

Supporting information for

Ionic Liquid-Enhanced Solid State Electrolyte Interface (SEI) for Lithium-Sulfur Batteries

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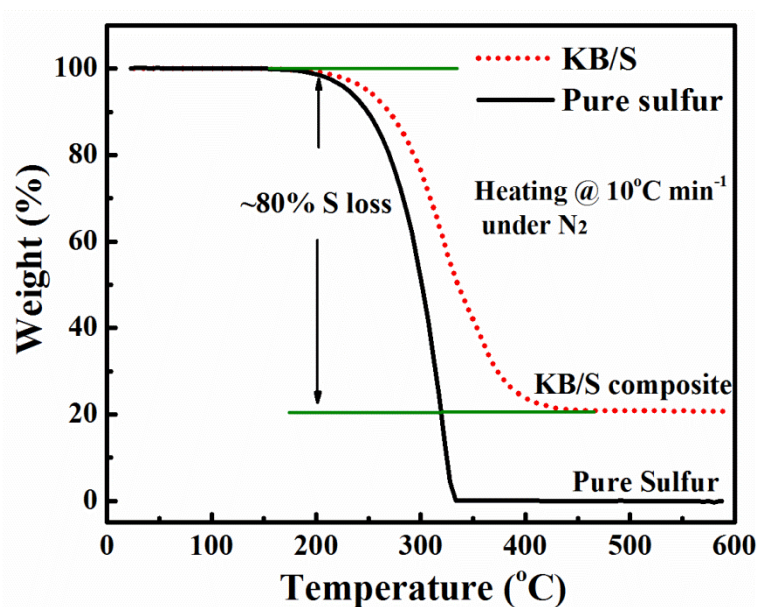


Fig. S1 shows the thermogravimetric analysis (TGA) of the pure sulfur and KB/S composite. The weight loss for KB/S composite is 79.3%, very close to the sulfur content as predetermined during preparation.

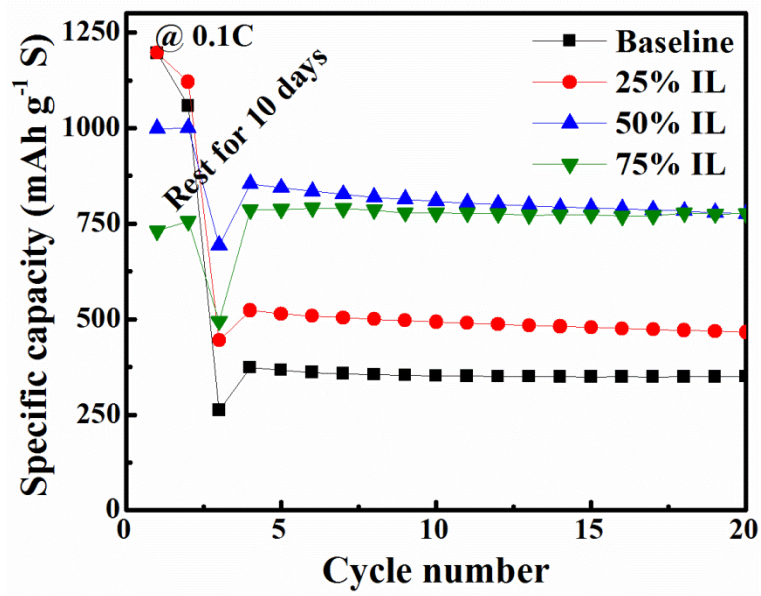


Fig. S2 shows the self-discharge behaviors of Li-S cells with electrolytes containing different IL contents. With the increase of IL content in the electrolyte, the self-discharge rate of Li-S cell is greatly reduced.

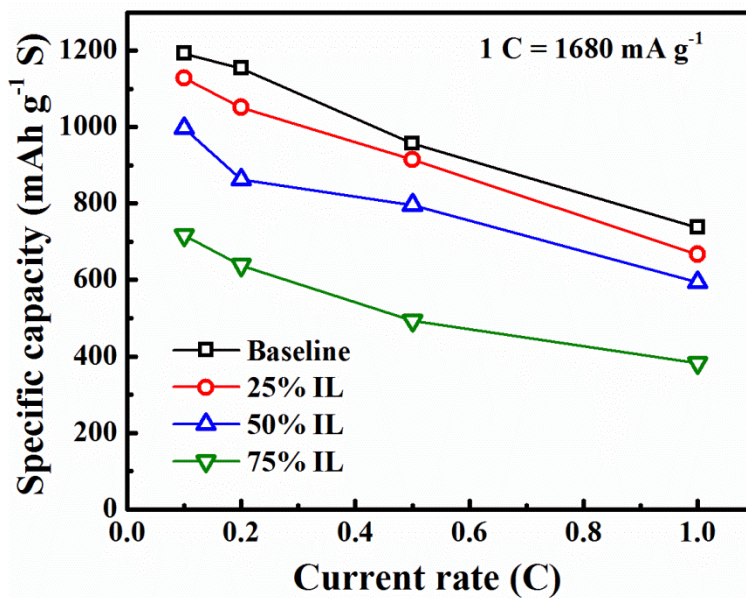


Fig. S3 shows the rate performance of Li-S cells using electrolyte containing different amounts of Py₁₄TFSI (1 C = 1680 mA g⁻¹). The result shows that the increase of IL content brings negative effect to the rate capability of Li-S cell, due to the increase of electrolyte viscosity and the decrease of electrolyte conductivity.

