GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Material upcycling, PG_00069300		
Field of study	Chemical Technology, Chemistry, Biotechnology, Engineering and Technologies of Energy Carriers, Corrosion , Green Technologies, InfoBioChem		
Date of commencement of studies	February 2026	Academic year of realisation of subject	2026/2027
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 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		

Lesson types

Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
Number of study hours	15.0	0.0	30.0	0.0	0.0	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 familiarise students with the idea, technologies and practices of material upcycling as an innovative approach to processing waste into valuable raw materials and products. During the lectures, students will learn to identify the potential of waste materials and become familiar with solutions consistent with the principles of circular economy and sustainable development. The laboratories focus on issues related to the recovery of materials from lithium-ion batteries. As part of the laboratory classes, students will acquire practical skills in the separation, purification and restoration of the structure of active electrode materials for reuse in new lithium-ion batteries.

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	has the knowledge necessary to identify current and future directions for research, technology and equipment related to material recycling and upcycling, and their significance in the context of sustainable development and the circular economy.	[SW1] Assessment of factual knowledge [SW3] Assessment of knowledge contained in written work and projects
[K7_U02] carries out experiments using properly selected techniques and apparatus, taking advantage of new developments in technology and related fields	is able to plan and conduct experiments related to material recycling and upcycling. The student is able to select and apply appropriate techniques and tools for processing selected waste materials in recycling and upcycling processes, taking into account current technological advances in materials processing and environmental engineering.	[SU1] Assessment of task fulfilment [SU3] Assessment of ability to use knowledge gained from the subject
[K7_K02] understands the non-technical aspects and implications of graduate activity, including the impact on the environment	is ready to identify potential environmental and social impacts resulting from the recycling and upcycling methods used, and proposes solutions to minimize negative impacts. They understand the environmental, social, and economic aspects of material upcycling and its importance for sustainable development and the circular economy.	[SK5] Assessment of ability to solve problems that arise in practice

<table>
<tr><td>Subject contents</td><td>Course content – lecture
1. What is upcycling? History and definitions

2. Upcycling vs recycling: differences, benefits and challenges

3. Ecology and the circular economy (CE)

4. Recycling and upcycling application in strategic technologies

5. Critical and strategic elements their impact on the development of recycling and upcycling

6. Materials for upcycling

7. Methods and technologies for processing and valorising recovered materials
Course content – laboratory
Recovery of critical elements from used lithium-ion cells, including:

- pre-treatment preparation of batteries for further processes

- disassembly and separation of battery components

- hydrometallurgical and thermal processes for recovering graphite from anodes and transition metal oxides from cathodes of lithium-ion batteries

- testing the properties of recovered materials reuse in new batteries

The students' experimental work will include work in a chemical laboratory. During the classes, students will use: chemical synthesis stations, furnaces for thermal processes with controlled atmosphere, a glove box with controlled atmosphere, and advanced equipment for electrochemical measurements.</td></tr>
<tr><td>Prerequisites and co-requisites</td><td>Fundamentals of inorganic and organic chemistry.
Fundamentals of chemical technology.
Knowledge of unit processes in chemical technology.</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>zaliczenie</td><td>60.0%</td><td>50.0%</td></tr><tr><td>sprawozdanie</td><td>60.0%</td><td>50.0%</td></tr></table></td></tr>
<tr><td>Recommended reading</td><td><table><tr><td>Basic literature</td><td>1. B. Bridgens et al., Journal of Cleaner Production 189 (2018) 145-154
2. L. L. Driscoll et al., Joule 8 (2024) 27352754.
3. L. Gaines, One Earth 1 (2019) P413-415.
4. B. Wang et al., Mater. Horiz., 10 (2023) 41-51.</td></tr><tr><td>Supplementary literature</td><td>O. Guselnikova et al., Chem. Soc. Rev., 52 (2023) 4755-4832.

Z.-Y. Wang, X.-K. Liu, Chinese J. Polym. Sci. 2024, 42, 15251535</td></tr><tr><td>eResources addresses</td><td></td></tr></table></td></tr>
<tr><td>Example issues/ example questions/ tasks being completed</td><td>1. Provide definitions of recycling and upcycling.
2. Explain what a circular economy is.
3. What are critical elements?
4. What material processing technologies do you know?
5. What is the valorisation of recycled materials? Give examples.</td></tr>
<tr><td>Practical activites within the subject</td><td>Not applicable</td></tr>
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