Supporting information

Novel hybrid Si nanocrystals embedded in a conductive SiO$_x$@C matrix from one single precursor as a high performance anode material for Lithium-ion batteries

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Fig. S1 Si/SiO$_x$@C sample after TGA in air changed from a black color to brownish.
Fig. S2 Survey XPS spectrum of Si/SiO\textsubscript{x}@C.
Fig. S3 XRD pattern of the nano-crystalline Si.
Fig. S4 TEM image of the nano-crystalline Si.
Fig. S5 Charging/discharging profiles of the Si/SiO$_x$@C anodes of the 1$^{\text{st}}$, 2$^{\text{nd}}$, 3$^{\text{rd}}$, 4$^{\text{th}}$, 5$^{\text{th}}$, 10$^{\text{th}}$, 20$^{\text{th}}$, and 50$^{\text{th}}$ cycle.
Fig. S6 Rate performance of nano-crystalline Si at various current densities. The voltage range is 0.01–2.0 V vs. Li⁺/Li.
Fig. S7 Charging/discharging profiles of nano-crystalline Si of the 1st cycle.
Fig. S8 Cycling performance and CE of Si@C and Si/SiOx@C at a current density of 0.1 A g⁻¹ for the 1ˢᵗ, 2ⁿᵈ and 3ʳᵈ cycle, then at 0.4 A g⁻¹ for the latter cycles. The Si@C material is a Si/SEG/C composite and the material was prepared and tested using the method reported in Ref. S2.
Fig. S9 Nyquist plots conducted on Si/SiOx@C and Si anodes after ten cycles at a current density of 400 mA g\(^{-1}\).
Fig. S10 TEM images of Si/Si/SiOₓ@C after 200 charging/discharging cycles, obtained after charging to 2.0V.
Fig. S11 Photos of the spent (a)Si/SiO$_x$@C and (b)Si anodes after 200 cycles.
Table S1. Specific capacity and cycling capability of various kinds of anodes for LIBs

<table>
<thead>
<tr>
<th>Materials</th>
<th>Specific capacity (mAh/g)</th>
<th>Current density (A/g)</th>
<th>Cycling capability</th>
<th>Ref.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Si/SiO(_x)@C</td>
<td>1250</td>
<td>0.4</td>
<td>200(^{th}), 81.84%</td>
<td>This work</td>
</tr>
<tr>
<td>SiOC anode</td>
<td>676</td>
<td>0.2</td>
<td>250(^{th}), 125%</td>
<td>S1</td>
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<tr>
<td>Si/C composite</td>
<td>1796</td>
<td>0.2</td>
<td>250(^{th}), 12.36%</td>
<td>S1</td>
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<tr>
<td>Si/SEG/C composite</td>
<td>1056</td>
<td>0.5</td>
<td>50(^{th}), 84.70%</td>
<td>S2</td>
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<tr>
<td>Silicon–Carbon–Nitrogen Composite</td>
<td>314</td>
<td>0.1</td>
<td>100(^{th}), 99%</td>
<td>S3</td>
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<tr>
<td>Hierarchical composites Si@SiC@C</td>
<td>1328</td>
<td>1</td>
<td>50(^{th}), 78.84%</td>
<td>S4</td>
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<tr>
<td>Hollow core shell-structured Si–C composites</td>
<td>1780</td>
<td>0.1C</td>
<td>50(^{th}), 22%</td>
<td>S5</td>
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<tr>
<td>silicon/nitrogen-doped carbon/carbon nanotube spheres</td>
<td>1484</td>
<td>0.5</td>
<td>100(^{th}), 69%</td>
<td>S6</td>
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<tr>
<td>Si/SiO(_2)@C composite</td>
<td>658.8</td>
<td>0.05</td>
<td>100(^{th}), 73.16%</td>
<td>S7</td>
</tr>
</tbody>
</table>

References


S2 Yu-Ying Huang, Da Han, Yan-Bing He, Qinbai Yun, Ming Liu, Xianying Qin, Baohua Li, and Feiyu Kang, 'Si Nanoparticles Intercalated into Interlayers of Slightly Exfoliated Graphite Filled by Carbon as Anode with High Volumetric Capacity for Lithium-Ion Battery', Electrochimica Acta, 184 (2015), 364-70.


S4 Chundong Wang, Yi Li, Kostya Ostrikov, Yonggang Yang, and Wenjun Zhang, 'Synthesis of Sic Decorated Carbonaceous Nanorods and Its Hierarchical Composites Si@Sic@C for High-Performance Lithium Ion Batteries', Journal of Alloys and Compounds, 646 (2015), 966-72.

