Highly Dispersed Silicon Particles in Nanostructured Carbon for Li-ion Battery Anodes

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Silicon, which is cheap and has the highest gravimetric and volumetric storage capacities known ($Li_{15}Si_4$ ≈ 3579 mA h/g, 8340 mA h/mL), is a very attractive candidate anode material. Unfortunately, the intrinsic, ~300% volume expansion/contraction during lithiation/delithiation causes micrometer-size Si particles to fracture, diminishing electrical contact of the particles with other electrode components and resulting in poor cycling performance. Due to the high surface to volume ratio, Si nanoparticles offer the potential of fast charge-discharge kinetics. In this study, two strategies have developed to prepare highly dispersed Si nanoparticles (20nm) in nanostructured carbon, e.g., 1) Si nanoparticles encapsulated in a mesoporous carbon and 2) Si nanoparticles dispersed in the inter-layers of graphene sheets which are exfoliated from graphite. These novel materials showed very high power capabilities as well as stable cycling performances as anodes for Li-ion battery. The results of using these composites as anode for a Li-ion battery, the charge/discharge behavior and cycling performances will be presented.