Chitosan complements entrapment of silicon inside nitrogen doped carbon to improve and stabilize the capacity of Li-ion batteries

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A facile strategy to entrap milled silicon (m-Si) particles using nitrogen-doped-carbon (N-C@ m-Si) to overcome the dramatic volume changes in Si during intercalation of lithium ions and to improve its electronic conductivity is reported here. The only natural nitrogen containing biomaterial polysaccharide, i.e., chitosan, is used as the carbon source. Simple hydrothermal technique followed by a subsequent carbonization process is used to synthesize N-C and N-C@ m-Si particles. N-C@ m-Si exhibited significantly improved electrochemical performance as compared to bare m-Si, which is confirmed by the obtained discharge capacity of 942.4 mAh g⁻¹ and columbic efficiency of 97% after 50 cycles at 0.1C rate. With regard to the N-C electrodes, the obtained discharge capacity of 485.34 mAh g⁻¹ and columbic efficiency of 99.78%, after 50 cycles at 0.1C rate is superior to the commercial graphite electrodes. The solid electrolyte interphase (SEI) layer that formed over m-Si and N-C@ m-Si electrodes is characterized using X-ray photoelectron spectroscopy. Compared to the SEI layer that formed over m-Si electrode after 10 charge-discharge cycles, the N-C@ m-Si electrode had a stable lithium fluoride and carbonate species. Brief reaction mechanisms, representing the formation of different species in the SEI layer, is derived to explain its behavior during the electrochemical processes.

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