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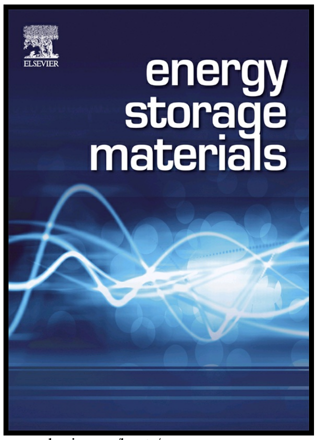

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$SnSe_2$ Quantum Dot/rGO composite as high performing lithium anode

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Abstract

There have been limited applications in Tin Selenide based anode materials for lithium ion batteries due to low capacities from the alloying process (SnSe: 596 mAh g^{-1}, $SnSe_2$: 426 mAh g^{-1}). This is mainly due to the significant loss of capacity during initial conversion process with the formation of Li_2Se; a process that is considered irreversible in Tin based (SnX_n, X = O, S, Se, n = 1 or 2) anode materials. Herein, ultra-fine Quantum Dots (QDs) of $SnSe_2$ were designed to be embedded in a 3D matrix of rGO to release Sn nanoparticles that are able to catalyze the decomposition Li_2Se and drive the conversion of Sn to $SnSe_2$. In this manner, both conversion and alloying reactions can be utilized that greatly increases the effective capacity of $SnSe_2$ anode. Through facile solvothermal synthesis followed by freeze-drying and thermal annealing, the rationally designed $SnSe_2$ QDs/rGO effectively promoted reversible conversion of Sn to $SnSe_2$. As a result, the nanocomposite exhibited enhanced capacities (778.5 mAh g^{-1} at current density of 50 mA g^{-1}) that are beyond its theoretical values. The designed nanostructure also endowed the nanocomposite with high rate capabilities (324.5 mAh g^{-1} at current density of 5000 mA g^{-1}) and ultra-long cycle life (92.2 % capacity retention after 3000 cycles at 2000 mA g^{-1}). Post cycling analysis through *ex situ* TEM and XRD, coupled with electrochemical studies, were carried out to verify the reversible conversion reactions in $SnSe_2$ QDs/rGO. The successful utilization of both conversion and alloying reactions in $SnSe_2$ enables Tin Selenides to be on par with its oxide and sulfide analogues and hence a potential anode towards high energy density lithium ion

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