Fabrication of a 2.8 V high-performance aqueous flexible fiber-shaped asymmetric microsupercapacitor based on MnO$_2$/PEDOT:PSS-reduced graphene oxide nanocomposite grown on carbon fiber electrode

Leila Naderi$^{a,b}$, Saeed Shahrokhian$^{b,c,*}$, Francesca Soavi$^a,*$

$^a$Department of Chemistry ‘Giacomo Ciamician’, Alma Mater Studiorum-Universita’ di Bologna, Via Selmi 2, 40126, Bologna, Italy
$^b$Department of Chemistry, Sharif University of Technology, Tehran 11155–9516, Iran
$^c$Institute for Nanoscience and Technology, Sharif University of Technology, Tehran, Iran
Fig. S1. CV curves of prepared electrodes at different scan rates
Fig. S2. Length capacitance of the prepared electrodes as function of scan rate (A) Comparison of charge storage for rGO-PEDOT:PSS electrode at different scan rates.
Fig. S3. GCD curves of prepared electrodes at different current densities
**Fig. S4.** Areal (A), Volumetric (B) and length capacitance (C) of the PEDOT:PSS@CF as function of scan rate (D, E) Gravimetric capacitance of the different electrodes as function current density.
Fig. S5. (A) Long-term cyclic performance PEDOT:PSS-rGO electrode at a current density of 12 mA cm$^{-2}$ (inset: corresponding GCD curves of the last 30 cycles). FE-SEM images of PEDOT:PSS-rGO@CF (B, C), MnO$_2$/PEDOT:PSS-rGO@CF (D, E) and XRD spectrum of PEDOT:PSS-rGO, MnO$_2$/PEDOT:PSS-rGO samples after successive cycles (F).
Fig. S6. (A) CV curves of PEDOT:PSS-rGO as negative electrode at different scan rates, (B) Areal and Volumetric and (C) Length specific capacitance of PEDOT:PSS-rGO as a function of scan rate, (D) GCD curves of PEDOT:PSS-rGO at different current densities, (E) Areal and Volumetric, (F) Length and (G) Gravimetric specific capacitance of PEDOT:PSS-rGO as a function of current density.
Fig. S7. (A) Length capacitance of the fabricated micro-device as function of scan rate, (B) Length, (C) Volumetric capacitance as function of current density, (D) Length Ragon plot (Na$_2$SO$_4$-CMC solid-state electrolyte)
Fig. S8. Linear sweep voltammetry curves recorded at 10 mV/s in 27 m KOAC electrolyte.
Fig. S9. (A) CV curves of micro-device under straight and different bending states at 35 mV s\(^{-1}\). (B) Dependence of specific capacitance of the micro-device on bent cycle number. (27 m KOAC electrolyte)
Fig. S10. Length Ragon plot of assembled micro-device in 27m- KOAC electrolyte.
Fig. S11. (A) CV curves of micro-device at different potential windows, (B) CV curves of micro-device at different scan rates in 12 m NaNO₃, (C) GCD curves of the micro-device at different current densities. (D) Areal ragon plot of micro-device in Na₂SO₄-CMC, 12 m NaNO₃ and 27 m KOAC electrolytes.
