GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	, PG_00065828						
Field of study	Materials Engineering						
Date of commencement of studies	October 2024			Academic year of realisation of subject		2024/2025	
Education level	second-cycle studies			Subject group		Specialty 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	2			ECTS credits		2.0	
Learning profile	general academic profile			Assessment form		assessment	
Conducting unit	Department of Corrosion and Electrochemistry -> Faculty of Chemistry						
Name and surname of lecturer (lecturers)	Subject supervisor		dr hab. inż. Artur Zieliński				
	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	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		2.0	18.0		50
Subject objectives	Presentation and discussion of the theoretical foundations of classical electroanalytical measurements.						

Learning outcomes

Course outcome	Subject outcome	Method of verification
[K7_W06] Knows the theoretical basics the functioning of scientific equipment in the fields of science and scientific disciplines relevant to materials engineering.	The student uses electrochemical equipment (measuring cell, electrodes, potentiostat) in a manner that is correct and does not cause material losses.	[SW3] Assessment of knowledge contained in written work and projects
[K7_U04] Can undertake a detailed analysis of the obtained results and develop a technical report or presentation, also in English.	The student explains the principles of basic electrochemical measurements. The student calculates the values of parameters related to the kinetics and thermodynamics of electrochemical reactions.	[SU2] Assessment of ability to analyse information
[K7_W05] Knows methods, techniques, tools and materials for solving complex engineering tasks relevant to materials engineering.	The student draws conclusions based on the results of the measurement. He can present them in the form of a study that is understandable and transparent to the recipient, including a foreign language.	[SW1] Assessment of factual knowledge

<table>
<tr><td>Subject contents</td><td colspan="3">Construction of an electrochemical cell. Role of individual electrodes. Working (indicator) electrode. Materials used to manufacture electrodes. Working potential ranges for different electrodes, requirements for cleanliness and preparation of the working electrode. Measurements under equilibrium conditions. Measurements under polarization conditions. Other electrodes in the electrochemical cell. Base electrolyte. Oxygen removal. Calibration of the measuring cell. Measuring equipment. Operational amplifier in an open system. Feedback loop. Voltage follower potentiostat. Compensation of electrolyte resistance. Bipotentiostat. Galvanostat. Theory of random walk and theoretical description of diffusion motion on a microscale. Transition to the macroscopic scale and description of a time-invariant matter flux. Fick's first law. Time-varying flux, i.e. description of places where substances are produced or consumed (electrode reaction). Fick's second law. Consequences of describing the diffusion process using partial differential equations. Chronoamperometry. Apparatus used in chronoamperometric (potentiostatic) measurements. Theoretical assumptions of the Cottrell experiment (a special case of chronoamperometric measurement). Calculations using the Laplace transformation. Cottrell's equation and its possible applications. Other cases of the chronoamperometric experiment. Chronopotentiometry. Assumptions of the technique. Method of measurement. Advantages and disadvantages. Transition time, Sand's equation, quantitative analysis. Form of the curve for reversible and irreversible systems, qualitative analysis. Influence of non-Faradaic current. Analysis of multicomponent systems. Inversion chronopotentiometry. Chronovoltammetry. Introduction (analytical usefulness of the chronovoltammetric approach). Experiment performance. Voltammetry on flat electrodes (reversible, irreversible and quasi-reversible reactions). Multicomponent systems. Voltammetry on static and hydrodynamic electrodes. Kinetics of electrode reactions. Dynamic equilibrium. Arrhenius concept. Active complex theory. Butler-Volmer model. Transition coefficient. Standard rate constant. Exchange current. Current-overpotential relationship. Activation and concentration overvoltages. Limiting current. Butler-Volmer equation and its special cases. Stern-Geary equation. Tafel equation.</td></tr>
<tr><td>Prerequisites
and co-requisites</td><td colspan="3">Foundations of electrochemistry</td></tr>
<tr><td rowspan="3">Assessment methods
and criteria</td><td>Subject passing criteria</td><td>Passing threshold</td><td>Percentage of the final grade</td></tr>
<tr><td>laboratory</td><td>100.0%</td><td>50.0%</td></tr>
<tr><td>lecture</td><td>50.0%</td><td>50.0%</td></tr>
<tr><td rowspan="3">Recommended reading</td><td>Basic literature</td><td colspan="2">Adolf Kisza, Elektrochemia 2. Elektrodyka, Wydawnictwa Naukowo-Techniczne, Warszawa, 2001. ISBN 83-204-2564-6.

Zbigniew Galus, Teoretyczne podstawy elektroanalizy chemicznej, Państwowe Wydawnictwo Naukowe, Warszawa, 1971.

Praca zbiorowa pod redakcja Zbigniewa Galusa, |Elektroanalityczne metody wyznaczania stałych fizykochemicznych, Państwowe Wydawnictwo Naukowe, Warszawa, 1979. ISBN 83-010-0139-9.</td></tr>
<tr><td>Supplementary literature</td><td colspan="2">Allen J. Bard, Larry R. Faulkner, Electrochemical methods: fundamentals and applications, John Wiley & Sons, New York, 2001. ISBN 04-710-4372-9.</td></tr>
<tr><td>eResources addresses</td><td colspan="2">Adresy na platformie eNauczanie:</td></tr>
<tr><td>Example issues/
example questions/
tasks being completed</td><td colspan="3">When is it better to use the standard rate constant and when is it better to use the exchange current? 2. What is the Cottrell experiment? 3. What is the purpose of the base electrolyte? 4. Discuss the shape of typical voltammetric graphs. 5. Characterize the properties of the reference electrode. Give several examples of such electrodes. 6. What is the voltammetric technique and what information is obtained? 7. Discuss the method of presenting the results of impedance measurements. 8. What is the role of the diffusion phenomenon in electrode processes?</td></tr>
<tr><td>Work placement</td><td colspan="3">Not applicable</td></tr>
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