SnBi alloy composites via co-reduction for high performance lithium-ion battery anode

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Alloying-based materials, such as tin (Sn) and bismuth (Bi) have attracted great attention as potential anode materials for Lithium-ion batteries (LIBs) due to their high theoretical volumetric capacities of 7246 and 3800 mAh cm^{-3}, respectively. However, alloying materials exhibit short cycle life because of the severe volume expansion at fully-lithiated state of $Li_{4.4}Sn$ (260 %) and Li_3Bi (215 %), which is a great challenge for the practical implementation. To address this issue, bismuth-tin (BiSn) alloy is designed through a co-reduction method using $NaBH_4$ followed by heat treatment at 900 °C. The different working voltage of Bi (0.7–0.8 V) and Sn (0.4–0.6 V) will hinder the extreme structural changes that occur upon cycling. At an initial discharge stage, the unreacted Sn phase acts as a buffer during the lithiation of Bi. Meanwhile, the lithiated state of Bi (Li_xBi) will buffer the contraction when Sn uptake the Li-ions. As a result, BiSn anode achieved a superior discharge capacity of 650 mAh g^{-1} at 50mA g^{-1}. The high tap density of BiSn alloy (2.46 g mL^{-1}) brings an outstanding volumetric capacity of 1600 mAh cm^{-3}.