

Selective Recovery of Critical Metals from Alkaline Battery Black Mass Using Ionic Solvents

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Black mass—the finely crushed residue left after mechanical processing of spent batteries—represents an underutilized but valuable secondary source of critical metals such as zinc (Zn), iron (Fe), and manganese (Mn). Efficiently recovering these metals is key to enabling a circular economy for battery materials and reducing dependence on virgin mineral extraction.

In this work, we explore the use of ionic solvents—specifically deep eutectic solvents (DESs) and protic ionic liquids (PILs)—as environmentally friendly and low-temperature alternatives for metal recovery. These solvent systems offer tunable chemical environments, capable of selectively dissolving and separating metal species based on differences in their chemical reactivity and solubility. We demonstrate a stepwise fractional extraction approach, where targeted metal ions are sequentially solubilized and recovered from alkaline battery black mass under mild conditions, without the need for high-temperature treatments or strong acids. Our results show promising selectivity and efficiency, highlighting the potential of ionic solvents as a sustainable platform for black mass valorisation.

This process aligns with global efforts to decarbonize metal supply chains and opens the door to modular, distributed recycling strategies that can reduce waste and environmental impact.

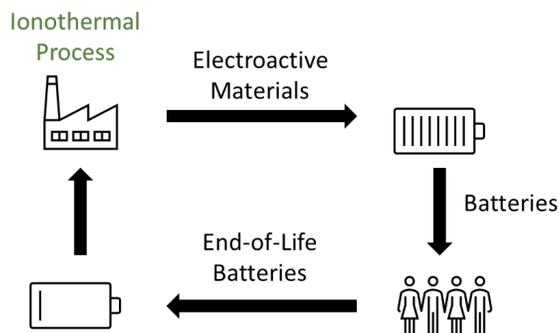


Figure 1. Concept for closed-loop ionothermal processing of spent alkaline batteries.

References

1. Malaret F.; Hallet J.; Campbell, K. * *Mater. Adv.* **2020**, 1(9), 3597 – 3604.



Dr. Francisco Malaret is CEO of Nanomox Ltd., an Imperial College London spin-out developing sustainable processes for advanced inorganic materials. He pioneered Oxidative Ionothermal Synthesis (OIS) to produce high-performance metal oxides for semiconductors, solar panels, and batteries. He earned his PhD at Imperial, researching ionic liquids for separations. Previously, he worked eight years in France as a senior process engineer in LNG. He holds degrees in chemical engineering, chemistry, and oil refining.