GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Applications of molecular electronics, PG_00039463		
Field of study	Technical Physics		
Date of commencement of studies	February 2023	Academic year of realisation of subject	2022/2023
Education level	second-cycle studies	Subject group	Optional subject group Subject group related to scientific research in the field of study
Mode of study	Full-time studies	Mode of delivery	at the university
Year of study	1	Language of instruction	Polish
Semester of study	1	ECTS credits	3.0
Learning profile	general academic profile	Assessment form	assessment
Conducting unit	Department of Physics of Electronic Phenomena -> Faculty of Applied Physics and Mathematics		
Name and surname of lecturer (lecturers)	Subject supervisor	dr Małgorzata Franz	
	Teachers	dr inż. Piotr Grygiel dr Małgorzata Franz	

Lesson types and methods of instruction

Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
Number of study hours	15.0	15.0	15.0	0.0	0.0	45

E-learning hours included: 0.0

Learning activity and number of study hours

Learning activity	Participation in didactic classes included in study plan	Participation in consultation hours	Self-study	SUM
Number of study hours	45	6.0	24.0	75

Subject objectives

The aim of the course is to familiarize students with issues related to the physical basis of the operation of electronic elements built of molecular materials and their production technology. The lecture consists of three parts, the first presents the properties of molecular materials, the charge carriers transport and generation and recombination processes. In the second part description of the processes taking place at the junctions is described. In the third part, for selected devices, the fabrication, the principles of operation, basic characteristics and parameters are represented.

Learning outcomes

Course outcome	Subject outcome	Method of verification
[K7_U05] Can plan and conduct theoretical calculations, experimental research and computer simulations, critically analyze their results, draw conclusions and form reasoned opinions.	Student can use the knowledge of the physical basis of the operation of molecular electronics elements for solving the problems. Student can plan and carry out the experiment, and then analyze the measurement data and make a report.	[SU2] Assessment of ability to analyse information
[K7_W02] Has enhanced, theoretically-founded, detailed knowledge of selected field of physics, and sufficient knowledge of related fields of science or technology.	Student is able to describe qualitatively and quantitatively the processes occurring in molecular electronics devices.	[SW1] Assessment of factual knowledge

Subject contents	Electrical and magnetic properties of molecules, Intermolecular interaction, Molecular crystals and molecular structures, Charge carriers generation and recombination processes: ways of charge carriers generation, geminate and bimolecular recombination, Langevina model, Charge carriers injection: contact phenomena, metal-molecular material junction, p-n junction, heterojunction, thermal, optical, excitonic and tunnel injection, Mechanisms of charge carriers transport in molecular materials: diffusion model, Einstein's formula, charge carriers mobility, Methods of thin films production and basic stages of the device manufacturing process: vacuum evaporation, methods of producing layers from the solution, printing methods, LB layers, layered structures of devices, electrodes of various geometry, Fundamentals of OLEDs operation: single-layer diode, multilayer diodes, characteristics and OLED parameters, applied strategies to improve OLED performance, OSC basics: principle of OSC operation on the example of a single-layer cell, current-voltage characteristics and basic cell parameters, cell performance, multilayer cells, Organic field-effect transistor: construction, operating principle, current-voltage characteristics, transistor operation parameters, effective mobility of charge carriers, characteristics of selected molecular materials used to build transistors, exemplary characteristics of transistors based on molecular materials, operational and environmental stability of devices, Detection of materials using organic field effect transistors: OFET as gas sensors, OFET as chemical and biological sensors, ion-selective organic field effect transistor (ISOFET), selected applications OFET sensors, electronic nose, electronic skin, intelligent textiles, Selected elements of molecular electronics based on single molecules: rectifier diodes, molecular switches, molecular memory, molecular transistors, Perspectives of molecular electronics development
Prerequisites and co-requisites	Earlier participation in classes in the subject "Molecular electronics" is not required but it is advisable to fully understand and assimilate the presented material
Assessment methods and criteria	

Subject passing criteria	Passing threshold	Percentage of the final grade
passing the lecture	50.0%	50.0%
passing laboratories	60.0%	20.0%
passing the exercises	50.0%	30.0%

Recommended reading	Basic literature	J. Godlewski, Wstęp do elektroniki molekularnej, Wydawnictwo Politechniki Gdańskiej, Gdańsk 2008 A. Köhler i H. Bässler, Electronic Processes in Organic Semiconductors, Willey-VCH Verlag GmbH & Co. KGaA Weinheim, Germany 2015
	Supplementary literature	S. M. Sze Semiconductor Devices, Physics and Technology John Wiley & Sons Singapore 1985 P. Atkins i J. de Paula Chemia Fizyczna PWN Warszawa 2016
	eResources addresses	Adresy na platformie eNauczanie:
Example issues/ example questions/ tasks being completed	Example of the task which will be solved during exercises: Calculate the interaction energy of two water molecules in the mutual distance r, knowing their dipole moment p. Sample question from a set of questions to pass the lecture: Present the current-voltage characteristics and main parameters characterizing the organic field-effect transistor.	
Work placement	Not applicable	