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Synthesis and Electrochemical Performance of a PEDOT:PSS@Ge Composite as the Anode Materials for Lithium-Ion Batteries

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The theoretical specific capacity and volume specific capacity of Ge anode active materials can reach to 1600 $mAhg^{-1}$ and 8500 mAh/cm^3, respectively, which offers a significant advantage to high-power lithium-ion batteries used for miniaturization and weight reduction. However, the volume expansion rate of Ge is as high as 300% during cycling, resulting in poor first Coulomb efficiencies and cyclic stabilites. In this paper, a new type of organic shell (PEDOT: PSS) @ inorganic core (Ge) composite anode material for lithium ion batteries was designed and synthesized by a simple solution impregnation method . The nano-Ge anode active material was prepared by a simple liquid phase reduction method. The composition, structure and electrochemical properties of the prepared composites were analysed by field emission scanning electron microscopy (SEM), transmission electron microscopy (TEM), X-ray diffraction (XRD), energy spectrum analysis (EDS), infrared spectroscopy (FT-IR), galvanostatic charge-discharge and alternating current impedance. The results show that the conductive polymer, PEDOT:PSS, was successfully coated onto the surface of the prepared nano-Ge particles. The composite electrodes exhibits a reversible capacity of 405 $mAhg^{-1}$ after 200 cycles at 0.2C and rate capability of 800 and 700 $mAhg^{-1}$ at 2C and 4C respectively, which is much better than nanostructured Ge anodes without PEDOT:PSS coating. Meanwhile, there are higher initial discharge capacity (Up to 1400 $mAhg^{-1}$) and Coulomb efficiencies (89%, pure Ge is 81%) for PEDOT@Ge. The significantly enhanced cycle performance is attributed to the face that the PEDOT:PSS coating can effectively improve the electronic conductivity of Ge and provide buffer framework to reduce the volume change in electrochemical lithium reactions.

Keywords: PEDOT:PSS, Ge, conductive polymers, lithium-ion battery

FULL TEXT