GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Electrode materials and their recycling, PG_00058364		
Field of study	MATERIAŁY ELEKTRODOWE I ICH RECYKLING		
Date of commencement of studies	October 2022	Academic year of realisation of subject	2025/2026
Education level	first-cycle studies	Subject group	Obligatory subject group in the field of study 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	4	Language of instruction	Polish
Semester of study	7	ECTS credits	3.0
Learning profile	general academic profile	Assessment form	assessment
Conducting unit	Department of Corrosion and Electrochemistry -> Faculty of Chemistry -> Wydziały Politechniki Gdańskiej		
Name and surname of lecturer (lecturers)	Subject supervisor	dr hab. inż. Paweł Ślepski	
	Teachers	mgr inż. Zuzanna Zarach	

Lesson types	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	6.0	39.0	75

Subject objectives	The aim of the course is to provide students with comprehensive knowledge of the properties, manufacturing methods, and applications of electrode materials used in modern electrochemical systems, such as lithium-ion batteries, supercapacitors, and fuel cells. Particular emphasis is placed on issues related to the selection and optimization of anode and cathode materials, their degradation processes during operation, and the factors affecting their durability and performance. An integral part of the course is the study of recycling and the recovery of critical raw materials from end-of-life electrochemical devices, taking into account technological, environmental, and economic aspects.

Learning outcomes

Course outcome	Subject outcome	Method of verification
[K6_U02] can work individually and in a team, can communicate using various techniques in a professional environment, as well as document and analyze the results of their work, can estimate the time needed to perform the entrusted task	The student can work individually and in a team when conducting experiments/projects related to electrode materials and recycling. They can effectively communicate using various techniques for presenting results, as well as document and analyze the outcomes of their work, while planning and assessing the time required for research tasks.	[SU1] Ocena realizacji zadania [SU4] Ocena umiejętności korzystania z metod i narzędzi [SU5] Ocena umiejętności zaprezentowania wyników realizacji zadania
[K6_W04] knows the basic properties of materials used in solving simple engineering tasks related to the field of study, in particular has basic knowledge in the field of materials science and is able to relate the properties of materials with their structure and composition, knows the theoretical description of phenomena occurring in materials subjected to external factors	The student knows the basic properties of materials used in electrochemical systems, can relate their structure and chemical composition to their functional properties, and understands the influence of external factors on the processes that occur, including degradation and recycling potential.	[SW3] Ocena wiedzy zawartej w opracowaniu tekstowym i projektowym [SW1] Ocena wiedzy faktograficznej
[K6_W19] has knowledge of the properties of electrolyte solutions, electrode processes and some electrochemical processes relevant to industrial practice and the application of electrochemistry in practice	The student knows the properties of electrolyte solutions, electrode processes, and selected electrochemical processes relevant to industrial practice, and understands their significance in the operation and recycling of modern electrochemical systems.	[SW3] Ocena wiedzy zawartej w opracowaniu tekstowym i projektowym [SW1] Ocena wiedzy faktograficznej

Subject contents

1. Introduction to electrode materials in electrochemical systems
2. Classification and properties of anode and cathode materials
3. Electrodes in electrochemical capacitors
4. Electrode materials in primary alkaline cells
5. Degradation processes of electrode materials during the operation of electrochemical devices
6. Methods of synthesis and fabrication of advanced electrode materials
7. Characterization techniques for electrode materials (morphology, composition, structure, electrochemical properties)
8. Critical raw materials in electrochemical systems significance and availability
9.. Recycling of materials from fuel cells and supercapacitors
10. Environmental and economic aspects of recycling electrochemical systems

Laboratory classes:

Recycling methods for batteries (mechanical, hydrometallurgical, pyrometallurgical). Recovery of lithium, cobalt, nickel, and other critical raw materials (e.g. from lithium-ion batteries). Methods of synthesis and fabrication of advanced electrode materials and the utilization of materials obtained from recycling processes.

Prerequisites and co-requisites

Successful completion of the following courses is required: *Fundamentals of Electrochemistry* and *Electrochemical Energy Sources*.

Assessment methods and criteria

Subject passing criteria	Passing threshold	Percentage of the final grade
	60.0%	70.0%
	60.0%	30.0%

Recommended reading	Basic literature	1. Kebede M., Ezema F. (red.), *Electrode Materials for Energy Storage and Conversion*, CRC Press (Taylor & Francis), Boca Raton, 2021. 2. Breitkopf C., Swider-Lyons K. (red.), *Springer Handbook of Electrochemical Energy*, Springer, BerlinHeidelberg, 2017. 3. Zhang S. S., *Energy Storage Materials Characterization: Determining Properties and Performance, Volumes 12*, Elsevier, Amsterdam, 2020. 4. Liu B., Zhang J. (red.), *Electrode Materials in Energy Storage Technologies: Applications in Lithium-, Sodium-, Potassium-, Sulfur- and Zinc-Based Rechargeable Batteries*, Wiley-VCH, Weinheim, 2022. 5. Czerniak J., *Jakość i recykling alkalicznych ogniw pierwotnych*, Wydawnictwo Uniwersytetu Ekonomicznego w Krakowie, Kraków, 2022.
	Supplementary literature	1. Scientific publications available on the websites of publishers such as Elsevier, Wiley, and others 2. Internet sources
	eResources addresses	
Example issues/ example questions/ tasks being completed		
Practical activites within the subject	Not applicable	

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