Can we Use Silicon as Stable and High Capacity Anode Material in Lithium Ion Batteries? Yes we can!

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In this presentation, we demonstrate a cost-effective synthesis route for coated, highly porous Si that is simple to implement and provides Si-based anode materials with capacities between 2000 and 3000 $mAhg^{-1}$, Coulombic efficiencies above 99.5 %, and almost 100 % capacity retention over more than 100 cycles. The Si-based composite is prepared from porous silicon (obtained by reduction of silica) by encapsulation in an organic carbon and polymer-derived siliconoxycarbide (C/SiOC) matrix. Molecular-dynamics (MD) simulations show that the highly porous silicon morphology delivers free volume for the accommodation of strain leading to no macroscopic changes during initial Li-Si alloying. In addition, a carbon layer provides an electrical contact whereas the SiOC matrix significantly diminishes the interface between the electrolyte and the electrode material and thus suppresses the formation of a solid electrolyte interphase (SEI) on Si. Electrochemical tests of the micrometer-sized, glass-fibres derived silicon demonstrate the up-scaling potential of the presented approach.

[1] Vrankovic, D.; Graczyk-Zajac, M.; Kalcher, C.; Rohrer, J.; Becker, M.; Stabler, C.; Trykowski, G.; Albe, K.; Riedel, R.; Highly Porous Silicon Embedded in a Ceramic Matrix: A Stable High-Capacity Electrode for Li-Ion Batteries, ACS Nano, 11(11) (2017) 11409-11416.