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Investigating the impact of the particle size on the performance and internal resistance of aqueous zinc ion batteries with a manganese sesquioxide cathode

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Aqueous zinc ion batteries composed of an intercalation cathode and a metallic zinc anode are considered to be one of the most promising battery types for stationary storage applications. Due to the aqueous electrolyte they are inherently safe concerning flammability and in addition they are environmentally friendly. Manganese oxide has attracted much attention because of its relatively high capacities as cathode material. In this work we investigate the strong influence of the particle size of the manganese oxide. A ball milling process was applied to downsize the particle diameter and laser diffraction analysis was used to investigate the particle size distribution within the resulting powder. These powders were mixed with carbon black and binder (LA133) and coated on stainless steel foil. These cathodes were assembled in coin cells with zinc foil, aqueous electrolyte and separator as full cells for further investigations. The different particle sizes showed a high impact on the capacity of the battery under different current densities (Figure 1). It was shown that a smaller particle size triples the initial capacity and causes a capacity breakdown at high current densities. With the aid of an equivalent circuit model, the reason for this increased capacity and breakdown was analysed. The possible influence of shorter diffusion paths in the solid phase, altered porosities and crystal structure, particle contacting and surface on the capacity are considered and examined.

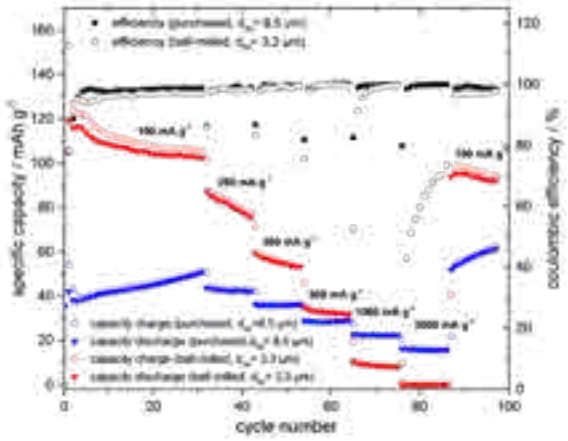

Figure 1: Manganese Sesquioxide purchased from Alfa Aesar (purchased, d_{50}=8,5 µm) and after ball milling treatment (ball-milled, d_{50}=3,3 µm) cycled with different current densities.

Biography

Christian Bischoff has completed the MSc in mechanical engineering from the University of Rostock, Germany, in 2016 and works at the Fraunhofer ISE in Freiburg since that time. He is a scholarship holder of the Heinrich-Boll-Stiftung. He is pursuing the PhD on the fabrication and performance of aqueous zinc ion batteries.

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