

Development of an in-house recycling process of spent Li-ion batteries: alternatives to established recycling options in compliance with legal and safety requirements

KYBURZ Switzerland A.G in collaboration with TLS group, Empa St Gallen.

In a cooperation with KYBURZ we give scientific support to the development of a small low-tech pilot plant for the recycling of spent LiFePO₄ (LFP) batteries. KYBURZ develops and produces high quality Electric Vehicles (EV) for the Swiss postal service, industrial sector and private market. In total, KYBURZ uses 2500 LFP batteries per year to produce a fleet over 22000 EV. This type of batteries contains valuable materials such as copper, aluminum, transition metal oxides and lithium salts that can be recovered.

According to the Swiss regulation, it is mandatory for manufactures and importers of batteries to pay an advance-recycling fee and guarantee a proper disposal of the batteries. Thus, KYBURZ wants to establish its own in-house recycling process. This process is both environmentally friendly and cost-efficient in compliance with legal and safety requirements in Switzerland. The role of our group at Empa in the project focus on the process optimization, chemical characterization of the recovered materials, assessment of environmental impacts and safety implementation of the treatment process. Currently, the recovered materials have been analyzed and characterized (in particular graphite and metal oxides using EDS, SEM and ICP).

Recycling Process of spent LFP batteries

The pilot plant has a recycling capacity of 130 kg/day and consists of two phases.

Phase 1

First, spent LiFePO₄ batteries are collected, passively discharged to a residual voltage of 2.5V and then semi-automatically dismantled inside of a globe box. The recycled byproducts from this stage correspond to the plastic housing, plastic separator and, cathode and anode, which are separated in different containers (see Figure 1).

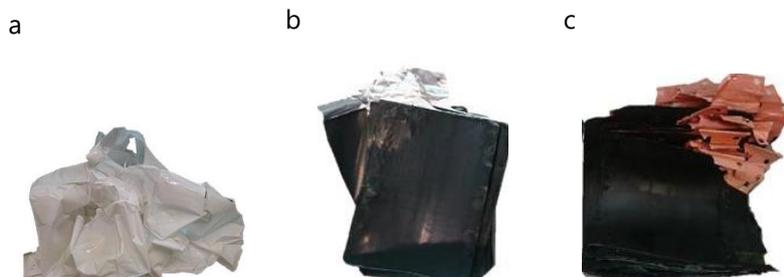


Figure 1: Recycling byproducts a) Plastic separator b) Cathode c) Anode

Currently, the first phase of the pilot plant is done and was presented to the public last Friday, 4th of September, at the Circular Economy Congress by KYBURZ (Figure 2).



Figure 2. Battery Recycling Pilot Plant of KYBURZ-Switzerland. @Werner Hauser, KYBURZ

Phase 2:

The separation of the coating materials from the electrode foils consists of a carbonate bath to dissolve and concentrate the lithium salt (LiPF_6) which is part of the composition of the electrolyte. After, the electrodes are soaked in water to separate the metal oxide from the aluminum foil (Cathode) as well as the graphite from the copper foil (Anode) (see Figure 3). The metal oxide (LiFePO_4) and graphite are further separated from water via filtration and centrifugation. The recovered materials have been preliminary analyzed by Energy Dispersive X-Ray Spectroscopy (EDX), Scanning Electron Microscope (SEM) and Inductively Coupled Plasma Spectroscopy (ICP).

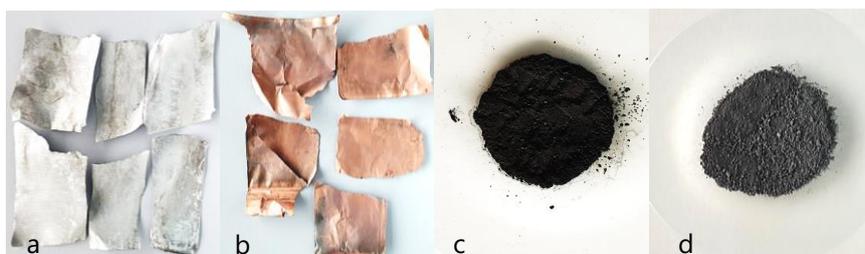


Figure 3: Recovered materials: a) Aluminum foil b) Copper foil c) Graphite d) Metal Oxide

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