DIRECT ACCESS TO FUNCTIONAL POROUS MATERIALS FOR HIGH PERFORMANCE LITHIUM-SULFUR BATTERIES

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Lithium-sulfur (Li-S) batteries are regarded as potential high-energy storage devices due to their outstanding energy density. However, the low electrical conductivity of sulfur, dissolution of the active material, and sluggish reaction kinetics cause poor cycle stability and rate performance. A variety of approaches have been attempted to resolve the above issues and achieve enhanced electrochemical performance. However, inexpensive multifunctional host materials which can accommodate large quantities of sulfur and exhibit high electrode density are not widely available, which hinders the commercialization of Li-S batteries. Herein, mesoporous carbon microspheres with ultrahigh pore volume are synthesized, followed by the incorporation of Fe-N-C molecular catalysts into the mesopores, which can act as sulfur hosts. The ultrahigh pore volume of the prepared host material can accommodate up to ~87 wt.% sulfur while the uniformly controlled spherical morphology and particle size of the carbon microspheres enable high areal/volumetric capacity with high electrode density. Furthermore, the uniform distribution of Fe-N-C (only 0.33 wt.%) enhances the redox kinetics of conversion reaction of sulfur and decreases the overpotential. The resulting electrode with 5.2 mg sulfur per cm2 shows excellent cycle stability and 84% retention of the initial capacity even after 500 cycles at a 3 C rate.