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Toward In-Situ Protected Sulfur Cathodes by Using Lithium Bromide and Pre-Charge

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Abstract

Lithium-sulfur (Li-S) batteries suffer from the dissolution of its intermediate charge products (polysulfides) in organic electrolytes, which limits the utilization, rate performance and cycling stability of S cathode materials. Formation of protective surface coatings on S cathodes may effectively overcome such a challenge. Here, we explored a simple, low cost, and widely applicable method that offers *in-situ* formation of a protective coating on the S-based cathode by using lithium bromide (LiBr) as a novel electrolyte additive. Quantum chemical (QC) studies suggested that pre-cycling a S cathode at high potentials is needed to oxidize the Br⁻ and induce formation of DME(-H) radicals, which are involved in the formation of a polymerized protective layer of a solid electrolyte interphase (SEI) on a S cathode at high potentials. Experimental studies with a LiBr additive confirmed that 3 pre-cycles in a voltage range of 2.5-3.6V are sufficient to achieve the formation of a robust Li ion permeable SEI on the cathode, effectively preventing the dissolution of polysulfides into electrolyte. As a result, almost no degradation was observed within 200 cycles, compared to more than 40% of capacity loss in the benchmark control cells without LiBr or the pre-cycles. *Post-mortem* analysis on both the cathode and anode sides of the LiBr-comprising cells further provided evidence for the *in-situ* SEI formation on the cathode and the lack of polysulfides' re-precipitation. In addition, such studies showed smooth surface on the cycled Li metal anode, in contrast to the rough Li SEI with dendrites and polysulfides in the benchmark cells.

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