Brief information about the project

Title	IRN AP25794557 Electrochemical extraction of lithium from lithium-ion battery recycling solutions
Relevance	Effective methods for recycling lithium-ion batteries are crucial for reducing environmental impact and ensuring sustainable resource use. This project will not only improve existing technologies but also make a significant contribution to the development of Kazakhstan's circular economy and reduce reliance on primary raw material extraction. The project on electrochemical extraction of lithium from lithium-ion battery recycling solutions is timely and important for the advancement of modern science and technology. A key aspect of its relevance is that lithium extracted from spent batteries, i.e., from waste, can be directed to the production of new rechargeable batteries thanks to an optimized electrochemical process and an accessible laboratory setup developed within the project. This closes the cycle of material use, offering significant environmental benefits: reduced waste volumes and decreased need for primary lithium mining, which has a substantial environmental impact. Moreover, this approach, based on creating efficient and economical extraction technology, helps lower the costs of purchasing new lithium, making battery production more economically viable and competitive.
Goal	The project's goal is to optimize the method for extracting valuable components, particularly lithium, from circulating (model) solutions obtained from electrochemical processing of lithium-ion batteries, and to create an inexpensive and efficient laboratory setup.
Tasks	To achieve this goal, the following tasks must be completed: 1. Electrode material selection. This involves searching for a stable material capable of selectively extracting lithium ions, and one that is mechanically and chemically resistant in aqueous solutions. Examples of such materials include those used as cathodes for lithium-ion batteries: $LiCoO_2$ (lithium cobalt oxide), $LiMn_2O_4$ (lithium manganese spinel), $LiFePO_4$ (lithium iron phosphate), as well as $LiNiMnCoO_2$ (NMC) and $LiNiCoAlO_2$ (NCA). An electrolyte for electrochemical lithium extraction will also be selected and modeled. Model electrolytes containing lithium ions will be used to study the kinetics of lithium intercalation processes and its behavior at the cathode. 2. Optimization of the selected electrode material synthesis process. This involves developing a methodology to create electrodes with improved

	properties such as high conductivity, stability, selectivity, and durability. 3. Delithiation method development (material activation). When using lithium cathode materials, oxidizers will be employed to extract lithium via a chemical method. 4. Electrolyzer manufacturing. This task focuses on designing a structure that aligns with the project's goals and process. It's crucial to consider geometry, reaction conditions, and the potential for future scaling. 5. Optimization of electrolyzer operating parameters for lithium extraction with the selected intercalation-based material. The possibility of adding complexing agents, surfactants, and polymeric substances to minimize contamination of the lithium electrode by transition metals (Fe, Co, Mn) will be considered.
Expected and Achieved Results	An electrochemical extraction method for lithium from solutions imitation (model) lithium-ion battery recycling solutions will be developed, and a cheap and effective laboratory setup for extracting and concentrating lithium in the form of its salts will be proposed. The project's ultimate outcome will be an efficient electrochemical setup for extracting lithium from solutions of spent lithium-ion batteries. All scientific results obtained will be published in peer-reviewed international scientific journals listed in the Scopus and Web of Science databases, in accordance with the competition documentation. Publication of articles in international peer-reviewed scientific journals includes: - at least 2 (two) articles in journals from the first three quartiles by impact factor in the Web of Science database or with a CiteScore percentile in the Scopus database of at least 50. Each article will include information about this grant as a funding source. The scientific results achieved can be applied in the field of lithium-ion battery recycling.
Names and Surnames of Research Group Members with Their Identifiers (Scopus Author ID, Researcher ID, ORCID, if available) and Links to Corresponding Profiles	Tazhibayeva Aigerim Shotaevna Master of engineering and technology in chemical technology of inorganic substances, PhD candidate WoS Researcher ID: AFX-1089-2022 ORCID: 0000-0002-4680-5846 Malchik Fyodor Igorevich Associate professor, PhD in Chemistry H – index 13 Scopus Author ID: 57196147903 Researcher ID: D-5721-2015 ORCID: 0000-0001-6381-0738

Publications list with links to them	*Tazhibayeva A. Sh.*, Bayeshova A.K., Bayeshov A., Osińska M. Electrodeposition of nickel-titanium dioxide coatings and powders from aqueous sulfate solutions // Polyhedron. – 2025. - Vol. 277. – 117571 (Q2, процентиль 62) https://doi.org/10.1016/j.poly.2025.117571 Bayeshov A., *Tazhibayeva A.Sh.*, Bayeshova A.K., Osińska M., Zharmenov A.A.. Electrodeposition of composite coatings based on copper matrix included titanium dioxide in sulfuric acid solutions // International Journal of Biology and Chemistry. – 2023. – Vol.16, № 1. – P. 87-95. https://doi.org/10.26577/ijbch.2023.v16.i1.09 Баешов А., Турлыбекова М.Н., *Тажибаева А.Ш.*, Баешова А.К., Жарменов А.А. Мыс-молибден (VI) оксиді композициялы қаптамасын катодты поляризациялау арқылы алу // Химический журнал Казахстана. – 2022. – Вып. 4 №80. – С. 120-130. https://doi.org/10.51580/2022-3/2710-1185.100
Patent information	Баешов А., Тажибаева А. Ш., Баешова А. К., Турлыбекова М. Н., Жарменов А.А., Бердикулова Ф. А. Способ получения композиционного железо-титансодержащего порошка// Патент №8875 на полезную модель. – Опубл. 23.02.2024. Баешов А., Тажибаева А. Ш., Баешова А. К., Турлыбекова М. Н., Жарменов А.А. Электрохимический способ получения защитных цинкосодержащих композиционных покрытий на поверхности меди // Патент №8876 на полезную модель. – Опубл. 23.02.2024. Баешов А., Баешова А. К., Турлыбекова М. Н., Тажибаева А. Ш. Электролит для блестящего меднения // Патент №7508 на полезную модель. – Опубл. 14.10.2022. Баешов А. Б., Турлыбекова М. Н., Тажибаева А. Ш., Баешова А. К., Дагубаева А. Т. Способ получения никель-титансодежащих порошковых композиционных материалов // Патент №7634 на полезную модель. – Опубл. 02.1.2022.