All Conducting Polymer Electrodes for Asymmetric Solid-State Supercapacitors

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Electronic Supplementary Information (ESI)

Specific areal capacitance ($C_A$) and cell capacitance ($C_{cell}$) were calculated from the charge-discharge curves according to the following equations.

Specific areal capacitance (mF/cm$^2$) was calculated by dividing the single PEDOT electrode capacitance by area.

$C_A = \frac{i}{A_{single}} \left( \frac{\Delta t}{\Delta E} \right)$ (for 3-electrode configuration).

$A_{single}$ is the area of single electrode, $i$ is the current applied, $\Delta t$ is the discharge time and $\Delta E$ is the potential window.

Cell capacitance ($C_{cell}$) = \( \left( \frac{i}{A_{two}} \right) \left( \frac{\Delta t}{\Delta V} \right) \) (for 2-electrode configuration).

$A_{two}$ is the total area of both the electrodes.

Volumetric stack capacitance (F/cm$^3$) was calculated by considering the total volume of the both the electrodes.

$C_{vol} = \frac{i}{v_i} \left( \frac{\Delta t}{\Delta V} \right)$

Energy density ($E$) = \( \frac{1}{2} C_{vol} V^2 \) (in Wh/cm$^3$)
Power density \( (P) = \frac{E}{\Delta t} \) (in \( \text{W/cm}^3 \)).

Where \( i \) is the discharge current density, \( A_{\text{single}} \) and \( A_{\text{two}} \) are the areas of the single and two electrodes in \( \text{cm}^2 \) respectively, \( C_{\text{cell}} \) is the cell capacitance, \( C_{\text{vol}} \) is the volumetric stack capacitance, \( v_t \) is the total volume of the electrodes.

\[ \text{Fig. S1} \] (a) CVs of PEDOT in different negative potential windows. (b) Charge-discharge curve for the PEDOT in a wide potential window of 1.4 V.

The sharp rise in the current below -0.6 V is due to hydrogen evolution reaction (see red curve in Figure S1a).
Fig. S2 (a) and (b) CV and CD of 5 minute deposited PEDOT sample. (c) CV and (d) CD of 15 minute deposited PEDOT sample.

Fig. S3 (a) CV and (b) CDs of symmetric PEDOT/Au/PEN//PEDOT/Au/PEN solid state device using PVA/H₂SO₄ gel electrolyte. (c) Nyquist plot for the symmetric PEDOT solid state device.
**Fig. S4** CVs of PANI in different positive potential windows at a scan rate of 80 mV/s. CV is getting narrow down above the potential of 0.8 V.

**Fig. S5** Unoptimised CVS of the PANI//PEDOT ASC.
**Fig. S6** (a) CVs of ASC device at a scan rate of 80 mV/s in different potential windows. (b) CV scans at a scan rate of 80 mV/s and (c) CDs of ASC device at different current densities after 100 cycles of charging and discharging. (d) Cycling stability of the optimized PANI//PEDOT ASC solid state supercapacitor over 10,000 cycles. Inset shows the charge-discharge curves at a current density of 2 mA/cm$^2$. 
Table S1. Comparison of the electrochemical performance of the ASCs reported in the literature.

<table>
<thead>
<tr>
<th>S. No.</th>
<th>ASC</th>
<th>Electrolyte</th>
<th>Potential window</th>
<th>Energy density (mWh/cm³)</th>
<th>Power density (W/cm³)</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>VO₂⁺/VN</td>
<td>PVA/LiCl</td>
<td>1.8</td>
<td>0.61</td>
<td>0.85</td>
<td>Lu et al., Nano Lett. 2013, 13, 2628–2633</td>
</tr>
<tr>
<td>2.</td>
<td>PANI//MoO₃/WO₃</td>
<td>PVA/H₃PO₄</td>
<td>1.9</td>
<td>1.9</td>
<td>0.73</td>
<td>Xiao et al., Adv. Energy Mater. 2012, 2, 1328–1332</td>
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<tr>
<td>3.</td>
<td>MnO₂ NWs//Fe₂O₃ NTs</td>
<td>PVA/KCl</td>
<td>1.6</td>
<td>0.55</td>
<td>0.139</td>
<td>Yang et al., Nano Lett. 2014, 14, 731–736</td>
</tr>
<tr>
<td>4.</td>
<td>Co₉S₈ // Co₅O₄@RuO₂</td>
<td>PVA/KOH</td>
<td>1.6</td>
<td>1.44</td>
<td>0.89</td>
<td>Xu et al., ACS Nano, 2013, 7, 5453–5462</td>
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<tr>
<td>5.</td>
<td>PANI//PEDOT</td>
<td>PVA/H₂SO₄</td>
<td>1.6</td>
<td>9</td>
<td>2.8</td>
<td>This work</td>
</tr>
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