Machine learning-driven framework for lithium-ion battery recycling

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Technological innovation has led to the widespread adoption of lithium-ion batteries (LIBs) for portable energy storage. Hence, it is crucial to find sustainable solutions to manage the growing volume of battery waste. Lithium, cobalt and graphite are essential materials for LIB production flagged by the EU as critical raw materials. Waste LIBs may therefore be viewed as a sizeable source of valuable materials rather than waste – securing an alternative supply of these resources. Therefore, the efficient recovery of metals from LIBs is a crucial step to ensure the circularity of batteries. However, it can be challenging to identify optimal leaching conditions given the variety of available battery chemistries and leaching agents, while considering not only economic but also environmental concerns.

In this work, a methodical data-driven approach is taken to model the leaching of key metals from LIB cathodes, exploiting the available literature to create a versatile leaching model built using machine learning algorithms. The output from such models is then used to compute a rough economic and environmental assessment, accounting for key performance indicators (heating requirements, solvent cost and environmental impact, amongst others) and thus allowing for the agile screening of potential leaching conditions. The methodology described herein is an important step in integrating emerging computational tools in the development of novel, greener metal recycling processes.

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