Identification of Capacity Fading Mechanisms in Dual-Ion Batteries and Development of Countermeasures

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The dual-graphite battery (DGB) features a promising alternative option to stationary energy storage applications besides the market-dominating lithium ion battery[1]. The technology is based on a simultaneous intercalation of anions and cations into the positive and negative graphite electrode, respectively. Until now, there is a still a lack of knowledge concerning the fundamental working principle of DGBs. Here, we light up the mechanisms of capacity fading during charge/discharge operation, focusing on the mismatch of parasitic reactions at both electrodes and its impact on the cell capacity. The effect of higher Coulombic efficiency at the positive electrode compared to the negative one, leading to anion accumulation as well as the effect of higher Coulombic efficiency at the negative electrode, leading to cation accumulation/plating, is discussed in detail. Following the lithium inventory model, which is known for lithium ion batteries[1], we introduce the terms "ion couple inventory" and "insertion site inventory", which can be applied for DIBs. This type of capacity fading mechanism, which is completely different to the fading mechanism in lithium ion batteries, is investigated by electrochemical charge/discharge measurements in combination with X-ray diffraction measurements. These fundamental studies will help to further advance the development of DGBs with enhanced cycle life.

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[2] Smith AJ, Burns JC**,** Xiong D, Dahn JR, **2011**. *'Interpreting High Precision Coulometry Results on Li-ion Cells'* Journal of The Electrochemical Society 158, A1136-A1142