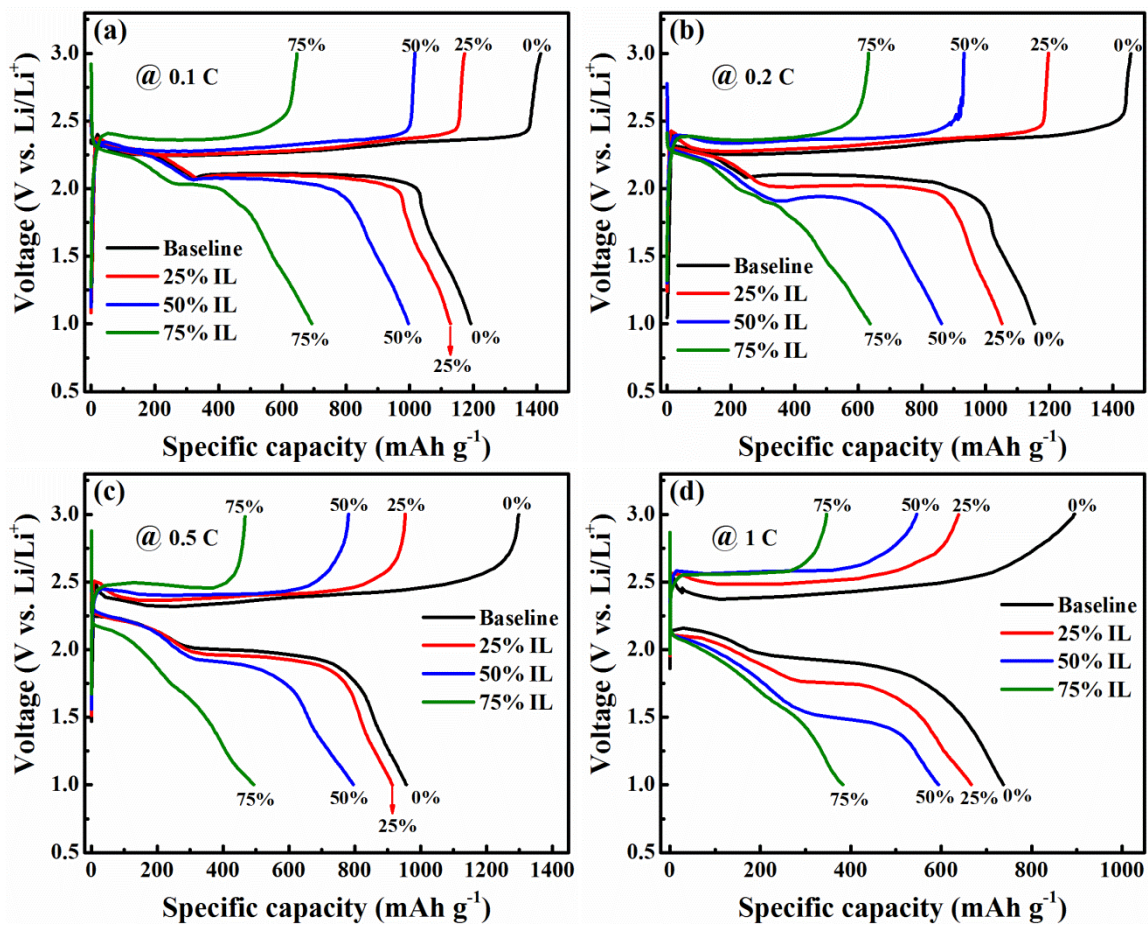


Fig. S4 shows the initial discharge/charge profiles of Li-S cells using electrolyte comprised of 1 M LiTFSI in DME/DOL with different amount of Py₁₄TFSI (1 C = 1680 mA g⁻¹).

