Metal-Organic Framework Derived Iron Sulfide-Carbon Core-Shell Nanorods as a Conversion-Type Battery Material

We report the design and nanoengineering of carbon-film-coated iron sulfide nanorods (C@Fe7S8) as an advanced conversion-type lithium-ion storage material. The structural advantages of the iron-based metal-organic framework (MIL-88-Fe) as both a sacrificed template and a precursor are explored to prepare carbon-encapsulated ploy iron sulfide through solid-state chemical sulfurizing. The resulting core-shell nanorods consisting of approximately 13% carbon and 87% Fe7S8, have a hierarchically porous structure and a very high specific surface area of 277 m²g⁻¹. When tested for use in fabrication of a redox conversion-type lithium-ion battery, this composite material has demonstrated high lithium-ion storage capacity at 1148 mA h g⁻¹ under the current rate of 500 mA g⁻¹ for 170 cycles and an impressive rate-retention capability at 657 mA h g⁻¹ with a current density of 2000 mA g⁻¹. On the basis of systematic structural analysis and microscopic mapping, we discuss the charge-discharge mechanisms and the crucial factors associated with the stability and structural changes upon charge-discharge cycling.