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Innovative bio-metallurgical approach to lithium recovery from polymetallic waste Li-ion batteries for sustainability and circular economy

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The constantly growing demand for electronic equipment, modern electric vehicles, and power magazines determines the increase in the number of lithium-ion batteries produced. This also affects the growth in the amount of their waste, which must be properly processed due to the presence of many chemical substances, including metals, which pose a global threat to living organisms, the environment, and climatic conditions. Recycling battery waste is also economically beneficial. Growing consumerism, and therefore our demand, means that the natural resources of critical metals, including lithium, are constantly being overused, which can quickly lead to their depletion. The variety of their sources is also important to secure supplies of such elements and, consequently, the constant production of various goods, including Li-ion batteries. Therefore, thanks to recovery technologies, secondary raw materials can be reused and natural non-renewable resources are not over-exploited - the raw materials cycle is closed, in line with the circular economy and green transformation assumptions and Sustainable Development Goals.

In connection with this, concepts of a biological approach to the processing of waste Li-ion batteries were proposed using bacteria, fungi, as well as volcanic microalgae, which were studied in this context for the first time. Biometallurgy is a promising alternative to chemical and thermal recovery processes, using extremophilic microorganisms naturally occurring in the environment, making the process environmentally neutral while maintaining the same metal recovery efficiency as conventional methods. As a result of conducted experiments, it has been shown that effective bio-recovery of lithium from waste Li-ion batteries is possible, which indicates the potential of using this method in innovative, comprehensive technologies for processing polymetallic waste. This allows for the reuse of metals in new products, which provides for sustainable resource management and minimizing the impact of mining on the environment while securing the supply of raw materials and ensuring the continuity of appropriate waste recycling.