Table S1. Comparison of specific capacitances of the present work and other electrode materials in a three-electrode system

<table>
<thead>
<tr>
<th>Sample</th>
<th>Electrolyte</th>
<th>Specific capacitance</th>
<th>Current density or Scan rate</th>
<th>Voltage window</th>
<th>ref</th>
</tr>
</thead>
<tbody>
<tr>
<td>CF@ PEDOT:PSS-rGO/ MnO&lt;sub&gt;2&lt;/sub&gt;</td>
<td>1M Na&lt;sub&gt;2&lt;/sub&gt;SO&lt;sub&gt;4&lt;/sub&gt;</td>
<td>2920 mF/cm&lt;sup&gt;2&lt;/sup&gt; 194.25 F/cm&lt;sup&gt;3&lt;/sup&gt; 549.72 mF/cm&lt;sup&gt;2&lt;/sup&gt;</td>
<td>5 mA/cm&lt;sup&gt;2&lt;/sup&gt;</td>
<td>– 0.1 – 0.9 V</td>
<td>This work</td>
</tr>
<tr>
<td>Ni(OH)&lt;sub&gt;2&lt;/sub&gt;/Ni–Cu/copper wire</td>
<td>NaOH (1M)</td>
<td>12200 mF/cm&lt;sup&gt;2&lt;/sup&gt; 1220.89 F/cm&lt;sup&gt;3&lt;/sup&gt; 1530 mF/cm&lt;sup&gt;2&lt;/sup&gt;</td>
<td>4 mA/cm&lt;sup&gt;2&lt;/sup&gt;</td>
<td>0 - 0.55 V</td>
<td>66</td>
</tr>
<tr>
<td>CNT/MnO&lt;sub&gt;2&lt;/sub&gt; @ CF</td>
<td>1M Na&lt;sub&gt;2&lt;/sub&gt;SO&lt;sub&gt;4&lt;/sub&gt;</td>
<td>527 F/cm&lt;sup&gt;3&lt;/sup&gt;</td>
<td>10 mV/s</td>
<td>0 -0.8 V</td>
<td>67</td>
</tr>
<tr>
<td>MnO&lt;sub&gt;2&lt;/sub&gt;/ACF</td>
<td>1M Na&lt;sub&gt;2&lt;/sub&gt;SO&lt;sub&gt;4&lt;/sub&gt;</td>
<td>26.64 mF/cm&lt;sup&gt;2&lt;/sup&gt;</td>
<td>0.1 mA/cm</td>
<td>0- 1 V</td>
<td>68</td>
</tr>
<tr>
<td>CF/MnO&lt;sub&gt;2&lt;/sub&gt;</td>
<td>KOH</td>
<td>66.4 mF/cm&lt;sup&gt;2&lt;/sup&gt;</td>
<td>0.5 mA/cm&lt;sup&gt;2&lt;/sup&gt;</td>
<td>-0.1 – 0.8V</td>
<td>70</td>
</tr>
<tr>
<td>PEDOT:PSS/MoO&lt;sub&gt;3&lt;/sub&gt;</td>
<td>Sulfuric acid</td>
<td>99 F/g 2.99 mF/cm&lt;sup&gt;2&lt;/sup&gt;</td>
<td>1 mV/s</td>
<td></td>
<td>38</td>
</tr>
<tr>
<td>PEDOT:PSS@CuO on Cu foam</td>
<td>3M KOH</td>
<td>907.5 mF/cm&lt;sup&gt;2&lt;/sup&gt;</td>
<td>3 mA/cm&lt;sup&gt;2&lt;/sup&gt;</td>
<td>–0.1 – 0.3 V</td>
<td>39</td>
</tr>
<tr>
<td>rGO/MoS&lt;sub&gt;2&lt;/sub&gt;/PEDOT on carbon fiber cloth</td>
<td>1M H&lt;sub&gt;2&lt;/sub&gt;SO&lt;sub&gt;4&lt;/sub&gt;</td>
<td>241.81 mF/cm&lt;sup&gt;2&lt;/sup&gt;</td>
<td>0.5 mA/cm&lt;sup&gt;2&lt;/sup&gt;</td>
