All solid-state Lithium-Sulfur battery with state-of-the-art solid electrolytes

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Ranging from electric vehicles to mobile devices, as well as electric grid stabilization, the demand for batteries with a high energy density is rapidly growing. Unfortunately, the current commercially available Li-ion battery chemistry is approaching a theoretical limit. [1] Utilizing Sulfur or Li_2S as cathode active materials, which have theoretical capacities of 1672 mAh/g and 1170 mAh/g, respectively, represents one of the promising choices for the next generation batteries. [2] However, the formation of high-order polysulfides, which are soluble in organic solvents, significantly deteriorates the capacity retention of batteries through the loss of active materials and severe over potential arising from electronically and ionically non-conductive materials deposited on the electrode. [3,4] All of which makes the use of conventional liquid electrolytes challenging. To overcome this issue, we employ a solid-state inorganic Li-ion conductor as an alternative electrolyte. The all-solid-state Li-S battery cells, composed of state-of-the-art Li-ion conductors (e.g. Li_6PS_5Cl, Li_6PS_5Br, and $Li_7P_3S_{11}$), exhibit no evidence of the shuttle effect and an initial discharge capacity of over 1000 mAh/g. Nevertheless, rapid capacity fading still occurs during cycling. Toward the generation of batteries exhibiting enhanced performance, the potential causes of such poor capacity retention are discussed in relation to the stability of the solid electrolytes, the effect of different type of carbons additives and the contact loss due to continuous volume changes within the active materials.

References:

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