Major Progress on Lithium-Sulfur Batteries

The lithium-sulfur battery holds a high theoretical energy density, four to five times as high as that of today's lithium-ion batteries, yet its applications have been hindered by poor electronic conductivity of the sulfur cathode and, most importantly, the rapid fading of its capacity due to the formation of soluble polysulfide intermediates (Li_2S_n, n=4-8).

Despite numerous efforts concerning this issue, combating sulfur loss remains one of the greatest challenges. A research group led by Prof. GUO Yuguo from the CAS Key Laboratory of Molecular Nanostructure and Nanotechnology, in cooperation with researchers from Institute of Physics and Bosch Research & Technology Center, shows that this problem can be effectively diminished by controlling the sulfur as smaller allotropes.

They have successfully realized the metastable sulfur allotropes S_{2-4} via confining them in conductive carbon micropores (Figure 1). These confined small S_{2-4} molecules exhibit a high Li electroactivity and a novel electrochemical behavior with a single output plateau at -1.9 V, in contrast to the common cyclo-S_8. The results demonstrated that the confined S_{2-4} as a new cathode material can totally avoid the unfavorable transition between the commonly used large S_8 and S_4^{2-}, and essentially solve the critical problem of polysulfide dissolution in conventional Li−S batteries. The as-obtained S_{2-4} in S/(CNT@MPC) show a high specific capacity of 1670 mA•h/g, an impressive cycling stability of 1150 mA•h/g after 200 cycles, and a favorable high-rate capability of 800 mA•h/g at 5 C. The success of the novel S cathode promises a new Li−S battery with higher energy density (785W•h/kg based on anode and cathode) than state-of-the-art Li-ion batteries (theoretically 387 W•h/kg in a $LiCoO_2$/C battery) for applications in portable electronics, electric vehicles, and large-scale energy storage systems.

The results have been published in *J. Am. Chem. Soc.*, 2012, 134, and highlighted by *Chemical & Engineering News* entitled "High-Energy Battery Built To Last"

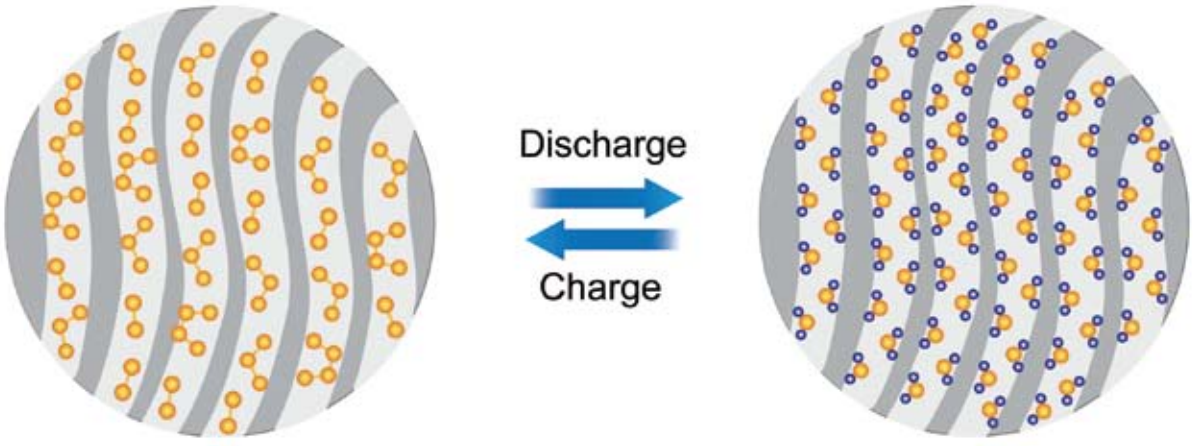

Figure 1: Schematic illustration of the smaller sulfur molecules for better lithium−sulfur batteries. (Image by GUO Yuguo)