<td>–0.2 – 0.8 V</td>
<td>44</td>
</tr>
<tr>
<td>WS&lt;sub&gt;2&lt;/sub&gt;/PEDOT:PSS Freestanding</td>
<td>1M H&lt;sub&gt;2&lt;/sub&gt;SO&lt;sub&gt;4&lt;/sub&gt;</td>
<td>86 mF/cm&lt;sup&gt;2&lt;/sup&gt; (411 F/cm&lt;sup&gt;3&lt;/sup&gt;)</td>
<td>40 mV/s</td>
<td>–0.3 – 0.5 V</td>
<td>40</td>
</tr>
<tr>
<td>PEDOT/Polyaniline Freestanding</td>
<td>H&lt;sub&gt;2&lt;/sub&gt;SO&lt;sub&gt;4&lt;/sub&gt;</td>
<td>112.6 F/g</td>
<td>5 mV/s</td>
<td>–0.2 – 0.8 V</td>
<td>41</td>
</tr>
<tr>
<td>PPy/PEDOT:PSS@ MWCNT/SF Silk Fabric</td>
<td>1M Na&lt;sub&gt;2&lt;/sub&gt;SO&lt;sub&gt;4&lt;/sub&gt;</td>
<td>5296 mF/cm&lt;sup&gt;2&lt;/sup&gt;</td>
<td>2 mA/ cm&lt;sup&gt;2&lt;/sup&gt;</td>
<td>–0.4 – 0.6 V</td>
<td>42</td>
</tr>
<tr>
<td>Cellulose/PEDOT:PSS/MWCNT</td>
<td>KOH</td>
<td>485 F/g</td>
<td>1 A/g</td>
<td>–0.4 – 0.1 V</td>
<td>43</td>
</tr>
<tr>
<td>SWCNT/PEDOT:PSS/CuHcF</td>
<td>1M H&lt;sub&gt;2&lt;/sub&gt;SO&lt;sub&gt;4&lt;/sub&gt;</td>
<td>969.8 mF/cm&lt;sup&gt;2&lt;/sup&gt;</td>
<td>5 mV/s</td>
<td>–0.2 – 0.6 V</td>
<td>62</td>
</tr>
<tr>
<td>PANi/PEDOT/PANI/ Ultralarge rgo</td>
<td>1M H&lt;sub&gt;2&lt;/sub&gt;SO&lt;sub&gt;4&lt;/sub&gt;</td>
<td>1300 F/cm&lt;sup&gt;3&lt;/sup&gt;</td>
<td>3 A/cm&lt;sup&gt;3&lt;/sup&gt;</td>
<td>–0.2 – 0.8 V</td>
<td>45</td>
</tr>
<tr>
<td>PEDOT:PSS/MnO&lt;sub&gt;2&lt;/sub&gt; Freestanding</td>
<td>0.5 M Na&lt;sub&gt;2&lt;/sub&gt;SO&lt;sub&gt;4&lt;/sub&gt;</td>
<td>92.8 F/g</td>
<td>0.1 A/g</td>
<td>0– 0.9 V</td>
<td>47</td>
</tr>
<tr>
<td>rGO/MnO&lt;sub&gt;2&lt;/sub&gt;/PEDOT:PSS binder on nickel foam</td>
<td>1.0 M Na&lt;sub&gt;2&lt;/sub&gt;SO&lt;sub&gt;4&lt;/sub&gt;</td>
<td>169.1 F/g</td>
<td>0.1 A/g</td>
<td>0– 1.0 V</td>
<td>46</td>
</tr>
<tr>
<td>PEDOT:PSS/MoS&lt;sub&gt;2&lt;/sub&gt;/PEDOT</td>
<td>1M H&lt;sub&gt;2&lt;/sub&gt;SO&lt;sub&gt;4&lt;/sub&gt;</td>
<td>51.01 mF/cm&lt;sup&gt;2&lt;/sup&gt; 463.73 F/cm&lt;sup&gt;3&lt;/sup&gt;</td>
<td>0.1 mA/cm&lt;sup&gt;3&lt;/sup&gt;</td>
<td>–0.2 – 1 V</td>
<td>63</td>
</tr>
<tr>
<td>PEDOT:PSS/MnO&lt;sub&gt;2&lt;/sub&gt;/PEDOT</td>
<td>1 M H&lt;sub&gt;2&lt;/sub&gt;SO&lt;sub&gt;4&lt;/sub&gt;</td>
