Mechanically manufactured composite materials for cathodes in lithium-sulfur batteries

<u>Paul Titscher</u> [a,b], Alexander Götz von Olenhusen [a,b], Arno Kwade [a,b]

[a] *Institute for Particle Technology, Technische Universität Braunschweig, Volkmaroder Str. 5, 38104 Braunschweig, Germany*

[b] *Battery LabFactory Braunschweig, Technische Universität Braunschweig, Langer Kamp 19, 38106 Braunschweig, Germany*

E-Mail: p.titscher@tu-braunschweig.de

The expectations of the lithium-sulfur battery technology (LSB) as a potential next generation battery technology have been significantly weakened by the performance practically reached today. Furthermore, promising approaches on the material level are seldom economically scalable. The energy density, which is important for e-mobility, cannot record a significant increase compared to lithium-ion batteries. However, as potentials continue to exist, particularly in terms of profitability and specific energy, this research work focuses on the scalable production of composite materials for LSB application based on commercially available materials.

Elemental sulfur and carbon black are treated with different mechanical processes, such as ball milling and high intensive mixing in order to get a homogenous combination of both materials. The presented results show that the processes lead to different composite particle morphologies depending on the overall applied intensity. Starting with a low intensive mixing process the particle sizes of the generated composite can be controlled by the chosen process parameters. The homogeneity of sulfur and carbon within the composite particles increases with higher stress input, induced by the more intensive mixing processes. The applied stress can be correlated to the dissipated energy within the synthesis chamber leading to an effective merging of the sulfur with the carbon host material. In terms of a uniform particle size distribution, the mechanical treatment supports the sulfur infiltration with a breakup of the carbon host agglomerates and a continuous stress onto the composite particles.

In order to evaluate the electrochemical characteristics of the produced composite materials, sulfur composite cathodes are produced by a solvent based coating process and measured versus a lithium metal anode. The achieved performance is compared to sulfur cathodes based on materials without a high intensive mechanical treatment. On the one hand, the solvent based process is supported beneficially by coarser particles, leading to a lower solvent consumption by the material at the dispersing step. This allows using a higher solids content within the slurry. On the other hand, the stiff and equal distributed coarse composite particles stabilize the cathode structure and effect an overall internal distribution of the sulfur. This, in turn, leads to a higher C-rate stability. The practical achievable energy density can be increased as well by increasing the electrode density maintaining the required porosity for an unlimited ion transport.

Category 9. Li-Sulfur Batteries