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Atomic-layer-deposited TiO_2-SnZnO/carbon nanofiber composite as highly stable, flexible and freestanding anode material for lithium-ion batteries

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Abstract

We demonstrate the synthesis of a highly stable, freestanding, and flexible anode material for lithium-ion batteries created by depositing a conformal coating of TiO_2 on a SnZnO/carbon nanofiber (CNF) composite using atomic layer deposition. The term SnZnO is used here because metallic Sn is observed in the SnZnO/CNF composites after annealing under argon gas. The elemental composition of the material was confirmed by energy-dispersive X-ray spectroscopy, while the oxidation states of the elements were determined by X-ray photoelectron spectroscopy. Cross-sectional transmission electron microscopy showed that the core regions of the composite nanofibers were almost uniformly covered by a TiO_2 shell. The specific capacities of the TiO_2-coated and uncoated samples at a high current density (5C) were 413 and 159 $mAh \cdot g^{-1}$, respectively. An analysis of the surface morphology after cycling indicated that the stability of the solid electrolyte interface layer increased after the formation of the protective conformal TiO_2 layer. As a result, no signs of anode degradation were observed even after 700 cycles at a current density of 5C. We attribute this exceptional stability to the buffering of the anode material by the protective coating during volumetric expansion.

Keywords: Electrospinning, SnZnO, Carbon nanofiber, Atomic layer deposition, Lithium-ion battery, Anode

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