An Ultra-high Capacity Graphite/Li_2S Battery with Holey Li_2S Nanoarchitectures

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High-capacity Li_2S cathode (1,166 mAh g^{-1}) paired with lithium-free anode (LFA) provides an unparalleled potential in developing safe and energy-dense next generation secondary batteries. However, the low utilization of Li_2S cathode and the lack of electrolyte compatible to both electrodes are impeding the development. Here, we report a novel graphite/Li_2S battery system, which features a lost-cost, self-assembled, and holey Li_2S nanoarchitecture and a stable solid electrolyte interface (SEI) on the graphite electrode. The novel holey structure is beneficial in decomposing Li_2S at the first charging process due to the enhanced Li ion transfer between the Li_2S and electrolyte, and the concentrated dioxolane-rich electrolyte we designed favors to lower the irreversible capacity for SEI formation. By the combined strategies, the graphite/holey-Li_2S battery delivers an ultra-high discharge capacity of 810 mAh g^{-1} at 0.1 C (based on the mass of Li_2S active materials) and of 570 mAh g^{-1} at 1 C. Moreover, it exhibits an excellent cycling stability at 1C with a reversible capacity of 300 mAh g^{-1} and Coulombic efficiency above 99 % at 600th cycle. These results, which are far superior to those of the previous reported graphite/Li_2S batteries [1-5] and conventional lithium ion battery in terms of specific energy, suggest a great potential of LFA/Li_2S batteries for the practical use.

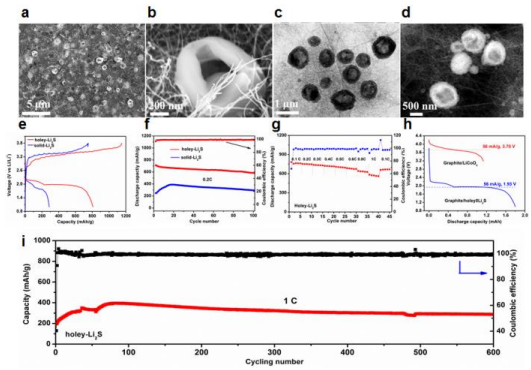

Figure. Microstructure characterization for holey Li_2S nanoarchitectures： SEM images (a) and (b), TEM images(c) and STEM images(d); Electrochemical characterization: initial charge/ discharge profile (e), cycle performance at 0.2 C (f), rate performance for graphite/holey-Li_2S battery (g), respectively, and comparison on energy densities for Graphite/holey-Li_2S and graphite/Li_2CoO_2 batteries (h); long cycle performance at 1 C for graphite/holey-Li_2S battery (i).

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