GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

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|---|---|---|---|
| Subject name and code | Material upcycling, PG_00069300 | | |
| Field of study | Chemical Technology | | |
| 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 | The student is able to identify current and future directions in 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<br>[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 | The student 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<br>[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 | The student identifies potential environmental and social impacts resulting from the recycling and upcycling methods used and proposes solutions to minimise negative impacts. The student understands 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<br>1. What is upcycling? History and definitions<br><br>2. Upcycling vs recycling: differences, benefits and challenges<br><br>3. Ecology and the circular economy (CE)<br><br>4. Recycling and upcycling application in strategic technologies<br><br>5. Critical and strategic elements their impact on the development of recycling and upcycling<br><br>6. Materials for upcycling<br><br>7. Methods and technologies for processing and valorising recovered materials<br><br>Course content – laboratory<br>Recovery of critical elements from used lithium-ion cells, including:<br><br>- pre-treatment preparation of batteries for further processes<br><br>- disassembly and separation of battery components<br><br>- hydrometallurgical and thermal processes for recovering graphite from anodes and transition metal oxides from cathodes of lithium-ion batteries<br><br>- testing the properties of recovered materials reuse in new batteries<br><br>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.<br>Fundamentals of chemical technology.<br>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<br>2. L. L. Driscoll et al., Joule 8 (2024) 27352754.<br>3. L. Gaines, One Earth 1 (2019) P413-415.<br>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.<br><br>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.<br>2. Explain what a circular economy is.<br>3. What are critical elements?<br>4. What material processing technologies do you know?<br>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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