Safeguarding a critical raw material base in Europe by closing the loop: The DiLiRec project

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The limited lifespan of lithium-ion batteries is causing an increase in the volume of used batteries and battery waste. At the same time, the demand for lithium iron phosphate (LFP) is growing. These electrical energy storage systems are of interest because of their safety, longevity, and cost efficiency. Efficient recycling strategies help to make the principles of the European Green Deal, i.e. the development of a sustainable industry while reducing the consumption of battery materials, a reality. Direct recycling is one of the most promising approaches in this regard.

As part of the DiLiRec project (GA: 03XP0549H), funded by the Federal Ministry of Education and Research (BMBF), nine project partners are developing novel recycling processes for the LFP cathode material on the basis of optimized black mass extraction, catering to real industrial needs.

The main focus of Fraunhofer IKTS is the development of a direct recycling route. To achieve this, it is necessary to define the requirements for the black mass and potential recyclates. Therefore, the recycled active materials are analyzed comprehensively to optimize the direct recycling process. The electrochemical performance of the recyclates produced is characterized in coin cells, wherein pure recovered materials as well as mixtures of recycled LFP cathode or graphite anode material with fresh active materials in different ratios are evaluated.

The first recycled electrodes are produced from waste LFP cathodes; the active material was recovered by a dry mechanical decoating process. For comparison, a reference LFP cathode is also analyzed. Compared with a reference electrode, the behavior of the recycled LFP material differed during electrode manufacturing and with regard to electrode porosity (Fig. 1). These effects can be related to the previous ingredients of the electrode, such as the binder and the conductive additive, or included impurities, such as aluminum. The result of the galvanostic cycling (Fig. 2) shows a very promising cycling performance for the recycled LFP cathode, amounting to more than 88 % of the reference capacity (commercial LFP: 154 mAh g^{-1} vs. recycled LFP: 136 mAh g^{-1}). In order to sustainably improve performance in the next step, the project team will investigate the influence and removal of impurities, as well as mixtures of recycled LFP and fresh LFP as cathode active material.

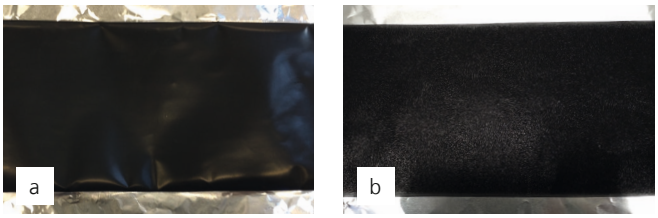

Fig. 1: LFP cathode active material. a) Fresh LFP as reference electrode. b) Pure recycled LFP cathode.

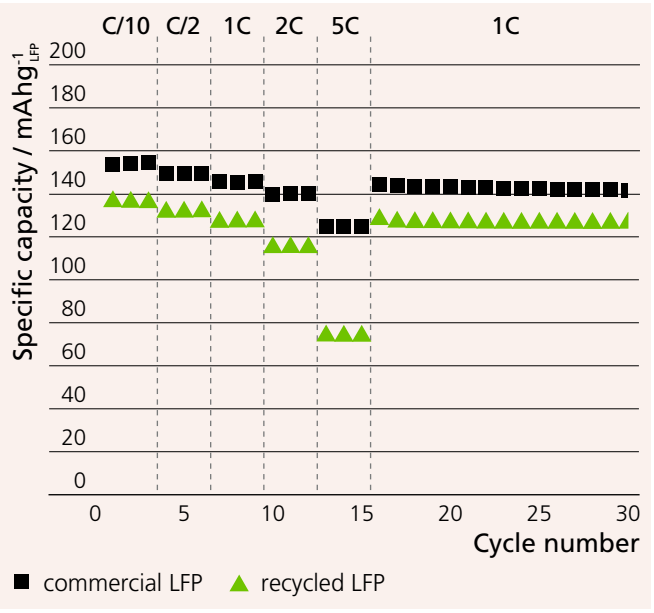

Fig. 2: Galvanostatic cycling performance (vs. Li/Li+) of a pure recycled and a commercial LFP material.

Within the DiLiRec project, Fraunhofer IKTS has demonstrated the potential of the direct recycling technology before even having optimized this recycling route, thus making an important contribution to the circular economy in the field of batteries, and safeguarding resources in Europe.

SynBatt Green Battery DiLiRec

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