Supporting Information

Stretchable Solid-State Zinc Ion Battery Based on Cellulose Nanofiber-Polyacrylamide Hydrogel Electrolyte and Mg0.23V2O5·1.0H2O

Cathode

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Figure S1. Photos of CNF and CNF-PAM solid-state electrolytes. (a) CNF dispersed in the solution of 1 M Zn(CF$_3$SO$_3$)$_2$; (b), (c) CNF-PAM prepared by the radical polymerization.
Figure S2. Cross-section SEM image of CNF-PAM film.
Figure S3. SEM (a, b) and TEM (c, d) images of CNFs
Figure S4. SEM images of (a, b) freeze-dried PAM film and (c, d) freeze-dried CNF-PAM films
Figure S5. Stress–strain curves of CFC/PAM hydrogel film
Figure S6. XRD pattern of $\text{V}_2\text{O}_5 \cdot \text{nH}_2\text{O}$. 
Figure S7. Crystal structure of Mg$_{0.23}$V$_2$O$_5$·1.0H$_2$O microspheres viewed from c axis.
Figure S8. Crystal structure of Mg$_{0.23}$V$_2$O$_5$·1.0H$_2$O microspheres in (a) xy, and (b) vanadium environments. The V atoms are shown by red ball, and O atoms are shown by yellow balls.
Figure S9. FTIR spectrum of $\text{Mg}_{0.23}\text{V}_2\text{O}_5\cdot1.0\text{H}_2\text{O}$ microspheres.
Figure S10. SEM images of V₂O₅·nH₂O nanowires.
Figure S11. XPS spectrum of Mg$_{0.23}$V$_2$O$_5$·1.0H$_2$O microspheres. (a) XPS survey, high-resolution XPS spectrum of (b) Mg 2s, (c) V 2p, (d) O 1s.
Figure S12. TGA curve of the prepared Mg$_{0.23}$V$_2$O$_5$·1.0H$_2$O microspheres.
Figure S13. CV curves of MVO/Zn solid-state batteries during the first three cycles at 0.1 mV/s.
Figure S14. Cycling performance of V$_2$O$_5$·nH$_2$O at current density of 500 mA/g.
Figure S15. Cycling performance at current density of 10 A/g.
Figure S16. Optical photos of (a, b) CNF and (c, d) CNF-PAM films
Figure S17. Optical photos of MVO/Zn solid-state ZIB with burning.
Figure S18. Nyquist plots of solid-state MVO/Zn batteries using CNF-PAM film and CNF film as electrolyte.
Figure S19. The CV curve at 0.1 mV/s. (The shaded area shows the capacitive contributions)
Figure S20. GITT profiles of V$_2$O$_5$·1.0H$_2$O based solid-state ZIBs, (e) diffusion versus different Zn$^{2+}$ insertion/extraction states,
Figure S21. XRD of MVO at initial and fully discharge states.
**Figure S22.** XPS survey of $\text{Mg}_{0.23}\text{V}_3\text{O}_5\cdot1.0\text{H}_2\text{O}$ microspheres at different charging/discharging states.
Figure S23. EDS mapping of $\text{Mg}_{0.23}\text{V}_2\text{O}_5\cdot1.0\text{H}_2\text{O}$ microspheres after fully discharge.
Figure S24. Schematic illustrations of Zn\textsuperscript{2+} storage during charge discharge process.
<table>
<thead>
<tr>
<th>Cathode</th>
<th>Operating voltage</th>
<th>Current rate</th>
<th>Capacity [mAh/g]</th>
<th>Cycle performance</th>
<th>Ref.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Our MVO/Zn solid-state batteries</strong></td>
<td>0.2-1.6 V</td>
<td>5 A/g</td>
<td>216 mAh/g</td>
<td>98.6% retention after 2000 cycles</td>
<td>[22]^1</td>
</tr>
<tr>
<td>VS$_2$</td>
<td>0.4-1.0 V</td>
<td>0.2 A/g</td>
