Micro-patterned sulfur electrode for high-sulfur-loaded lithium sulfur batteries

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Demands for rechargeable batteries with high energy density are ever increasing as the amount of energy required for next-generation portable electronic devices and electric vehicles increases. Rechargeable lithium-sulfur (Li/S) batteries have been intensively studied over the past several years to fully utilize their high theoretical specific energy density (2600 Wh kg^{-1}). However, it has been limited by the formation of passivating Li_2S layer on sulfur cathode. Although a higher sulfur loading is favored for the design of energy-dense Li/S battery, the problem becomes even worse with the high areal sulfur loading. Due to a low Li ion transport through the thick sulfur cathodes, Li_2S formation is concentrated on the surface of the elctrode, preventing further utilization of the inside active material.

In this work, we propose a patterned sulfur cathode, which features an effective ion transport channel normal to the sulfur electrode surface. By using the simple stamping method, we have successfully fabricated the sulfur electrode with micro-scaled-hole pattern. The micro-patterned electrode (Sulfur loading: 4 mg cm^{-2}) shows a high discharge capacity of 710 mAh g^{-1} with a capacity retention of 91% during 150 cycles at 0.5C, which is contrasted by a discharge capacity of 480 mAh g^{-1} for the unpatterned cathode. The improved discharge capacity and cycling performance are attributed to facile Li ion transport to the inner active materials. In addition, owing to the increased effective surface area, the effective current density is reduced, resulting in a thinner Li_2S layer and a lessened resistance. Therefore, the patterned sulfur cathode is highly effective in enhancing the performances of high-sulfur-loaded electrodes.