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Challenges in the Characterization of Black Mass in the Recovery of Graphite from Spent Lithium Ion Batteries

Authors : Anna Vanderbruggen, Kai Bachmann, Martin Rudolph, Rodrigo Serna

Abstract : Recycling of lithium-ion batteries has attracted a lot of attention in recent years and focuses primarily on valuable metals such as cobalt, nickel, and lithium. Despite the growth in graphite consumption and the fact that it is classified as a critical raw material in the European Union, USA, and Australia, there is little work focusing on graphite recycling. Thus, graphite is usually considered waste in recycling treatments, where graphite particles are concentrated in the “black mass”, a fine fraction below 1mm, which also contains the foils and the active cathode particles such as LiCoO2 or LiNiMnCoO2. To characterize the material, various analytical methods are applied, including X-Ray Fluorescence (XRF), X-Ray Diffraction (XRD), Atomic Absorption Spectrometry (AAS), and SEM-based automated mineralogy. The latter consists of the combination of a scanning electron microscopy (SEM) image analysis and energy-dispersive X-ray spectroscopy (EDS). It is a powerful and well-known method for primary material characterization; however, it has not yet been applied to secondary material such as black mass, which is a challenging material to analyze due to fine alloy particles and to the lack of an existing dedicated database. The aim of this research is to characterize the black mass depending on the metals recycling process in order to understand the liberation mechanisms of the active particles from the foils and their effect on the graphite particle surfaces and to understand their impact on the subsequent graphite flotation. Three industrial processes were taken into account: purely mechanical, pyrolysis-mechanical, and mechanical-hydrometallurgy. In summary, this article explores various and common challenges for graphite and secondary material characterization.

Keywords : automated mineralogy, characterization, graphite, lithium ion battery, recycling
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