Expanding recycling strategies for greener battery technologies

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Climate change remains a major obstacle to achieving Sustainable Development Goals (SDGs)[1], with the transition to clean energy being central to mitigation efforts. Lithium-ion batteries (LIBs) are pivotal in this shift, dominating the electrified mobility and energy storage sectors.[2] Global electric vehicle (EV) sales, which rose from 0.7 million in 2015 to 10 million in 2022, are projected to reach 30 million by 2030.[3] However, scaling LIB production presents critical challenges, including dependence on scarce raw materials, high manufacturing costs, and safety concerns.[4]

Each EV battery pack requires approximately 8 kg of lithium, implying a future demand of 240 million tonnes, vastly exceeding the currently estimated 20 million tonnes of global lithium reserves.[5] Beyond availability, production feasibility and purity constraints further stress supply chains, as lithium remains essential for other strategic applications. Managing end-of-life batteries is therefore crucial to mitigate environmental risks, resource depletion, and supply vulnerabilities. [5,6]

Battery reuse and recycling offer essential solutions, but conventional pyrometallurgical and hydrometallurgical approaches suffer from high energy consumption, chemical waste generation, and incomplete material recovery. [6,7] To overcome these limitations, diverse recycling pathways are emerging, including direct recycling techniques that enable more efficient resource use with reduced environmental impact.[8]

This presentation will explore innovative LIB recycling strategies, focusing on direct recycling methods coupled with detailed chemical-physical characterisation of recovered materials. It will also discuss the potential for these materials to be repurposed into sustainable electrode components, presenting preliminary insights into their electrochemical performance in new LIBs.