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Ultrafine SnO_2 nanoparticles encapsulated in ordered mesoporous carbon framework for Li-ion battery anodes

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Abstract

Ultrafine SnO_2 particles are encapsulated in the hollow nanochannels of ordered mesoporous carbon (OMC) framework by simple infiltration of tin precursor and heat treatment. The SnO_2@OMC anode delivers excellent cyclic stability with a reversible specific capacity of ~1000 mAh g^{-1} after 100 cycles at 100 mA g^{-1} for Li-ion batteries (LIBs). It also presents an excellent rate performance with a specific capacity of 680 mA g^{-1} at a high current density of 500 mA g^{-1}. Several functional features and ameliorating geometries play positive roles in Li-storage performance and stability of the electrode. They include (i) the intimate electrical contacts between the SnO_2 nanoparticles and the walls of OMC channels to facilitate fast ion/electron transfer, (ii) the large surface area originating from the unique architecture of the composite, and (iii) the encapsulation of SnO_2 particles within the channels to suppress their volume expansion during charge/discharge cycles. The reversibility of the conversion reaction is also supported by the high Li-ion diffusion coefficient with enhanced electrochemical reaction kinetics. Based on the above findings, this work may offer new insights into the rational nanostructural design of electrode materials for high performance rechargeable batteries.

Keyword: Tin oxide; Ordered mesoporous carbon; Soft-templating; Li-ion battery