goals

| Code | Goal |
|---|---|
| C1 | The course will be devoted to the main principles of photocatalysis and the photocatalytic materials. The mechanism and kinetic analysis of photocatalytic reactions; evaluation methods of photocatalytic activity; typical fabrication methods of common photocatalysts and the factors for improving photocatalytic activity will be studied. Examples of various practical applications of the photocatalysis and the photocatalysts will be presented. |

## Subject learning outcomes

| Code | Outcomes in terms of | Learning outcomes | Examination methods |
|---|---|---|---|
| **Knowledge – Student:** | | | |
| W1 | On successful completion of this course, a student will be able to describe the basic principles of photocatalysis (thermodynamics, kinetics, mass transfer, electron transfer and reactionmechanisms); give examples of photocatalytic reactions and its applications | FEN_K2_W01, FEN_K2_W06 | Oral colloquium, Test |
| W2 | On successful completion of this course, a student will be able to explain the basic characteristics of semiconductor / electrolyte interfaces and processes related to photocatalysis | FEN_K2_W01 | Oral colloquium, Test |
| W3 | On successful completion of this course, a student will be able to describe and compare energy efficiencies of the semiconductor nanomaterials and plasmon-based nanocomposites in photocatalysis | FEN_K2_W01, FEN_K2_W03 | Oral colloquium |
| W4 | On successful completion of this course, a student will be able to be acquainted with experimental techniques for investigation of semiconductor / electrolyte interfaces under light irradiation as well as be able to explain one of these techniques in detail | FEN_K2_W03, FEN_K2_W05 | Oral colloquium |
| **Skills – Student:** | | | |
| U1 | On successful completion of this course, a student will be able to explain the basic characteristics of semiconductor / electrolyte interfaces and processes related to photocatalysis | FEN_K2_U04 | Test |

## Study content

| No. | Course content | Subject learning outcomes | Activities |
|---|---|---|---|
| 1. | Principles of semiconductors and semiconductor surfaces | W1 | Lecture |
| 2. | Principles of solid state photoelectrochemistry and photocatalysis | W1 | Lecture |
| 3. | Semiconductor / electrolyte interface; mechanism of surface reactions and charge carrier transfer mechanisms at surfaces | W2, U1 | Lecture |
| 4. | Emerging photocatalytic nanomaterials and nanocomposites. Fabrication of practical photocatalysts | W3 | Lecture |
| 5. | The role of co-catalysts and the plasmon resonant photocatalysis | W3 | Lecture |
| 6. | Experimental techniques to study semiconductor / electrolyte interfaces under light irradiation | W4, U1 | Lecture |
| 7. | Applications of photocatalysts | W1 | Lecture |

## Additional information

| Activities | Teaching and learning methods and activities |
|---|---|
| Lecture | Lecture with a multimedia presentation of selected issues, Conversation lecture, Discussion |

| Activities | Credit conditions |
|---|---|
| Lecture | At the final written test, the student will receive 3 questions drawn from 3 groups of different complexity (one question from each group). The full answer for each question gives a score 1 point (pt). It is possible to improve the final score with an additional oral exam.<br>Very good (bdb; 5,0): 3 pts<br>Good plus (+db; 4,5): 2.5 pts<br>Good (db; 4,0): 2 pts<br>Satisfactory plus (+dst; 3,5): 1.5 pts<br>Satisfactory (dst; 3,0): 1 pt<br>Unsatisfactory (ndst; 2,0): <1 pt |

## Literature

**Obligatory**


1. H. Kisch, “Semiconductor Photocatalysis. Principles and Applications”, Wiley-VCH, 2015
2. R. Ameta, S. Ameta, “Photocatalysis. Principles and Applications”, Taylor and Francis Group, 2017
3. P. Pichat (ed.), “Photocatalysis and Water Purification”, Wiley-VCH, 2013
4. R. Memming (ed.), „Semiconductor Electrochemistry”, Wiley-VCH, 2015.
5. M. Kaneko, I. Okura (ed.), „Photocatalysis. Science and Technology”, Springer, 2003
6. C. Hussain, A. Mishra (ed.), “Handbook of Smart Photocatalytic Materials”, Elsevier, 2020


## Calculation of ECTS points

| Activities | Activity hours* |
|---|---|
| Lecture | 30 |
| Preparation for the exam | 30 |
| Preparation of a multimedia presentation | 30 |
| | |
| **Student workload** | **Hours**<br>90 |
| **Number of ECTS points** | **ECTS**<br>3 |

* academic hour = 45 minutes

## Efekty uczenia się dla kierunku

| Kod | Treść |
|---|---|
| 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_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_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_W05 | The graduate knows and understands the role of physical sciences in the context of fundamental dilemmas and challenges of modern civilization |
| FEN_K2_W06 | The graduate knows and understands basic concepts and principles in the area of industrial property protection and copyright |