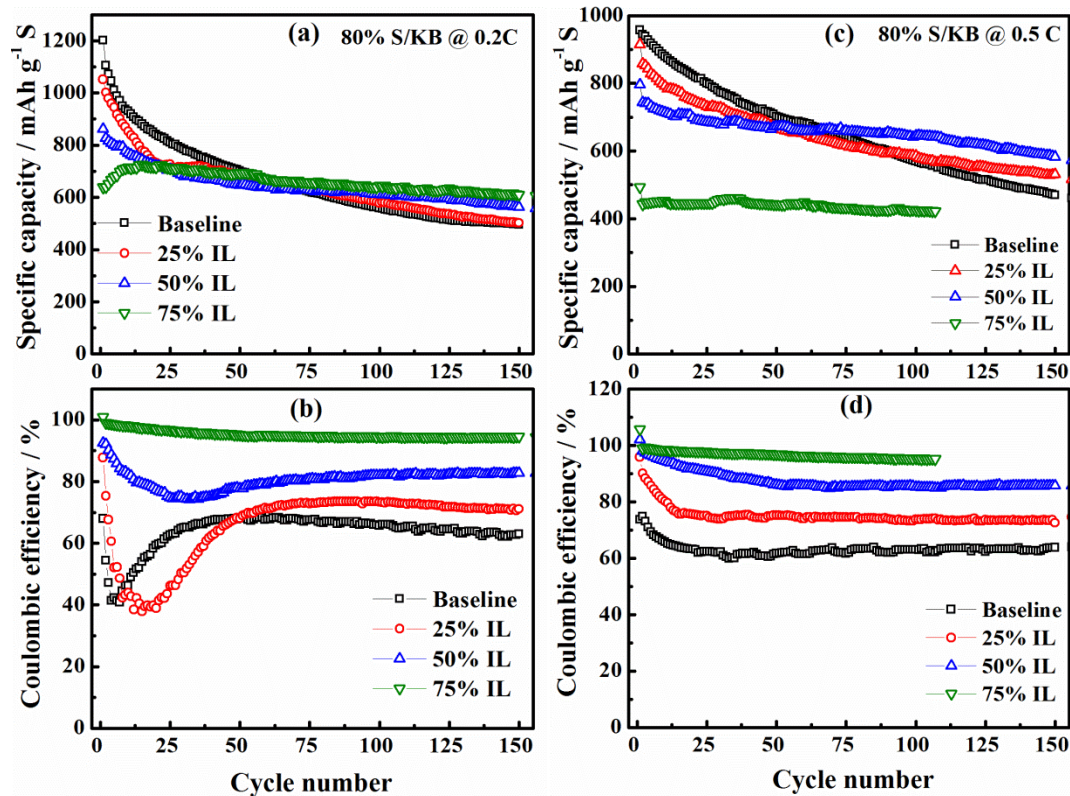


Fig. S5 shows the cycling performance and Coulombic efficiency of Li-S cells with baseline and IL-containing electrolyte at 0.2 C (a, b) and 0.5 C (c, d). The results demonstrate that the cycling performance and Coulombic efficiency are also significantly improved both at 0.2 and 0.5 C rates with the addition of ionic liquid Py₁₄TFSI.

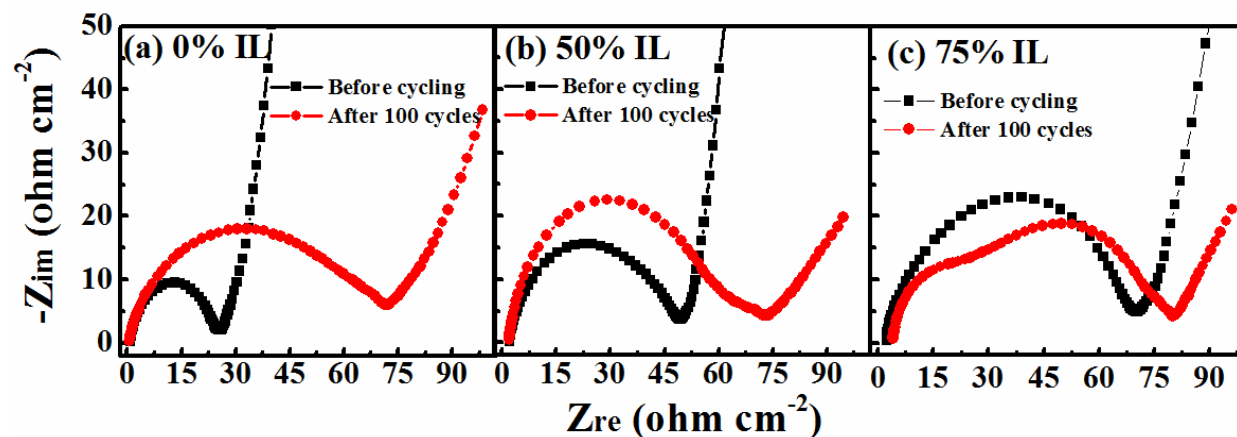


Fig. S6 compares the EIS spectra of Li-S cells with (a) baseline, (b) 50% IL and (c) 75% IL containing electrolyte before cycling and after 100 cycles at 0.2 C. Impedance was measured at fully charged state. The total resistance of cell with baseline electrolyte at 100th cycle is more than 3 times of that before cycling. In contrast, there is only about 50% increase of the total resistance for cell with 50% IL containing electrolyte after 100 cycles. EIS data suggest that lithium anode in IL electrolyte tends to form an optimized and stable Li/IL electrolyte interface during cycling, which decreases the parasitic reactions between polysulfides and lithium anode and suppresses the deposition of insoluble lithium sulfide ($\text{Li}_2\text{S}_2/\text{Li}_2\text{S}$) on lithium anode. That's why the sulfur cathode shows superior electrochemical performance in IL containing electrolyte.