High Capacity SnO_2/Graphene Composite Anode Materials for Li-Ion Batteries

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Abstract : Rechargeable lithium-ion batteries (LIBs) have become promising power sources for a wide range of applications, such as mobile communication devices, portable electronic devices and electrical/hybrid vehicles due to their long cycle life, high voltage and high energy density. Graphite, as anode material, has been widely used owing to its extraordinary electronic transport properties, large surface area, and high electrocatalytic activities although its limited specific capacity (372 mAh g-1) cannot fulfil the increasing demand for lithium-ion batteries with higher energy density. To settle this problem, many studies have been taken into consideration to investigate new electrode materials and metal oxide/graphene composites are selected as a kind of promising material for lithium ion batteries as their specific capacities are much higher than graphene. Among them, SnO_2, an n-type and wide band gap semiconductor, has attracted much attention as an anode material for the new-generation lithium-ion batteries with its high theoretical capacity (790 mAh g-1). However, it suffers from large volume changes and agglomeration associated with the Li-ion insertion and extraction processes, which brings about failure and loss of electrical contact of the anode. In addition, there is also a huge irreversible capacity during the first cycle due to the formation of amorphous Li_2O matrix. To obtain high capacity anode materials, we studied on the synthesis and characterization of SnO_2-Graphene nanocomposites and investigated the capacity of this free-standing anode material in this work. For this aim, firstly, graphite oxide was obtained from graphite powder using the method described by Hummers method. To prepare the nanocomposites as free-standing anode, graphite oxide particles were ultrasonicated in distilled water with SnO2 nanoparticles (1:1, w/w). After vacuum filtration, the GO-SnO_2 paper was peeled off from the PVDF membrane to obtain a flexible, free-standing GO paper. Then, GO structure was reduced in hydrazine solution. Produced SnO2- graphene nanocomposites were characterized by scanning electron microscopy (SEM), energy dispersive X-ray spectrometer (EDS), and X-ray diffraction (XRD) analyses. CR2016 cells were assembled in a glove box (MBraun-Labstar). The cells were charged and discharged at 25°C between fixed voltage limits (2.5 V to 0.2 V) at a constant current density on a BST8-MA MTI model battery tester with 0.2C charge-discharge rate. Cyclic voltammetry (CV) was performed at the scan rate of 0.1 mVs-1 and electrochemical impedance spectroscopy (EIS) measurements were carried out using Gamry Instrument applying a sine wave of 10 mV amplitude over a frequency range of 1000 kHz-0.01 Hz.

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