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# Lithium-Ion Battery Recycling by Physical Processing: Evaluation of Recovery and Metal Content in Shredding and Sieving Operations

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**Abstract.** Recycling of spent Li-ion batteries is essential for the sustainable management of critical raw materials for battery production. The pre-metallurgical steps, involving shredding and physical processing, are important operations for separation and concentration of the electrode powders constituting the black mass. This paper presents a laboratorial study of the shredding of pouch-type LIB cells to assess the efficiency of liberation of the powders of electrode materials, envisaging their recovery. The particle size distribution and the elemental chemical analysis of the main metals in the cathode materials (Li, Ni, Co, Mn) as well as the main contaminants (Al, Cu) allowed to assess the recovery yields and purity of the fine fraction obtained in the sieving operation. The results showed that the cell casings (aluminum laminate) were essentially present in the coarser sizes (8–10 mm). Cathode metals were mainly in the intermediate and fine fraction, both as liberated particles and as particles within Al foil (thus, not liberated). Several scenarios for separation of cathode powders were studied. The main conclusion is that, by using a separation sieve of 0.5 mm, it is possible to recover 44% of the cathode materials with low contamination of Al and Cu (with contents 0.6% and 3.7%, respectively). This is a good achievement when considering simple shredding and sieving operations. Higher recoveries would need more grinding steps and other physical processing operations.

**Keywords:** Li-ion batteries · Recycling · Physical processing · Shredding

## 1 Introduction

Li-ion batteries (LIBs) are the most used electrochemical devices, with a broad spectrum of applications ranging from mobile devices to electric vehicles, in addition to their role in stationary energy storage. The energy transition, based on renewables, is strongly dependent on energy storage and particularly on batteries, with the availability of raw