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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 spectros-copy (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 103mA $g^{-1}$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.