<td>391.36 F/cm&lt;sup&gt;3&lt;/sup&gt;</td>
<td>3.75 A/cm&lt;sup&gt;3&lt;/sup&gt;</td>
<td>–0.2 – 1 V</td>
<td>48</td>
</tr>
<tr>
<td>MnO&lt;sub&gt;2&lt;/sub&gt;@PEDOT:PSS@OCNTF</td>
<td>2M LiCl</td>
<td>837.6 mF/cm&lt;sup&gt;2&lt;/sup&gt;</td>
<td>0.6 mA/cm&lt;sup&gt;2&lt;/sup&gt;</td>
<td>0– 0.8 V</td>
<td>64</td>
</tr>
<tr>
<td>PEDOT:PSS/rGO</td>
<td>1 M H&lt;sub&gt;2&lt;/sub&gt;SO&lt;sub&gt;4&lt;/sub&gt;</td>
<td>45.91 F/g</td>
<td>1 A/g</td>
<td>0- 0.8 V</td>
<td>65</td>
</tr>
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</table>
Table S2. Electrochemical performances of recent reported supercapacitors

<table>
<thead>
<tr>
<th>Positive electrode</th>
<th>Negative electrode</th>
<th>Electrolyte</th>
<th>Specific capacitance</th>
<th>Current density</th>
<th>Voltage window</th>
<th>Maximum Energy density</th>
<th>Maximum Power density</th>
</tr>
</thead>
<tbody>
<tr>
<td>CF/@PEDOT:PSS-rGO/ MnO₂</td>
<td>CF/@PEDOT:PSS-rGO</td>
<td>Na₂SO₄- CMC</td>
<td>550.72 mF/cm² 100.97 mF/cm 35.43 F/cm³</td>
<td>3 mA/cm²</td>
<td>2 V</td>
<td>295.0 µWh/cm² 55 µWh/cm</td>
<td>19 mWh/cm³</td>
</tr>
<tr>
<td>Ni(OH)₂Ni-Cu / copper wire</td>
<td>RGO/CF</td>
<td>NaOH (1M)</td>
<td>550 mF/cm² 86 mF/cm 42.3 F/cm³</td>
<td>3.2 mA/cm²</td>
<td>1.6 V</td>
<td>195 µWh/cm³ 30.7 µWh/cm 15.04 mWh/cm³</td>
<td>295.0 µWh/cm² 55 µWh/cm 19 mWh/cm³</td>
</tr>
<tr>
<td>CNT/MnO₂ @CF</td>
<td>PVA/LiCl</td>
<td>91.6 F/cm³</td>
<td>0.8 V</td>
<td>12.72 mWh/cm²</td>
<td>46.38 mW/cm³</td>
<td>67</td>
<td></td>
</tr>
<tr>
<td>CF/MnO₂</td>
<td>CF/Mo₃</td>
<td>4.86 mF/cm³</td>
<td>0.5 mA/cm³</td>
<td>2 V</td>
<td>2.7 µWh/cm³</td>
<td>8.3 mW/cm³</td>
<td>69</td>
</tr>
<tr>
<td>MnO₂/C</td>
<td>PVA/NaCl</td>
<td>63 F/g</td>
<td>24 mF/cm</td>
<td>1 V</td>
<td>1.089 µWh/cm</td>
<td>126.65 µW/cm</td>
<td>70</td>
</tr>
<tr>
<td>rGO/MoS₂/PE DOT on carbon fiber cloth</td>
<td>PVA/H₃PO₄</td>
<td>10.35 mF/cm²</td>
<td>0.104 mA/cm³</td>
<td>1 V</td>
<td>1.44 µWh/cm³ at 0.06 mW/cm³</td>
<td>44</td>
<td></td>
</tr>
<tr>
<td>WS₃/PEDOT:PSS Freestanding</td>
<td>H₂PO₄/PVA</td>
<td>34.5 mF/cm² (86 F/cm³)</td>
