Molecular Nanoelectronics

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.4ab603590a809c90bfaa31a6be87bbc1.23 **Lecture languages** english **Mandatoriness** Obligatory **Block** General Modules **Course related to scientific research** Yes **USOS code** 693-INT-xS-113

Course coordinator	Konrad Szaciłowski
Lecturer	Konrad Szaciłowski

Period Summer semester	**Method of verification of the learning outcomes** Exam **Activities and hours** Lectures: 15	**Number of ECTS credits** 2

Goals

C1	Zapoznanie studentów z podstawowymi zagadnieniami nanoelektroniki oraz elektroniki molekularnej
C2	Przekazanie wiedzy z zakresu chemii półprzewodników i polimerów przewodzących, szczególnie w kontekście zjawisk związanych z przetwarzaniem informacji
C3	Uświadomienie słuchaczom problemów związanych z funtamentalnymi i technologicznymi ograniczeniami mikroelektorniki

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	Studnet zna podstawowe właściwości materiałów półprzewodnikowych i polimerów przewodzących		Activity during classes
W2	Znajomość podstaw nanoelektroniki molekularnej		Examination
W3	Podstawowa znajomość teorii pasmowej ciała stałego oraz fizykochemii półprzewodników		Examination
Social competences – Student is ready to:			
K1	Umiejętność rozwiązywania problemów w grupie		Activity during classes

Student workload

Activity form	Average amount of hours* needed to complete each activity form
Lectures	15
Preparation for classes	15
Realization of independently performed tasks	30
Student workload	**Hours** 60
Workload involving teacher	**Hours** 15

* hour means 45 minutes

Program content

No.	Program content	Course's learning outcomes	Activities

1.	Molecular nanoelectronics: The course consists of three parts. The first part deals with basic principles of classical electronics: construction and operational properties of basic active components (diodes, bipolar transistors, FET transistors), structure and fabrication technology of monolithic integrated circuits. Technological and physical limits of classical electronic semiconducting devices are also included in this part. The second part is mostly devoted to synthesis, properties and electronic structure of molecular precursors used in molecular electronics (fullerenes, porphyrins, phthalocyanines, policenes, tetrathiafulvalenes and carbon nanotubes). Properties critical for applications of these materials in electronics are especially emphasized. The third part of the course discusses techniques used for fabrication and investigation of nqnoelectronic structures using single molecules and thin layers. Organic field effect transistors (OFET), organic photovoltaic systems and molecular optoelectronic switches are described in detail.	W1, W2, W3, K1	Lectures

Extended information/Additional elements

Teaching methods and techniques:

Lectures, Discussion, Group work

Activities	Methods of verification	Credit conditions
Lectures	Activity during classes, Examination	

Prerequisites and additional requirements

Basic knowledge of chemistry and physics

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

Lectures: Studenci uczestniczą w zajęciach poznając kolejne treści nauczania zgodnie z syllabusem przedmiotu. Studenci winni na bieżąco zadawać pytania i wyjaśniać wątpliwości. Rejestracja audiowizualna wykładu wymaga zgody prowadzącego.

Literature

Obligatory

1. Infochemistry: Information Processing at the Nanoscale Konrad Szacilowski ISBN: 978-0-470-71072-2

Optional

1. Biomolecular Information Processing: From Logic Systems to Smart Sensors and Actuators Evgeny Katz ISBN:9783527332281

Scientific research and publications

Research

1. Nanostrukturalne układy neuromimetyczne

Publications

1. Towards synthetic neural networks: can artificial electrochemical neurons be coupled with artificial memristive synapses?, E. Wlaźlak, D. Przyczyna, R. Gutierrez, G. Cuniberti, K. Szaciłowski Jpn. J. Appl. Phys.59 SI0801 (2020), https://doi.org/10.35848/1347-4065/ab7e11 In-materio neuromimetic devices: dynamics, information processing and pattern recognition, D. Przyczyna, P. Zawal, T. Mazur, M. Strzelecki, P. Luigi Gentili, and K. Szaciłowski, Japanese Journal of Applied Physics 59, 050504 (2020), https://doi.org/10.35848/1347-4065/ab82b0 Memristor in a Reservoir System - Experimental Evidence for High-Level Computing and Neuromorphic Behavior of PbI_2, E. Wlaźlak, M. Marzec, P. Zawal, and K. Szaciłowski, ACS Appl. Mater. Interfaces 11, 17009−17018 (2019), https://doi.org/10.1021/acsami.9b01841 Synaptic plasticity, metaplasticity and memory effects in hybrid organic–inorganic bismuth-based materials, Tomasz Mazur, Piotr Zawal, Konrad Szaciłowski, Nanoscale 11, 1080-1090 (2019), https://doi.org/10.1039/c8nr09413f Halogen-containing semiconductors: From artificial photosynthesis tounconventional computing, S. Klejna, T. Mazur, E. Wlaźlak, P. Zawal, Han Sen Soo, K. Szaciłowski Coordination Chemistry Reviews 415, 213316 (2020), https://doi.org/10.1016/j.ccr.2020.213316