



## Subject card

Subject name and code	Conductive Polymers, PG_00039677						
Field of study	Materials Engineering, Materials Engineering, Materials Engineering						
Date of commencement of studies	February 2023		Academic year of realisation of subject		2023/2024		
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	2		Language of instruction		Polish		
Semester of study	3		ECTS credits		2.0		
Learning profile	general academic profile		Assessment form		assessment		
Conducting unit	Department of Chemistry and Technology of Functional Materials -> Faculty of Chemistry						
Name and surname of lecturer (lecturers)	Subject supervisor		prof. dr hab. Anna Lisowska-Oleksiak				
	Teachers		prof. dr hab. Anna Lisowska-Oleksiak  Daria Roda				
Lesson types and methods of instruction	Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
	Number of study hours	15.0	0.0	15.0	0.0	0.0	30
	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	30		5.0		15.0	50
Subject objectives	The aim of the course is to familiarize students with the current state of knowledge and technology about the properties and applicability of high-molecular organic compounds (polymers), which are conductors of electric current. Topics include both ion and electronic conductors.						
Learning outcomes	Course outcome		Subject outcome		Method of verification		
	K7_U06		The student is able to assess the suitability of polymeric materials showing the ability to conduct electricity. Is able to assess the impact of macromolecule structure on physicochemical properties. Is able to assess the usefulness of a conducting material in a variety of applications of new technologies, knowing the advantages and limitations of conductive polymers.		[SU2] Assessment of ability to analyse information [SU1] Assessment of task fulfilment		
	K7_W07		223/5000 The student has knowledge about new achievements in the field of polymeric conductors:solid polymer electrolytes, ionic polymers such as ionomers, polyelectrolytes, so-called electroactive polymers - synthetic metals, redox polymers.		[SW1] Assessment of factual knowledge		

Subject contents	A) Lecture:  Introduction to solid state electrochemistry. Solid (E) electrolytes, Electrical properties of ionic current conductors. Polymer solid electrolytes. Gel electrolytes, hydrogels and gel electrolytes with aprotic solvents. Polyelectrolytes, ionomers, ion-selective membranes (Nafion other) Phase boundary electrode (type 1 conductor) - electrolyte, phase boundary polyconductor / electrolyte. Electrode materials (MA) Electroactive polymers synthetic metals polyaniline, polypyrrole, polythiophene, methods of preparation, electrical and mechanical properties. Low molecular weight PM conductors. Integral electrodes, transition metal chalcogenides, porphyrins, phthalocyanines, transition metal hexacyanometalates. The mechanism of charge transport in ion-electron conductors with transition metal atoms in the structure Molecular luminescent layers. Applications of organic compounds in light emitting devices. Carbon materials with graphene surfaces; nanomaterials.  B) Laboratory  <ul style="list-style-type: none"><li>• Synthesis and properties of the so-called polymer synthetic metal (polypyrrole, polythiophene). - pdf manual</li><li>• Determining the material's electric charge capacity by means of impedance spectroscopy pdf instruction</li><li>• Electrochromic properties of polyaniline. Investigation of color changes of the polymer layer under the influence of the electric field.</li><li>• Construction of amodified electrode containing with redox centers of transition metal atoms for electrocatalysis.</li><li>• Gel type electrolyte - EIS method for conductivity measurements.</li></ul>		
Prerequisites and co-requisites	Basic knowledge in general chemistry, physical chemistry		
Assessment methods and criteria	Subject passing criteria	Passing threshold	Percentage of the final grade
	laboratoria -reports and tests	100.0%	40.0%
	lecture - tests	51.0%	60.0%
Recommended reading	Basic literature	1. Materiały do wykładu.  2. A. Lisowska-Oleksiak, A.P. Nowak , Przewodzące Materiały Organiczne, Gdańsk, 2005.  3. Instrukcje do ćwiczeń.  4.R.W. Kelsall, I.W. Hamley, M. Geoghegan, Nanotechnologie Rozdz. 8, PWN 2012.  5. A. Franky So Organic Electronics, CRC Press 2010.  6. W. Bogusz. F. Krok, Elektrolity stałe, WNT 1998.	
	Supplementary literature	1. M.F. Gray Polymer Electrolytes  2. G. Inzelt, Conducting Polymers  3. P.G. Bruce, Solid State Electrochemistry, Cambridge University press 2000  4. A. Lasia, Electrochemical Impedance spectroscopy and its applications, Springer 2014	
	eResources addresses	Adresy na platformie eNauczanie:	
Example issues/ example questions/ tasks being completed	1. The mechanism of charge transport in amorphous poly (oxyethylene electrolytes containing lithium salts 2. Methods for obtaining conjugated polymers of so-called synthetic metals 3. The theory of hard and soft acids and HSAB bases describes coordination in polymer solid electrolyte systems. 4. Polyaniline as an example of an electrochromic compound 5. Determine the Electric equivalent circuit model for the Impedance of an electroactive polymer electrode in contact with electrolyte 6. What physicochemical quantities can be determined by measuring the impedance of electroactive polymer layers?		
Work placement	Not applicable		