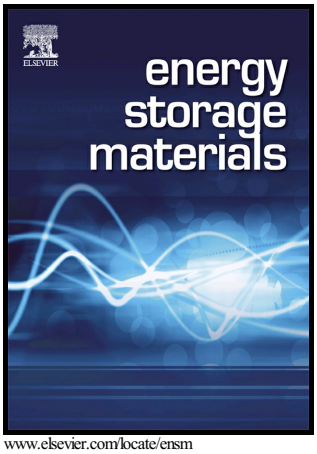

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Dispersion-strengthened microparticle silicon composite with high anti-pulverization capability for Li-ion batteries

Yaxiong Yang [a], Chaolun Ni [a,b], Mingxia Gao [a], Jiangwei Wang *[a,b], Yongfeng Liu *[a], Hongge Pan[a]

[a]State Key Laboratory of Silicon Materials, Key Laboratory of Advanced Materials and Applications for Batteries of Zhejiang Province and School of Materials Science and Engineering, Zhejiang University, Hangzhou 310027, China

[b]Center of Electron Microscopy, Zhejiang University, Hangzhou 310027, China

Email: mselyf@zju.edu.cn (Y. F. L)

Email: jiangwei_wang@zju.edu.cn (J. W. W)

* Corresponding author:

Abstract

Micrometre-sized silicon materials can be potentially used in high-capacity lithium ion batteries, owing to their high volumetric energy density, ease of mass production, and low costs, as compared to those of silicon nanoparticles. However, they exhibit severe pulverisation and rapid capacity fading during cycling. Herein, we demonstrate a silicon composite, in microparticulate form, where polycrystalline Si particles were embedded in a SiOC matrix strengthened by the dispersion of SiC and Li_2SiO_3 nanocrystals. Such unique composite particles are successfully fabricated by a facile and scalable mechanical milling process of prelithiated Si microparticles in a CO_2 atmosphere. The dispersion-strengthening effect remarkably suppresses the lithiation-induced volume expansion and particle pulverization, and consequently alleviates the degradation of anodes upon cycling. As a result, a high specific capacity (1268 mAh g^{-1} at 100 mA g^{-1}), a long-term cyclability (957 mAh g^{-1} after 400 cycles), a good rate performance (895 mAh g^{-1} at 1000 mA g^{-1}) and a high volumetric capacity (1268 mAh cm^{-3}) are achieved in the microparticle silicon composite anodes. The obtained results can be used to reasonably design micrometre-sized silicon anodes for high-performance lithium-ion batteries.