Silicon-Reduced Graphene Oxide Self-Standing Composites Suitable as Binder-Free Anodes for Lithium-Ion Batteries

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Supporting Information

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ABSTRACT: Silicon-reduced graphene oxide (Si-rGO) composites processed as self-standing aerogels (0.2 g cm⁻³) and films (1.5 g cm⁻³) have been prepared by the thermal reduction of composites formed between silicon nanoparticles and a suspension of graphene oxide (GO) in ethanol. The characterization of the samples by different techniques (X-ray diffraction, Raman, thermogravimetric analysis, and scanning electron microscopy) show that in both cases the composites are formed by rGO sheets homogeneously decorated with 50 nm silicon nanoparticles with silicon contents of ~40% wt. The performances of these self-standing materials were tested as binder-free anodes in lithium-ion batteries (LIBs) in a half cell configuration under two different galvanostatic charge−discharge cutoff voltages (75 and 50 mV). The results show that the formation of a solid electrolyte interphase (SEI) is favored in composites processed as aerogels due to its large exposed surface, which prevents the activation of silicon when they are cycled within the 2 to 0.075 V voltage windows. It is also found that the composites processed in the form of self-standing films exhibit good stability over the first 100 cycles, high reversible specific capacity per mass of electrode (~750 mAh g⁻¹), areal capacities that reach 0.7 mAh cm⁻², and high Coulombic efficiencies (80% for the first charge−discharge cycle and over 99% in the subsequent cycles).

KEYWORDS: self-assembly, nanoparticles, high density electrodes, energy storage, electrochemistry, nanostructured materials, free-standing electrodes