The Reuse of Recycled Graphite in Lithium-Ion Anodes

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Abstract

Recycling is vital to the sustainable scale-up of the lithium-ion battery (LIB) production, especially with regard to the great amount needed for electric vehicles, which places a significant strain on the critical raw materials[1]. Graphite – natural or synthetic – is the most dominant active material for the negative electrode[2]. Natural graphite, though, is considered a critical material within the EU[3], while synthetic graphite is obtained from coke[4] – a carbon precursor typically produced from coal or petroleum. By recycling graphite from spent LIBs, the eventual waste and CO_2 emissions can be substantially decreased, while the overall resources are preserved. In fact, the efficient recycling and reuse is key towards a truly circular economy concerning LIB fabrication[5].

Herein, we report a new and highly efficient process to obtain high-quality graphite from spent LIBs. Following a comprehensive physicochemical characterization of the materials obtained, we conducted an extensive electrochemical characterization in half-cells and graphite‖NMC_{532} full-cells and compared the results with the data obtained for half-cells and full-cells employing pristine commercial graphite. In half-cells, the recycled graphite reveals remarkably high reversible specific capacities (e.g., 350 mAh g^{-1} at C/20) and very stable cycling for several hundred cycles at 1C. The graphite‖NMC_{532} full-cells show an excellent cycling stability as well, with a capacity retention of 80% after about 1,000 cycles. In fact, the comparison with the pristine graphite comprising full-cells reveals very comparable performance, highlighting the great promise of recycled and reused graphite as key step towards truly sustainable LIBs and the great goal of a circular economy.

References

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