Electronic Supplementary Information for

**Sb@C coaxial nanotubes as superior long-life and high-rate anode for sodium ion batteries**

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**Experimental Section**

**Synthesis of Sb$_2$S$_3$ nanorods**: The Sb$_2$S$_3$ nanorods were synthesized through a simple hydrothermal method. In a typical synthesis, 4 mmol of SbCl$_3$, 8 mmol of L-cysteine, and 8 mmol of Na$_2$S·9H$_2$O were orderly dissolved in 80 mL of distilled water (DIW) under stirring for 3 h to form a homogeneous suspension. Afterwards, the above solution was transferred into a 100 mL Teflon-lined stainless steel autoclave and then kept at 180 °C for 12 h. After cooling down to room temperature naturally, the obtained dark-brown product was separated by centrifugation, washed with DIW and ethanol for several time before drying at 60 °C overnight under vacuum.

**Synthesis of Sb$_2$S$_3$@PDA core-shelled nanorods**: 30 mg of Sb$_2$S$_3$ nanorods and 40 mg of dopamine hydrochloride were dispersed into 100 mL of Tris-buffer solution (10 mM) with...
sonication for 10 minutes and then magnetic-stirring for 3 h. The resultant product was collected via centrifugation and washed with DIW and ethanol for three times, respectively, and dried at 60 °C overnight under vacuum.

**Synthesis of Sb@C coaxial nanotubes:** Sb$_2$S$_3$ nanorods were annealed at 500 °C for 1 h in Ar with a heating rate of 3 °C min$^{-1}$. The as-prepared Sb$_2$S$_3$@PDA core-shelled nanorods were annealed at 500 °C in Ar with a heating rate of 3 °C min$^{-1}$ for 2, 5, 20, and 40 min, respectively. After different annealing time, Sb$_2$S$_3$@PDA core-shelled nanorods are transformed into Sb@C doble-walled nanotubes.

**Materials characterization:** Field-emission scanning electron microscope (FESEM; JEOL JSM07600F) and transmission electron microscope (TEM; JEOL JEM-2100F) were used to characterize the microscopic features of the samples. A Rigaku D/MAX RINT-2000 X-Ray Diffractometer with Cu Kα radiation at a voltage of 40 kV and a current of 40 mA was used to collect the XRD patterns of the products. Thermogravimetric analysis (TGA) was performed with a temperature ramp of 10 °C min$^{-1}$ under air flow.

**Electrochemical measurements:** The battery tests were carried out in a half-cell configuration. The working electrode consists of active materials, conductivity agent (Carbon black, CB), and binder (Carboxymethylcellulose sodium, CMC-Na) with a weight ratio of 70:20:10. The mass loading of active materials was about 0.9 mg. The electrolyte was a solution of 1.0 M NaClO$_4$ in propylene carbonate with 5% fluoroethylene carbonate (FEC) additive. Sodium metal was used as both the counter electrode and reference electrode. The coin-type half cells were assembled in argon-filled glovebox and then tested in TOSCAT 3000 battery tester (TOSCAT 3000, Toyo Systems, Tokyo, Japan) with a voltage range between 0.01 and 2.0 V. Cyclic Voltammetry (CV) curves were tested using AUTOLAB potentiostat/galvanostat apparatus (AUT85698) with a scan rate of 0.1 mV s$^{-1}$. 

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**Fig. S1** FESEM image of Sb$_2$S$_3$ nanorods.
Fig. S2  XRD pattern and FESEM image of Sb$_2$S$_3$@PDA core-shell nanorods.
Fig. S3 XRD pattern (a) and FESEM image (b) of Sb$_2$S$_3$@PDA-2.
Fig. S4 XRD patterns of Sb@C-5, Sb@C-20, and Sb@C-40.
**Fig. S5** FESEM (a, b, c) and TEM (c, e, f, g, h, i) images of Sb@C-5 (a, d, g), Sb@C-20 (b, e, h), and Sb@C-40 (c, f, i).
Fig. S6 TGA analysis of Sb@C coaxial nanotubes at a temperature ramp of 10 °C min⁻¹ in air.
Fig. S7 XRD pattern and FESEM image of Sb$_2$S$_3$ nanorods after annealing at 500 °C for 1 h in Ar.
Fig. S8 Charge-discharge voltage profiles of Sb@C-20 (a) and Sb@C-40 (b) for the first five cycles at a current density of 100 mA g\(^{-1}\).
Fig. S9 Cycling performance of Sb$_2$S$_3$@PDA-2 at a current density of 1.0 A g$^{-1}$. 
Fig. S10 FESEM images of Sb@C-5 after 2000 cycles at a current density of 1.0 A g\textsuperscript{-1}. 
**Table S1.** Comparison of some representative Sb-based anode materials for SIBs.

<table>
<thead>
<tr>
<th>Sb-based anodes</th>
<th>Cycling performance</th>
<th>Rate capability</th>
<th>Ref.</th>
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<tbody>
<tr>
<td>Sb nanoparticles decorated N-rich carbon nanosheets</td>
<td>305 mAh g(^{-1}) after 60 cycles at 50 mA g(^{-1})</td>
<td>142 mAh g(^{-1}) at 10 A g(^{-1})</td>
<td>[1]</td>
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<tr>
<td>Sb/C nanofibers</td>
<td>350 mAh g(^{-1}) after 300 cycles at 100 mA g(^{-1})</td>
<td>88 mAh g(^{-1}) at 6 A g(^{-1})</td>
<td>[2]</td>
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<tr>
<td>Sb-C nanofibers</td>
<td>385 mAh g(^{-1}) after 500 cycles at 100 mA g(^{-1})</td>
<td>337 mAh g(^{-1}) at 3 A g(^{-1})</td>
<td>[3]</td>
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<td>Sb hollow nanosphere</td>
<td>622.2 mAh g(^{-1}) after 50 cycles at 50 mA g(^{-1})</td>
<td>315 mAh g(^{-1}) at 1.6 A g(^{-1})</td>
<td>[4]</td>
</tr>
<tr>
<td>Sb porous hollow microspheres</td>
<td>574 mAh g(^{-1}) after 100 cycles at 660 mA g(^{-1})</td>
<td>313 mAh g(^{-1}) at 3.2 A g(^{-1})</td>
<td>[5]</td>
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<td>Spherical nano-Sb@C composite</td>
<td>385 mAh g(^{-1}) after 500 cycles at 100 mA g(^{-1})</td>
<td>270 mAh g(^{-1}) at 4 A g(^{-1})</td>
<td>[6]</td>
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<td>Sb/Multilayer Graphene hybrid</td>
<td>405 mAh g(^{-1}) after 200 cycles at 100 mA g(^{-1})</td>
<td>210 mAh g(^{-1}) at 5 A g(^{-1})</td>
<td>[7]</td>
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<tr>
<td>Sb/MWCNT nanocomposite</td>
<td>380 mAh g(^{-1}) after 120 cycles at 200 mA g(^{-1})</td>
<td>225 mAh g(^{-1}) at 2 A g(^{-1})</td>
<td>[8]</td>
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<td>407 mAh g(^{-1}) after 240 cycles at 100 mA g(^{-1})</td>
<td>460 mAh g(^{-1}) at 100 mA g(^{-1})</td>
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<tr>
<td>Sb @C coaxial nanotubes</td>
<td>230 mAh g(^{-1}) after 2000 cycles at 1 A g(^{-1})</td>
<td>310 mAh g(^{-1}) at 20 A g(^{-1})</td>
<td>Present work</td>
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</tbody>
</table>

**References**


