GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Design of new materials for hydrogen technolgies, PG_00065895		
Field of study	Hydrogen Technologies and Electromobility		
Date of commencement of studies	October 2022	Academic year of realisation of subject	2024/2025
Education level	first-cycle studies	Subject group	
Mode of study	Full-time studies	Mode of delivery	at the university
Year of study	3	Language of instruction	Polish
Semester of study	6	ECTS credits	2.0
Learning profile	general academic profile	Assessment form	assessment
Conducting unit	Department of Functional Materials Engineering -> Faculty of Electronics, Telecommunications and Informatics		
Name and surname of lecturer (lecturers)	Subject supervisor	dr hab. inż. Sebastian Molin	
	Teachers	dr hab. inż. Sebastian Molin	

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	3.0	17.0	50

Subject objectives	The aim of the course is to equip students with competencies in designing materials used in technologies related to hydrogen production, storage, and utilization. Classes focus on developing the ability to analyze technical and functional requirements that structural materials must meet in hydrogen environments. Students gain knowledge about criteria for selecting materials resistant to corrosion, fatigue, and hydrogen-induced degradation. The course enables students to develop practical skills in surface and structural modification of materials to enhance their functional properties.

Learning outcomes

Course outcome	Subject outcome	Method of verification
[K6_K02] can work in a group taking on different roles in it	Collaborates effectively within a project team, taking responsibility for assigned tasks. Actively participates in team-based problem-solving related to material design. Clearly and effectively presents the results of teamwork to other group members.	[SK4] Assessment of communication skills, including language correctness
[K6_W13] knows the properties of materials used in the field of hydrogen energy and electromobility	Characterizes the properties of structural materials used in hydrogen production and storage installations. Distinguishes mechanisms by which hydrogen affects the mechanical and structural properties of engineering materials. Identifies suitable materials and their selection criteria for specific applications within hydrogen technologies.	[SW2] Assessment of knowledge contained in presentation
[K6_U05] can use analytical and simulation methods, prepare and for the formulation and solution of tasks in the field of hydrogen technologies, automation and robotics, electrical engineering, use various techniques to carry out engineering tasks related to electrical devices, hydrogen installations, control and robotics systems	Applies analytical methods to design materials for hydrogen installations. Uses simulation tools to evaluate material behavior in hydrogen environments. Develops and formulates project tasks related to material selection for hydrogen technologies.	[SU2] Assessment of ability to analyse information

Subject contents

The course provides an in-depth overview of topics related to the design and properties of advanced materials used in hydrogen production, storage, and utilization technologies. Students will learn about the interactions between hydrogen and structural materials, particularly hydrogen embrittlement mechanisms, and methods of mitigating these effects. Metallic materials, including stainless steels, nickel-based alloys, lightweight alloys (aluminum and titanium), as well as advanced composites and protective coatings, will be discussed in detail. Special attention will be paid to electrode and catalytic materials used in alkaline electrolyzers, PEM electrolyzers, and fuel cells. An essential component of the course includes discussing materials for high-pressure and cryogenic hydrogen storage tanks, as well as hydrogen-absorbing (hydride) materials. Students will explore various surface and structural modification techniques such as heat treatment, cladding, functional coatings, and gradient structures to improve material performance in hydrogen environments. The program incorporates computational simulation techniques (e.g., FEM, DFT) for analyzing material behavior under hydrogen exposure and validating material designs. Additionally, advanced material characterization methods, including electron microscopy, spectroscopy, and mechanical testing focused on hydrogen resistance, will be thoroughly covered. The course includes case studies and analyses of current industrial practices and emerging technologies in the hydrogen sector. The classes conclude with a summary of acquired knowledge and a discussion on future developments and research directions in materials for hydrogen technologies.

Prerequisites and co-requisites

Assessment methods and criteria

Subject passing criteria	Passing threshold	Percentage of the final grade
lecture test	55.0%	60.0%
laboratory assessment	60.0%	40.0%

Recommended reading

Basic literature	• Callister W.D. Jr., Rethwisch D.G., *Materials Science and Engineering: An Introduction*, 10th Edition, John Wiley & Sons, Hoboken, NJ, 2018. • Ashby M.F., Jones D.R.H., *Engineering Materials 1: An Introduction to Properties, Applications, and Design*, 5th Edition, Butterworth-Heinemann, Oxford, UK, 2018.
Supplementary literature	scientific publications available in online databases: Google Scholar, Elsevier
eResources addresses	Adresy na platformie eNauczanie: PROJEKTOWANIE NOWOCZESNYCH MATERIAŁÓW DLA TECHNOLOGII WODOROWYCH - Moodle ID: 45493 https://enauczanie.pg.edu.pl/moodle/course/view.php?id=45493

Example issues/ example questions/ tasks being completed	• Which structural materials are most resistant to hydrogen embrittlement? • Describe degradation mechanisms occurring in materials used in hydrogen installations. • What surface modification techniques enhance materials' resistance to hydrogen exposure? • How are catalytic materials selected for alkaline and PEM electrolyzers?
Work placement	Not applicable

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