Masterarbeit

Si-C Nanocomposite as an Anode Material for Li-ion Batteries

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Abstract

Silicon is one of the promising anode materials for the next-generation Li-ion batteries with a theoretical maximum capacity of 3578 mAh g^{-1} for the $Li_{15}Si_4$ phase. However, silicon suffers from huge volume change of ~300 % while lithiation and delithiation. This huge volume change leads to pulverization, loss of electrical contact, and delamination of the silicon-based anodes. Moreover, silicon also has a lower electrical conductivity. To overcome the issues associated with silicon anodes, a silicon-carbon (Si-C) nanocomposite seems to be a viable solution. The nanocomposite not only provides the buffer space for the volume expansion of silicon while cycling but could also provide good electrical contact with the current collector.

In this master's thesis, we aim to stabilize the silicon-carbon based anodes and improve the overall electrochemical performance. Herein, we have synthesized Si-C novel nanocomposite by two different approaches. The first being a simple and upsaclable mechanical-milling process, which embeds the silicon nanoparticles into the carbon matrix. As a second approach, Si-C nanocomposites are obtained by electrostatic self-assembly of the surface modified silicon nanoparticles with (3-aminopropyl) triethoxysilane (APTES) and the graphite oxide (GO) as shown in Figure 1. This was followed by the reduction of GO to rGO via reactive spray drying. Further on, the effect of electrolyte additives, such as fluoroethylene carbonate (FEC) and vinylene carbonate (VC), on the electrochemical performance and the formation of a solid-electrolyte interphase (SEI) was investigated.

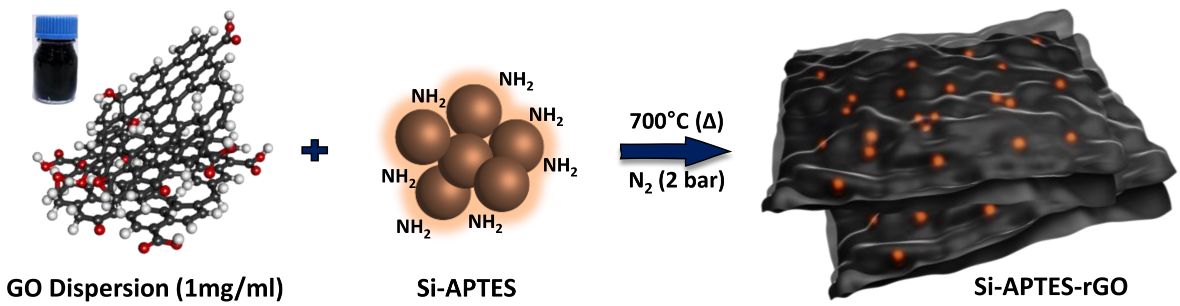

Figure 1: Schematic representation of the synthesis protocol for Si-APTES-rGO.