GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Chemical power sources, PG_00037313		
Field of study	Technical Physics		
Date of commencement of studies	October 2021	Academic year of realisation of subject	2024/2025
Education level	first-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	4	Language of instruction	Polish
Semester of study	7	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

Additional information:
Lecture course

Laboratories

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	2.0	18.0	50

Subject objectives

The aim of the course is to familiarize students with: a) basics of electrochemistry in the use of electrode reaction in devices for storage and conversion of electricity and b) familiarizing students with the chemistry of materials useful, among others, in the construction of galvanic cells, electrochemical capacitors, photoelectrochemical cells (PEC)

Learning outcomes

Course outcome	Subject outcome	Method of verification
K6_U01	Student is able to learn independently, obtain information from databases and critically selected sources	[SU5] Assessment of ability to present the results of task [SU4] Assessment of ability to use methods and tools [SU2] Assessment of ability to analyse information [SU1] Assessment of task fulfilment
K6_W02	Has structured knowledge in the scope of electrochemistry (electrodes and ionics), knows measurement methods of electrochemistry, knows the principles of selectionof electrode materials in the context of environmental protection and access to mineral resources	[SW3] Assessment of knowledge contained in written work and projects [SW1] Assessment of factual knowledge
K6_W01	Understands the civilizational significance of electrochemistry and its applications, especially in the face of climate change	[SW3] Assessment of knowledge contained in written work and projects [SW1] Assessment of factual knowledge

Subject contents

I. Basics in electrochemistry

Ionics - Charge transport in electrolytes: water electrolytes, aprotic electrolytes, polymer electrolytes, gel electrolytes, solid electrolytes

Electrodics - Metal/electrolyte interface, semiconductor/electrolyte interface, electrolyte membrane. Reaction kinetics electrodes; Butler-Volmer equation, exchange current, transfer coefficient, overpotential. Diffusional controll of the electrode process. Cottrell equationl. Electrocatalysis. Processes of creating a new phase - electrocrystallization, electrode polymerization. Mechanism of selected electrode processes: oxidation hydrogen, methanol, glucose, oxygen reduction. Methods of testing electrode processes: voltammetry, chronopotentiometry, chronoamperometry, electrochemical impedance spectroscopy.

II. Electricity storage and conversion devices:

A) Primary cells: zinc-manganese oxide, zinc-silver oxide, metal-air cells, primary lithium cells, large-size cells for special applications. Passivation of primary cell anodes, solid electrolyte phase boundary. Solid cathode materials, liquid cathodes of lithium cells. B) Secondary cells: lead-acid batteries, batteries containing metal alloy hydrides - NiMH, lithium batteries, lithium-ion batteries, lithium polymer batteries, intercalation phenomenon, insertion in sp2 carbons, electroactive polymers, polymer electrolytes, etc. Flow cells, so-called flow-cell redox. Batteries - ecological aspect, European Union law on recycling and restrictions use of certain ROSH compounds - EU directive. C) Electrochemical capacitors: a) EDLC capacitors - capacity of the electrical double layer, b) supercapacitors - redox pseudocapacitance. c) supercapacitor-cell hybrid systems galvanic. Electrode materials, electron collector materials, water electrolytes, electrolytes non-aqueous. D) Fuel cells on the example of biofuel cells, SOF cells, MCFC, PMFC, DMFC - Catalysts for the oxygen reduction reaction in fuel cells with a proton membrane. Methanol oxidation. Hydrogen as a fuel obtained from the photodecomposition of water. E) Optional for those interested: Photoelectrochemical decomposition of water (PEC cell) - selection rules electrode materials. Photo-supercapacitors

Prerequisites and co-requisites

basic knowledge in general chemistry and physics

Assessment methods and criteria

Subject passing criteria	Passing threshold	Percentage of the final grade
test zaliczeniowy pisemny	51.0%	60.0%
raport i testy zaliczeniowe	100.0%	40.0%

Recommended reading

Basic literature

A. Kisza, Elektrodyka, WNT 2000
A. Kisza, Jonika, WNT 2000
A. Czerwiński, Ogniwa Baterie, WNT, W-wa 2004.
C.A.Vincent, B. Scrosati, Modern Batteries , New York, 1997
Ed. P.J. Gellings, H.J.M.Bouwmeester The CRS Hanbook of Solid State Electrochemistry.

Materiały do wykładów pliki pdf

Instrukcje do ćwiczeń, pliki pdf

	Supplementary literature	Wpływ podłoża na kitetykę i mechanism reakcji wydzielenia wodowu. 2. Synteza i charakterystyka polimeru elektroaktywnego. 3. Metalany metali przejściowych jako elektrody do kondensatorow-badania woltamperometryczne. 4. Ditlenek tytanu jako fotoanoda, wyznaczenie fotoprądów elektrod: ITO/TiO, ITO/TiO2/BP. 5. Elektrolity żelowe - wyznaczanie przewodnictwa . 6. Wyznaczanie współczynnika dyfuzji depolaryzatora na podstawie krzywych woltamperometrycznych.
	eResources addresses	Adresy na platformie eNauczanie:
Example issues/ example questions/ tasks being completed	Calculate the theoretical charge capacity of the graphite electrode in a lithium-ion cell. Determine the exchange current and the transfer coefficient of the tested electrode reaction based on the measured polarization curve. How does the conductivity of a synthetic metal change with temperature? How an EDLC electrochemical capacitor is constructed. What do you know about the corrosion of electron collectors in high-energy galvanic cells? Present the Ragon diagram for selected electrochemical devices for energy storage (arrange L-ions, Na-ion cells, EDLC electrochemical capacitors, lead-acid cells). Sketch the polarization curves j= (f(E) for the transfer coefficient =0, 3; 05; 0.7 at the same exchange current.	
Work placement	Not applicable	

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