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Freestanding 3D Single-wall Carbon Nanotubes/WS_2 Nanosheets Foams as Ultra-Long-Life Anodes for Rechargeable Lithium Ion Batteries

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Abstract

Tungsten disulfide (WS_2) have been attracting increasing attention as anode materials for high performance lithium-ion batteries (LIBs) due to their high theoretical capacity and large interlayer spacing. However, the low conductivity and volume expansion during lithiation/delithiation process will lead to the low specific capacity and rapid capacity fading during long-term cycling. Here, we have used flexible single-wall carbon nanotubes (SWCNTs) with ultra-high electrical conductivity as conductive materials to construct a three-dimensional (3D) WS_2@SWCNT foam by a simple hydrothermal method followed by freeze-drying process. The 3D structure not only provide good electronic transportation pathways, but also can accommodate huge volume change of WS_2 due to the mechanical flexibility of SWCNTs, leading to the excellent cyclability as anode materials for LIBs. Benefiting from these excellent properties, the WS_2@SWCNT foam nanostructure delivers a specific capacity of 1050 mAh g^{-1} at a current density of 0.1 A g^{-1}, high reversible capacity of 688.3 mAh g^{-1} after 1000 cycles and a capacity retention of 113% over 1000 cycles at 1 A g^{-1}.

Keywords: carbon nanotube, graphene, lithium ion battery, cycle stability, three-dimensional structure