Utilizing a porous carbon material as minor constituent scaffold for attaching silicon in a silicon-carbon composite negative electrode

Herein, we present a strategy for the fabrication of a silicon-carbon composite (SCC) negative anode. The scheme involves the utilization of an easily functionalized porous carbon as a minor constituent (2-10% by weight) and a facile chemical reaction to covalently attach the silicon, polymer binder and carbon, in order to prevent the removal of the silicon nanoparticles from the electrode during the extreme volume changes that silicon undergoes during lithiation/delithiation. We will reveal work using two different silicon loadings in the carbon-silicon active material: 1) one SCC electrode at ~86% silicon and 2) another at ~16% silicon. We will also compare the SCC anodes to a bare silicon control without the functionalized porous carbon and covalent attachment. We will show how the covalent attachment greatly mitigates the disattachment of the silicon nanoparticles during lithiation/delithiation when compared to the bare silicon, greatly increasing the cycle life. We will also show how the silicon loading in the SCC electrodes effects the cell's columbic efficiencies, discharge capacities, cycle life, etc. and show the performance of the SCC negative electrode when configured as a full cell, without an unlimited lithium source that can often hide lithium depletion issues that come about from the necessary re-forming of the expanding SEI layer, due to the tremendous volume change in the silicon.