Bypassing methods of polysulfides dissolution in improved lithium sulfur batteries

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In this paper, we will present the electrochemical performance of an electrode consisting of sulfur confined within hollow-mesoporous TiO_2 (HMT) spheres that are interconnected via multi-wall carbon nanotubes (MWCNTs), designated hereafter as HMT@CNT. We successfully synthesized and characterized (i) a S-HMT@CNT sulfur cathode comprised of hollow, spherical, nanostructured TiO_2 and carbon nanotubes and (ii) DF-PCW interlayer comprised of highly porous carbon spheres and carbon nanotubes. We use a highly porous carbonaceous interlayer to improve the wettability with the electrolyte and hence to further improve the rate capability. We selected the chitosan binder in our electrode formulations in order to reduce the electrode volume expansion and loss of active material caused by dissolved lithium polysulfides. Moreover, the pores of TiO_2 allowed for high sulfur loadings and accommodation of the volume expansion at the electrode level. The CNT component provided an overlapping network that improved both the electronic conductivity and mechanical strength of the S-HMT@CNT and DF-PCW. The pores in the carbon interlayer played the role of a medium that scavenged the dissolved lithium polysulfides, while improving Li-ion and electron transports. Owing to our cathode characteristics and cell design, the lithium-sulfur cell fabricated demonstrated good cycle life, high efficiency, and high rate capability. Of significance, the excellent cycling realized at the 2C and 5C rates is appealing for utilizing the lithium-sulfur batteries in high power applications (Fig. 1).

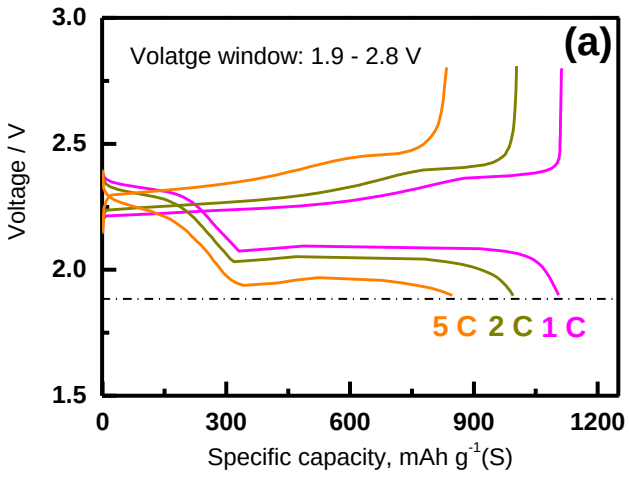

Figure 6. Voltage profiles of the S-HMT@CNT electrode in a cell constructed with DF-PCW interlayer and cycled between 1.9 and 2.8 V under increasing rates