Si-C void structures as anodes in Li-S full cells – From coin cell to pouch cell level

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Silicon is an attractive alternative anode material increasing both the safety and the cycle stability of lithium-sulfur batteries [1]. It has the highest lithium storage capacity (3579 Ah kg^{-1} $Li_{15}Si_4$) among known elements and the delithiation occurs at a low voltage around 0.4 V vs. Li/Li^+ [2]. During the lithiation process silicon undergoes a large undesirable volume expansion generally known from lithium alloys. This volume change leads to the degradation of the entire anode and fast capacity fading [3]. Nanostructured silicon carbon composites with free volume between the silicon core and a conductive carbon shell can potentially compensate the volume change and ensure a stabile solid electrolyte interphase (SEI) at the carbon surface preventing electrolyte consumption during cycling.
In contrast to the recently published references, an easily scalable process without hydrofluoric acid etching treatment is presented in order to gain a free volume between silicon cores and the carbon shells (Figure 1).

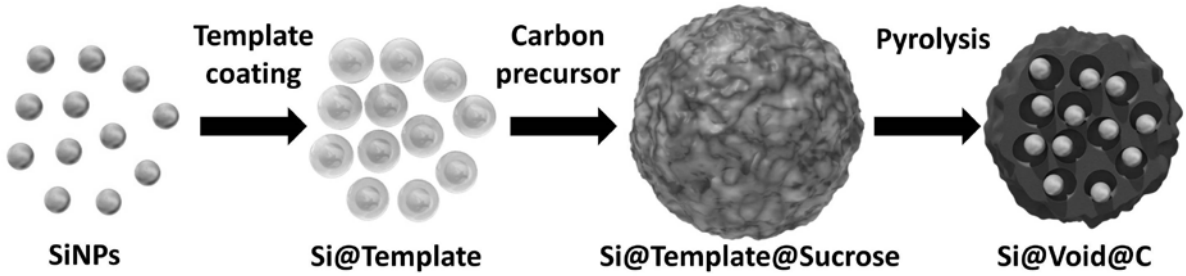

Fig. 1: Schematic illustration of the synthesis process of the silicon-carbon composite

These silicon carbon void structures reveal a much higher capacity and cycle stability in half cells vs. lithium compared to bare silicon nanoparticles and Si-C composites without void structure. The feasibility of the prelithiated silicon-carbon anodes in lithium-sulfur full cells with ether based electrolytes was successfully shown both in coin cells and in pouch cells.

References:

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