Electronic supplementary information

for

Hydrothermally encapsulating VO_2(A) nanorods into amorphous carbon by the carbonization of glucose as energy storage device

by

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Synthesis of pure VO$_2$(A) nanomaterials

VO$_2$(A) nanomaterials was synthesized according to the previous report (Solid State Commun., 2012, 152, 253) and modified. In a typical run, 1.82 g commercial V$_2$O$_5$ was dispersed into the mixture of 60 mL H$_2$O and 10 mL ethanol under magnetic stirring at a room temperature for 30 min. The solution was transferred into a 100 mL Teflon Lined stainless steel autoclave, which was sealed and maintained at 180 °C for 96 h. The as-synthesized sample was filtered off and washed several times with deionized water and ethanol, respectively, and then dried in vacuum for use. Then 0.71 g of the as-obtained sample VO$_2$(B) was dispersed into 60 mL H$_2$O and transferred to a 100 mL Teflon Lined stainless steel autoclave, which was heated at 220 °C for 12 days. The as-synthesized sample was filtered off and washed several times with deionized water and ethanol, respectively, and then dried in vacuum at 75 °C. XRD pattern (Fig. S1) revealed that pure-phase VO$_2$(A) was synthesized.

Synthesis of carbon spheres

The carbon spheres were synthesized by a hydrothermal method (Angew. Chem. Int. Ed., 2014, 43, 597). 1M aqueous glucose solution was transferred into a 50 mL Teflon Lined stainless steel autoclave, which was heated at 180 °C for 4 h. After washing with deionized water and ethanol and drying, the sample was then annealed in Ar at 700 °C for 2 h.

Fig. S1

![Fig. S1. XRD patterns of the as-obtained VO$_2$(A) and carbon spheres.](image_url)
Fig. S2. CV curves of VO$_2$(A)@C composites and Ni foam collected at a scan rate of 20 mV·s$^{-1}$.

Fig. S3. XRD patterns of the synthesized V$_2$O$_5$ nanowires.
Fig. S4

Fig. S4. SEM images of the synthesized V$_2$O$_5$ nanowires.

Fig. S5

Fig. S5. TEM images of VO$_2$(A)@C composites synthesized with different amount of glucose: (a) 1 g; (b) 2 g.
Fig. S6

Fig. S6. XRD patterns of the products synthesized with different reaction times.

Fig. S7

Fig. S7. CV curves of VO_x(A)@C composites on various potential limits collected at a scan rate of 20 mV·s⁻¹.
Fig. S8. Galvanostatic charge-discharge curves of VO\textsubscript{2}(A)@C composites synthesized with different amount of glucose collected at a current density of 1 A·g\textsuperscript{-1}.

Fig. S9. VO\textsubscript{2} contents of the VO\textsubscript{2}(A)@C core-shell composites synthesized with 1 g, 1.5 g, 2 g, 2.5 g and 3 g glucose.
Fig. S10. The coulombic efficiency of VO$_2$(A)@C composites and pure VO$_2$(A) calculated based on the GCD curves (Fig. 4f).

Fig. S11. SEM images of the working electrodes before (a) and after (b) the cycles in Na$_2$SO$_4$ aqueous solution.
Fig. S12. Cycling performance of VO$_2$(A)@C composites collected at various current densities.

Fig. S13. CV curves collected at a scan rate of 20 mV·s$^{-1}$ (a) and GCD curves collected at a current density of 1 A·g$^{-1}$ (b) of VO$_2$(A)@C composites in 0.5 M Na$_2$SO$_4$ aqueous electrolyte and LiCl/PVA gel electrolyte.
Fig. S14. CV curves collected at a scan rate of 20 mV·s$^{-1}$ (a) and GCD curves collected at a current density of 1 A·g$^{-1}$ (b) of the AC/VO$_2$(A)@C device in 0.5 M Na$_2$SO$_4$ aqueous electrolyte and

Fig. S15. Cycling performance of AC//VO$_2$(A)@C ASC device collected at a scan rate of 50 mV s$^{-1}$ for 1600 cycles in LiCl/PVA gel electrolyte.
Table S1

Table 1. Comparison of the electrochemical performance of supercapacitor devices.

<table>
<thead>
<tr>
<th>Types of device</th>
<th>Electrolyte</th>
<th>Specific capacitance /F·cm$^{-2}$</th>
<th>Cyclic performance</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>VO$_2$(A)//AC ASCs</td>
<td>0.5 M Na$_2$SO$_4$</td>
<td>0.50, 5 mV·s$^{-1}$</td>
<td>34.6% retention after 1000 cycles</td>
<td>This work</td>
</tr>
<tr>
<td>VO$_2$(A)//AC ASCs</td>
<td>5 M LiCl/PVA</td>
<td>0.22, 20 mV·s$^{-1}$</td>
<td>90.3% retention after 1000 cycles</td>
<td>This work</td>
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<tr>
<td>V$_2$O$_5$ SSCs</td>
<td>1 M LiClO$_4$/PVA</td>
<td>0.38, 1 mV·s$^{-1}$</td>
<td>88% retention after 1000 cycles</td>
<td>[1]</td>
</tr>
<tr>
<td>PET/Pt/MnO$_2$ SSCs</td>
<td>H$_3$PO$_4$/PVA</td>
<td>0.2, 10 mV·s$^{-1}$</td>
<td>82.2% retention after 10000 cycles</td>
<td>[2]</td>
</tr>
<tr>
<td>WO$_3$-x/MoO$_3$-x/PANI/carbon fabric ASCs</td>
<td>H$_3$PO$_4$/PVA</td>
<td>0.216, 2 mA·cm$^{-1}$</td>
<td>75% retention after 10000 cycles</td>
<td>[3]</td>
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<tr>
<td>PPy@MnO$_2$@rGO SSCs</td>
<td>H$_3$PO$_4$/PVA</td>
<td>0.41, 0.1 mA·cm$^{-3}$</td>
<td>92% retention after 4950 cycles</td>
<td>[4]</td>
</tr>
<tr>
<td>NiCo$_2$O$_4$ SSCs</td>
<td>KOH/PVA</td>
<td>0.16, 1 mA·cm$^{-2}$</td>
<td>100% after 3000 cycles</td>
<td>[5]</td>
</tr>
<tr>
<td>SWNT-MnO$_2$ SSCs</td>
<td>2 M Li$_2$SO$_4$</td>
<td>0.41</td>
<td>100% retention after 35000 cycles</td>
<td>[6]</td>
</tr>
</tbody>
</table>

ASCs = Asymmetric Supercapacitors; SSCs = Symmetric Supercapacitors; M = mol L$^{-1}$; PVA = Polyvinyl Alcohol