<td>0.4 mA/cm²</td>
<td>0.6 V</td>
<td>0.48 mWh/cm³</td>
<td>107.14 mW/cm³</td>
<td>41</td>
</tr>
<tr>
<td>PEDOT/Polyaniline Freestanding</td>
<td>PVA/H₃SO₄</td>
<td>242.5 mF/cm² (3.5 F/cm³)</td>
<td>1 V</td>
<td>0.48 mWh/cm³</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PPy/PEDOT:PSS@MWCNT/SF Silk Fabric</td>
<td>LiCl/PVA</td>
<td>1088.6 mF/cm² (13.44 F/cm³)</td>
<td>2 mA/cm²</td>
<td>1 V</td>
<td></td>
<td></td>
<td>42</td>
</tr>
<tr>
<td>Cellulose/PEDOT:PSS/MWCNT Ni foam</td>
<td>Cellulose/PEDOT T/PSS/MWCNT</td>
<td>PVA/KOH</td>
<td>380 F/g</td>
<td>50.4 F/cm³</td>
<td>0.25 A/g</td>
<td>0.05 A/cm³</td>
<td>1 V</td>
</tr>
<tr>
<td>Ag: PEDOT:PSS/ CNT</td>
<td>H₂PO₄ (2 electrode)</td>
<td>64 mF/cm² (85.3 F/g)</td>
<td>0.15 mA/cm²</td>
<td>0.8 V</td>
<td>8.89 µWh/cm³</td>
<td>0.83 µW/cm³</td>
<td>76</td>
</tr>
<tr>
<td>PEDOT--CNT on C/C</td>
<td>H₂SO₄/PVA</td>
<td>20.6 mF/cm² (82.4 F/cm³)</td>
<td>0.1 mA/cm²</td>
<td>1 V</td>
<td>2.82 µWh/cm³</td>
<td>0.046 W/cm²</td>
<td>77</td>
</tr>
<tr>
<td>SWCNT/PEDOT T/PSS/CuHCF</td>
<td>Mo doped</td>
<td>1M H₂SO₄ (2 electrode)</td>
<td>530.3 mF/cm² (100.1 F/cm³)</td>
<td>10 mV/s</td>
<td>1.4 V</td>
<td>30.08 Wh/L</td>
<td>10.79 kW/L</td>
</tr>
<tr>
<td>PAN/PEDOT/ PAN/ Ultrasre rgo</td>
<td>PEDOT/ MoO₂</td>
<td>125 F/cm³</td>
<td>3 A/cm³</td>
<td>0.8 V</td>
<td>5.4 mWh/cm³</td>
<td>265 mW/cm³</td>
<td>45</td>
</tr>
<tr>
<td>PEDOT/PSS/MnO₂/PEDOT</td>
<td>H₂PO₄/PVA</td>
<td>1 V</td>
<td>0.2 µWh/cm³ (1.81 mWh/cm³) under 0.09 mW/cm³ (0.82 W/cm³)</td>
<td></td>
<td></td>
<td>63</td>
<td></td>
</tr>
<tr>
<td>PEDOT/PSS/MnO₂/PEDOT</td>
<td>H₂PO₄/PVA</td>
<td>13.64 F/cm³</td>
<td>0.2 A/cm³</td>
<td>1 V</td>
<td></td>
<td></td>
<td>48</td>
</tr>
<tr>
<td>MnO₂@PEDOT T/PSS@OCNT F</td>
<td>LiCl/PVA</td>
<td>278.6 mF/cm²</td>
<td>0.6 mA/cm²</td>
<td>1.8 V</td>
<td>125.37 µWh/cm³</td>
<td>5400 µW/cm²</td>
<td>64</td>
</tr>
<tr>
<td>PEDOT/PSS/rGO</td>
<td>PVA/H₂SO₄</td>
<td>19.3 mF/cm²</td>
<td>20 mV/s</td>
<td>0.8 V</td>
<td>2.24 µWh/cm³</td>
<td>400 µW/cm²</td>
<td>65</td>
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</tbody>
</table>