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Recycling of Lithium-Ion Batteries – Engineering Artificial Minerals as a Promising Approach

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Session: Plenary Session

Abstract Body

The growing demand for lithium-ion battery (LIB) applications highlights the need for innovative recycling strategies in the circular economy context [1]. Combined pyrometallurgical and hydrometallurgical processing routes are gaining increasing attention for the recovery of Ni, Co, Cu, Li and Mn in particular [2]. However, further improvement of recycling efficiency is still a significant challenge, which is also linked to a detailed understanding of the phase behaviour of the multicomponent, multiphase lithium-containing slag at different temperatures and artificial composition states under realistic mineral processing conditions [1]. Engineered Artificial Minerals (EnAMs) are at the heart of a new approach to the design of scavenger compounds for the recovery of critical elements in a circular chemistry context [3, 4]. Therefore, a fundamental understanding of the solidification and melting of complex oxide melts is essential. This understanding can be achieved through a cross-evaluation of thermokinetic and molecular dynamic models in combination with XRD and XRF techniques [1, 3, 5, 6]. An overview of different recycling processing routes associated with specific EnAM developments and the methods involved are presented for LIB recycling. Special emphasis is also placed on the relationships between mineral processing conditions, elemental composition, and atmosphere (oxygen fugacity), as well as on Mn species, which is investigated in more detail by a combined computational and experimental analysis [5, 6]. Based on the application of this approach, improvements in lithium recovery efficiencies in combined pyrometallurgical and hydrometallurgical LIB slag recycling processing routes are discussed.

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