Behaviour of elements during flotation of the active material

How far are we with the recycling of lithium-ion batteries?

The amendment of the EU Battery Regulation stipulates higher recycling efficiencies for Lithium-Ion Batteries (LIBs, 65 % by weight by the end of 2025; 70 % by weight by the end of 2030) and sets more ambitious targets for the recovery rates of lithium Li (50 % by the end of 2027 and 80 % by the end of 2031) and for cobalt Co, nickel Ni and copper Cu (90 % by the end of 2027 and 95 % by the end of 2031).

The COMET Module FuLIBatteR (Future Lithium-Ion Battery Recycling for Recovery of Critical Raw Materials) transforms waste generated by our society into secondary raw materials through innovative, cross-sectoral recycling approaches divided into 3 projects. These are project 1, “Waste management and waste technology approaches for the recycling of LIBs”, project 2 “Pyrometallurgical processing of LIBs and black mass” and project 3 “Bio-hydro-metallurgical treatment of LIB residues”.

In project 1 of FuLIBatteR “Waste management and waste technological approaches for LIB recycling”, the scientific partner UVR-FIA GmbH (Germany, UVR-FIA for short) is working on the mechanical processing of active material using froth flotation. The primary objective is to separate the graphite (C) from the froth product to produce a cell product with a lower C content for further work within FuLIBatteR (pyrometallurgical treatment of the cell product for metal recovery in project 2, bio-hydrometallurgical treatment for metal recovery in project 3). In addition, the flotation wastewater will be treated using an ion exchanger to quantify the recovery of water-soluble components, such as Li or phosphorus. The C-rich product is evaluated, for instance, for its potential use as a secondary raw material in the refractory industry, particularly in magnesia-carbon bricks.

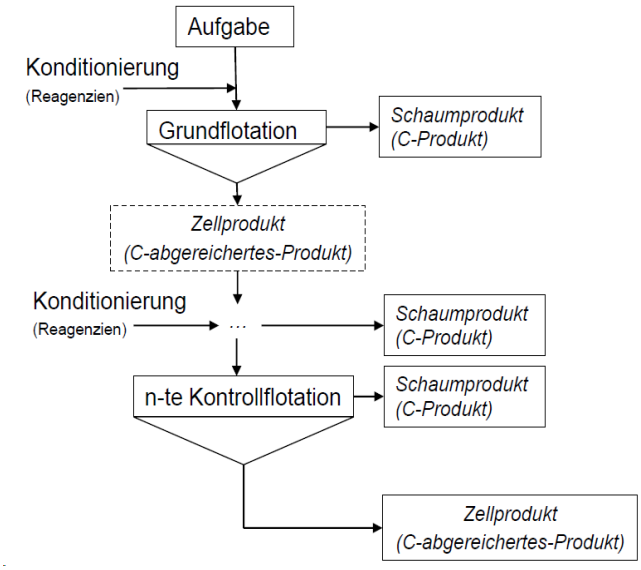

Figure 1: Principle of froth flotation for treating the active material; C carbon/ graphite (Quelle: UVR-FIA).

Figure 1 shows a schematic of the froth flotation for treating the active material. The last tests were carried out in a 4-liter flotation cell. A wide range of flotation reagents were used in the tests. For the first flotation step (rougher), a lignosulfonate was used as a dispersing agent, diesel as a collector, and pine oil as a foaming agent. The rougher is followed by one or more control flotations (scavenger) to bring the C separation (via the froth product) to a maximum value. Diesel and pine oil are also added during these scavenger steps.

Different active materials have been tested during FuLIBatteR so far (Ni-Mn-Co, NMC for short, and Li-Fe-Phosphate, LFP for short, as cathode material, C as anode material, traces of aluminum and Cu from the conductor foils)

Results showed C contents between 6 – 12 wt.% for the cell product (low-C product). With an initial C content of around 40 % by weight in the active material, up to 90 % of the carbon in the froth product is thus re-leased in some cases. C contents of up to 93 % by weight were achieved for the froth product (C-product). The residue consists mainly of Ni, Co, Al, Cu and Mn in varying proportions. The selectivity of the flotation and the quality of the flotation products strongly depend on the active material used.

In addition to the research work, efforts were also made to expand FuLIBatteR's international network. This includes participation as an associated partner of the IPCEI Eu-BatIn (participation in the "Recycling and Sustainability" work stream). From 14 to 15 March 2024, K1-MET will participate in the EU Battery Convention Days in Bologna (Italy) to increase awareness of the Module. At national level, the participation in "automotive.2024 – Austrian Roads to Excellence" on 6 June 2024 in Linz (voestalpine Stahlwelt) is currently planned.

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