Reduced Graphene Oxide Wrapped FeS Nanocomposite for Lithium-Ion Battery Anode with Improved Performance

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The fast growing business of portable electronics (e.g. computers, mobile phones, cameras) has stimulated the rapid development of lithium-ion batteries (LIBs) due to their high energy density, flexible and lightweight design, and longer lifespan than conventional battery technologies. Graphite is the most popular commercial anode. However, its low theoretical capacity (372 mAh/g) renders it hard to satisfy the increasing market demands. Recently, metal sulfides with high theoretical capacity are widely studied as another promising class of anode materials with excellent electrochemical performance.

Here, we report FeS based nanocomposite as anode for lithium-ion batteries. FeS nanoparticles wrapped in reduced graphene oxide (RGO) are produced via a facile direct-precipitation approach. The resulting nanocomposite FeS@RGO structure has better lithium ion storage properties exceeding those of FeS prepared without RGO sheets. The nanocomposite delivered an initial discharge capacity of 1357 mAh/g and a charge capacity of 1116 mAh/g, giving the first cycle coulombic efficiency of 82 %. The composite shows a very stable cyclic performance with its capacity remaining as high as 978 mAh/g even after 40 cycles at a current density of 100 mA/g. This value is almost three times the capacity of commercial graphite anode, and is comparable to those reported in literature. At current density of 300 mA/g, the composite delivered discharge capacity of 927, 690, and 618 mAh/g in the first, 10th, and 30th discharge cycles, respectively; while FeS suffered rapid capacity decline, only delivering 885, 518, and 382 mAh/g in the first, 10th, and 30th discharge cycles. Electrochemical impedance demonstrate that FeS@RGO has a lower electrochemical resistance than that of FeS. The enhanced electrochemical performance is attributed to the robust sheet-wrapped structure and the synergetic effects between FeS and RGO sheets, such as increased conductivity, shortened lithium ion diffusion path, and the effective prevention of polysulfide dissolution.