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Synthesis and Lithium Storage Properties of Zn, Co and Mg doped SnO_2 Nano Materials

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ABSTRACT

In this paper, we show that magnesium and cobalt doped SnO_2 (Mg-SnO_2 and Co-SnO_2) nanostructures have profound influence on the discharge capacity and coulombic efficiency of lithium ion batteries (LIBs) employing pure SnO_2 and zinc doped SnO_2 (Zn-SnO_2) as benchmark materials. The materials were synthesized via sol-gel technique. The structural, chemical and morphological characterization indicates that the Zn, Mg and Co dopants were effectively implanted into the SnO_2 lattice and that Co doping significantly reduced the grain growth. The electrochemical performances of the nanoparticles were investigated using galvanostatic cycling, cyclic voltammetry and electrochemical impedance spectroscopy (EIS). The Co-SnO_2 electrode delivered a reversible capacity of around 575 mAh g^{-1} at the 50th cycle with capacity retention of ~83% at 60 mA g^{-1}current rate. A capacity of ~415 mAh g^{-1} when cycling at 10^3 mA $g^{-1}$and >60% improvement in coulombic efficiency compared to the pure compound clearly demonstrate the superiority of Co-SnO_2 electrodes. The improved electrochemical properties are attributed to the reduction in particle size of the material up to a few nanometers, which efficiently reduced the distance of lithium diffusion pathway and reduction in the volume change by alleviating the structural strain caused during the Li^+ intake/outtake process. The EIS analyses of the electrodes corroborated the difference in electrochemical performances of the electrodes: the Co-SnO_2 electrode showed the lowest resistance at different voltages during cycling among other electrodes.