<td>120 mAh/g</td>
<td>250 cycles</td>
<td>[22]^1</td>
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<tr>
<td>NH$_4$V$_2$O$_8$</td>
<td>0.2-1.4 V</td>
<td>0.5 A/g</td>
<td>133 mAh/g</td>
<td>200 cycles</td>
<td>[23]^2</td>
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<tr>
<td>MnO$_2$ nanocrystallites zinc orthovanadate</td>
<td>0.4-1.5 V</td>
<td>4 A/g</td>
<td>125 mAh/g</td>
<td>2000 cycles</td>
<td>[25]^4</td>
</tr>
<tr>
<td>MnO$_2$</td>
<td>1.0-2.0 V</td>
<td>1.3 A/g</td>
<td>127 mAh/g</td>
<td>1000 cycles</td>
<td>[26]^5</td>
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<tr>
<td>α-MnO$_2$</td>
<td>0.9-2.0 V</td>
<td>2.772 A/g</td>
<td>100 mAh/g</td>
<td>1000 cycles</td>
<td>[27]^6</td>
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<tr>
<td>MnO$_2$/PEDOT</td>
<td>0.9-1.8 V</td>
<td>1.11 A/g</td>
<td>280 mAh/g</td>
<td>300 cycles</td>
<td>[28]^7</td>
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<tr>
<td>NaV$_3$O$_8$∙1.5H$_2$O</td>
<td>0.3-1.25 V</td>
<td>0.5 A/g</td>
<td>~125 mAh/g</td>
<td>120 cycles</td>
<td>[29]^8</td>
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<tr>
<td>MnO$_2$</td>
<td>0.9-1.9 V</td>
<td>1.232 A/g</td>
<td>190 mAh/g</td>
<td>1000 cycles</td>
<td>[30]^9</td>
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<tr>
<td>VS$_2$</td>
<td>0.4-1.0 V</td>
<td>0.5 A/g</td>
<td>128 mAh/g</td>
<td>200 cycles, 91% of initial capacity</td>
<td>[31]^10</td>
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<td>MoS$_2$</td>
<td>0.3-1.5 V</td>
<td>1 A/g</td>
<td>~150 mAh/g</td>
<td>500 cycles, 97.7% of initial capacity</td>
<td>[32]^11</td>
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<tr>
<td>MnO$_2$</td>
<td>0.9-1.9 V</td>
<td>0.924 A/g</td>
<td>~150 mAh/g</td>
<td>100 cycles</td>
<td>[33]^12</td>
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<tr>
<td>MnO$_2$</td>
<td>0.9-1.8 V</td>
<td>2.4 A/g</td>
<td>146 mAh/g</td>
<td>600 cycles, 87% of initial capacity</td>
<td>[34]^13</td>
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<tr>
<td>FeHCF</td>
<td>0-2.3 V</td>
<td>3 A/g</td>
<td>57 mAh/g</td>
<td>100 cycles</td>
<td>[35]^14</td>
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<tr>
<td>Co$_{0.247}$V$<em>2$O$</em>{5}$·0.944H$_2$O</td>
<td>0.6-2.2 V</td>
<td>4 A/g</td>
<td>200 mAh/g</td>
<td>5500 cycles, 94.5% of initial cycle</td>
<td>[36]^15</td>
</tr>
<tr>
<td>Material</td>
<td>Voltage (V)</td>
<td>Current (A/g)</td>
<td>Capacity (mAh/g)</td>
<td>Cycles</td>
<td>Percentage of Initial Cycle</td>
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<tr>
<td>NiCo</td>
<td>1.2-2.0</td>
<td>96</td>
<td>70</td>
<td>16000</td>
<td>65%</td>
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<tr>
<td>CoFe(CN)₆</td>
<td>0.75-2.0</td>
<td>2</td>
<td>110</td>
<td>2000</td>
<td></td>
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<tr>
<td>δ-MnO₂</td>
<td>0.9-1.9</td>
<td>10</td>
<td>~100</td>
<td>55</td>
<td></td>
</tr>
</tbody>
</table>

**Reference**

