GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Electrochemistry in functional materials research, PG_00069286		
Field of study	Chemical Technology		
Date of commencement of studies	February 2025	Academic year of realisation of subject	2025/2026
Education level	second-cycle studies	Subject group	
Mode of study	Full-time studies	Mode of delivery	at the university
Year of study	1	Language of instruction	Polish
Semester of study	2	ECTS credits	3.0
Learning profile	general academic profile	Assessment form	assessment
Conducting unit	Department of Chemistry and Technology of Functional Materials -> Faculty of Chemistry -> Wydziały Politechniki Gdańskiej		
Name and surname of lecturer (lecturers)	Subject supervisor	dr hab. inż. Andrzej Nowak	
	Teachers		

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	15.0	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	5.0	25.0	75

Subject objectives

The aim of the course is to familiarize students with selected modern electrochemical systems, such as supercapacitors, electrochemical cells, water electrolysis and hydrogen production systems, photoelectrocatalysts and amperometric sensors. Students will learn to use appropriate electrochemical measurement techniques for their study and analysis.

Learning outcomes

Course outcome	Subject outcome	Method of verification
[K7_W05] recognises the key developments in research, apparatus and technology in technology and related fields	The student has knowledge about the directions of research development and the equipment used	[SW1] Assessment of factual knowledge
[K7_U02] carries out experiments using properly selected techniques and apparatus, taking advantage of new developments in technology and related fields	The student is able to select appropriate techniques and equipment when conducting an experiment.	[SU3] Assessment of ability to use knowledge gained from the subject
[K7_K03] can interact and work in a group, taking on a variety of roles	The student is able to work as a team member and carry out assigned tasks	[SK1] Assessment of group work skills
[K7_U03] designs innovative technological solutions for obtaining useful goods based on the state of the knowledge in accordance with the latest scientific literature	The student is able to work as a team member and carry out assigned tasks	[SU4] Assessment of ability to use methods and tools

<table>
<tr><td>Subject contents</td><td>Lecture:
1. Introduction to applied electrochemistry.
2. Discussion of selected measurement techniques.
3. Methods of preparing electrodes.
4. Hydrogen production and characterization of electrocatalysts.
5. Energy storage systems (electrochemical capacitors and cells)
6. Photoelectrochemical methods of hydrogen generation
7. Electrochemical sensors.

Laboratory:
1. Study of hydrogen evolution electrocatalyst: Measurement of electrocatalyst activity in the hydrogen evolution reaction. Determination of overvoltage at a fixed current density, analysis of the Tafel curve, and assessment of catalyst efficiency.)
2. Photoelectrochemical water decomposition: Study of photoelectrochemical phenomena on the example of water decomposition under the influence of light. Measurement of the generated photocurrent on two examples of photoelectrocatalysts.
3. Construction and characterization of a supercapacitor: Construction of an electrochemical capacitor using selected electrode materials and an electrolyte. Electrochemical characterization using cyclic voltammetry and galvanostatic charge/discharge.
4. Testing a laboratory lithium-ion battery: Construction of a Li-ion cell in a glovebox. Analysis of cell operating parameters.
5. Characterization of an amperometric sensor: Construction of a simple electrochemical sensor. Calibration of the sensor and measurements of analyte concentration using amperometry. Discussion of accuracy, selectivity and potential applications.
Seminar:

During the seminars, students, with the support of the instructors in selecting literature, prepare and deliver presentations based on scientific publications on electrode materials and electrochemical techniques. The classes focus on developing skills in clear communication of scientific content and critical analysis of presented data and research methods.</td></tr>
<tr><td>Prerequisites and co-requisites</td><td></td></tr>
<tr><td>Assessment methods and criteria</td><td>
<table>
<tr><th>Subject passing criteria</th><th>Passing threshold</th><th>Percentage of the final grade</th></tr>
<tr><td>Seminar</td><td>51.0%</td><td>20.0%</td></tr>
<tr><td>Laboratory</td><td>51.0%</td><td>40.0%</td></tr>
<tr><td>Lecture</td><td>51.0%</td><td>40.0%</td></tr>
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<tr><td>Recommended reading</td><td>
<table>
<tr><td>Basic literature</td><td>Allen J. Bard, Larry R. Faulkner, Electrochemical Methods: Fundamentals and Applications, 2nd Edition, Wiley, 2000.

Adolf Kisza, Elektrochemia II, Elektrodyka, Wydawnictwo Naukowe WNT, 2001.</td></tr>
<tr><td>Supplementary literature</td><td>P. Cavaliere, Water Electrolysis for Hydrogen Production, Springer, 2022</td></tr>
<tr><td>eResources addresses</td><td></td></tr>
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<tr><td>Example issues/ example questions/ tasks being completed</td><td>1. How to determine the specific capacitance of a supercapacitor/lithium-ion battery based on galvanostatic charge/discharge curves and assess their cyclic stability?

2. How to use electrochemistry to determine the concentration of chloride ions?

3. How to determine the hydrogen evolution overvoltage?
4. How to work with electrode materials sensitive to moisture and oxygen?
5. How does the photocurrent change depending on the photoelectrode potential and the type of semiconductor used?</td></tr>
<tr><td>Work placement</td><td>Not applicable</td></tr>
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