GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	, PG_00067221		
Field of study	Laboratorium Dyplomowe		
Date of commencement of studies	February 2024	Academic year of realisation of subject	2024/2025
Education level	second-cycle studies	Subject group	
Mode of study	Full-time studies	Mode of delivery	at the university
Year of study	2	Language of instruction	Polish
Semester of study	3	ECTS credits	10.0
Learning profile	practical profile	Assessment form	assessment
Conducting unit	Department of Energy Conversion and Storage -> Faculty of Chemistry -> Faculties of Gdańsk University of Technology		
Name and surname of lecturer (lecturers)	Subject supervisor	dr hab. inż. Monika Wilamowska-Zawłocka	
	Teachers	dr hab. inż. Monika Wilamowska-Zawłocka	

Lesson types	Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
	Number of study hours	0.0	0.0	200.0	0.0	0.0	200
	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	200	0.0	0.0	200

Subject objectives	
	The aim of the course is to develop practical skills in conducting experimental research related to a selected issue in materials science, chemistry, chemical engineering and technology, including the design of experiments, operation of measurement equipment, and analysis and interpretation of results. The student develops competencies in laboratory work, critical evaluation of data, and the application of theoretical knowledge in research practice.

Learning outcomes

Course outcome	Subject outcome	Method of verification
K7_W03	The student knows and understands the processes occurring in measuring equipment and control systems used in cathode material testing. They know measurement methods and techniques (including XRD, SEM, electrochemical tests, spectroscopic methods) and their impact on the assessment of technological processes related to NMC cathode recycling. They understand current trends in the control of technological processes and the measurement of material properties.	[SW1] Ocena wiedzy faktograficznej [SW3] Ocena wiedzy zawartej w opracowaniu tekstowym i projektowym
K7_W08	The student has extended knowledge of the design of technological processes related to the recovery and modification of cathode materials. They understand the mechanisms of material degradation during the operation of lithium-ion batteries and ways to improve their properties through the appropriate selection of recycling and lithium reinsertion processes.	[SW1] Ocena wiedzy faktograficznej [SW3] Ocena wiedzy zawartej w opracowaniu tekstowym i projektowym
K7_U04	The student is able to assess the usefulness and applicability of modern recycling techniques and analytical methods for solving complex research and engineering problems related to the recovery of electrode materials.	[SU4] Ocena umiejętności korzystania z metod i narzędzi [SU2] Ocena umiejętności analizy informacji [SU1] Ocena realizacji zadania
K7_W02	The student knows and understands the processes occurring in industrial equipment used in the production and recycling of lithium-ion cells. They have knowledge of the processes of conversion and modification of the functional properties of electrode materials and current development trends in the field of energy storage and transmission technologies.	[SW3] Ocena wiedzy zawartej w opracowaniu tekstowym i projektowym [SW1] Ocena wiedzy faktograficznej
K7_U01	The student is able to plan and conduct laboratory experiments related to the recycling of NMC cathodes, apply appropriate research methods, interpret the results obtained and formulate conclusions. They are also able to formulate and test hypotheses concerning the impact of process parameters on the properties of recovered materials.	[SU1] Ocena realizacji zadania [SU2] Ocena umiejętności analizy informacji [SU4] Ocena umiejętności korzystania z metod i narzędzi

Subject contents

Course content – laboratory
1) Introduction to research work principles of planning and conducting laboratory experiments.
2) Operation of measuring equipment used for testing electrode materials (XRD, SEM, spectroscopic methods, electrochemical tests).
3) Testing of pre-treatment processes for electrode materials methods of delamination and removal of binding materials.
4) Testing of lithium reinsertion processes hydrothermal methods, solid-state reactions and combined methods.
5) Characterisation of recovered materials structural, morphological and electrochemical analysis.
6) Analysis and compilation of results comparison of the effectiveness of different methods and assessment of the suitability of recycled materials.
7) Preparation of reports and presentations of research results.

Prerequisites and co-requisites

Assessment methods and criteria

Subject passing criteria	Passing threshold	Percentage of the final grade
theoretical study	60.0%	30.0%
experimental works	60.0%	70.0%

Recommended reading	Basic literature	H. Bae et al., Technologies of lithium recycling from waste lithium ion batteries: a review, Mater. Adv., 2 (2021) 3234. L. L. Driscoll et al., Phase-selective recovery and regeneration of end-of-life electric vehicle blended cathodes via selective leaching and direct recycling, Joule, 8 (2024) 2735. G. Jiang et al., Acetone as an agent for PVDF recovery and delamination of lithium-ion battery electrodes, Resources, Conservation & Recycling 209 (2024) 107778. L. E. Sita et al., Direct Recycling of LixNi0.5Mn0.3Co0.2O2 from Production Scrap and End-Of-Life Batteries, Using Solid-State Relithiation, Batteries & Supercaps 2024, e202400536 (1 of 14)
	Supplementary literature	J. P. Pender et al., Electrode Degradation in Lithium-Ion Batteries, ACS Nano 2020, 14, 12431295 P. Zhu et al., Direct reuse of aluminium and copper current collectors from spent lithium-ion batteries, Green Chem., 2023, 25, 3503. A. Zorin et al., Acid-Assisted Separation of Cathodic Material from Spent Electric Vehicle Batteries for Recycling, Metals 2023, 13, 1276.
	eResources addresses	
Example issues/ example questions/ tasks being completed	1) What parameters of the delamination process affect the effectiveness of binder removal and the quality of the recovered material? 2) How do different methods of pre-treatment and lithium reinsertion modify the structure and properties of the cathode? 3) How to interpret XRD spectra to assess changes in the crystal structure of the material? 4) What are the advantages and limitations of individual characterisation methods (SEM, spectroscopic methods, electrochemical tests)? 5) How to compare the effectiveness of lithium reinsertion methods into the cathode structure? 6) Compilation of research results and preparation of a laboratory report.	
Practical activites within the subject	Not applicable	

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