Hierarchically mesoporous carbon nanopetal based electrodes for flexible supercapacitors with super-long cyclic stability

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Table S1. Comparison of gravimetric capacitances achieved by the various carbon nanomaterials based supercapacitors.

<table>
<thead>
<tr>
<th>Ref.</th>
<th>Electrode Material/s</th>
<th>Electrolyte</th>
<th>$C_{\text{sc,sp,m}}$ (F/g)</th>
</tr>
</thead>
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<tr>
<td>[S2]</td>
<td>SWNTs</td>
<td>1 M NaCl (aqueous)</td>
<td>25-30</td>
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<tr>
<td></td>
<td>MWNTs</td>
<td>1 M NaCl (aqueous)</td>
<td>6-10</td>
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<tr>
<td>[S3]</td>
<td>MWNTs</td>
<td>1 M LiPF$_6$ (EC-DEC)</td>
<td>35</td>
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<tr>
<td>[S4]</td>
<td>Normal CNTs</td>
<td>1 M LiClO$_4$ (EC-DEC)</td>
<td>25</td>
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<tr>
<td></td>
<td>Activated CNTs</td>
<td>1 M LiClO$_4$ (EC-DEC)</td>
<td>50</td>
</tr>
<tr>
<td>[S5]</td>
<td>CO$_2$-oxidized CNTs</td>
<td>--</td>
<td>47</td>
</tr>
<tr>
<td>[S6]</td>
<td>MWNTs</td>
<td>6 N KOH</td>
<td>21</td>
</tr>
<tr>
<td>[S7]</td>
<td>MWNTs</td>
<td>1 M H$_2$SO$_4$</td>
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<tr>
<td>[S8]</td>
<td>SWNTs</td>
<td>6 M KOH</td>
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<td>[S9]</td>
<td>Pristine CNTs</td>
<td>Aprotic electrolyte</td>
<td>12.9</td>
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<tr>
<td></td>
<td>Pristine CNTs</td>
<td>Protic electrolyte</td>
<td>10.9</td>
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<tr>
<td></td>
<td>Cup-stacked CNTs</td>
<td>Aprotic electrolyte</td>
<td>55.7</td>
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<td></td>
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<td>Protic electrolyte</td>
<td>28.4</td>
</tr>
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<td>[S10]</td>
<td>Pristine DWNTs</td>
<td>0.5 M H$_2$SO$_4$</td>
<td>22</td>
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<td></td>
<td>Pristine DWNTs</td>
<td>1 M Et$_4$NBF$_4$/PC</td>
<td>34</td>
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<td>DWNT-HNO$_3$</td>
<td>0.5 M H$_2$SO$_4$</td>
<td>54</td>
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<td></td>
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<td>1 M Et$_4$NBF$_4$/PC</td>
<td>38</td>
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<td>[S11]</td>
<td>MWNTs grown on metals</td>
<td>6 M KOH</td>
<td>10.75-21.57</td>
</tr>
<tr>
<td>[S12]</td>
<td>CNTs grown on Ni-foam</td>
<td>6 M KOH</td>
<td>25</td>
</tr>
<tr>
<td>[S13]</td>
<td>SWNT film</td>
<td>1 M LiClO$_4$ (EC-DEC-DMC)</td>
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<td>[S14]</td>
<td>MWNTs</td>
<td>38 wt% H$_2$SO$_4$</td>
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<tr>
<td>[S15]</td>
<td>SWNTs</td>
<td>7.5 N KOH</td>
<td>180</td>
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</table>
Method S1. Calculation of ionic conductivity of CNPs/UCF electrodes.

The ionic conductivity of the supercapacitor electrodes is calculated by using the equation

$$\sigma = \frac{T}{R_b \times A}$$

Where $\sigma$ is the ionic conductivity in S/cm, $T$ is the total thickness of the supercapacitor cell (in cm), $R_b$ is the bulk electrolyte resistance (in $\Omega$), and $A$ is the geometrical area of electrodes (in cm$^2$).

Method S2: Calculation of discharge capacitance of CNPs/UCF supercapacitor.

The discharge capacitance of the supercapacitor is calculated by using equation

$$C_{sc} = \frac{I t_{dis}}{\Delta E}$$

Where, $C_{sc}$ is the discharge capacitance of the supercapacitor, $I$ is the charging current, $t_{dis}$ is the discharging time, and $\Delta E$ is the operating potential window.

Method S3: Calculation of areal capacitance of CNPs/UCF supercapacitor.

The areal capacitance of the supercapacitor is calculated by using the equation

$$C_{sc, A} = \frac{C_{sc}}{A_{sc}}$$

Where, $C_{sc, A}$ is the areal capacitance of the supercapacitor and $A_{sc}$ is the total geometric area of two supercapacitor electrodes (i.e., two times the area of single electrode).

Method S4: Calculation of volumetric capacitance of CNPs/UCF supercapacitor.

The volumetric capacitance of the supercapacitor is calculated by using the equation

$$C_{sc, V} = \frac{C_{sc}}{V_{sc}}$$

| Present Work | CNPs synthesized on UCF | 5 M KOH | 220 (at 2.77mA/cm$^2$) | 154 (at 16.66mA/cm$^2$) |
Where, $C_{sc,v}$ is the volumetric capacitance of the supercapacitor and $V_{sc}$ is the total volume of the supercapacitor (total volume of two supercapacitor electrodes + volume of the separator with electrolyte).

**Method S5: Calculation of volume specific capacitance of CNPs/UCF supercapacitor.**

The volume specific capacitance of the supercapacitor is calculated [S1] by using the equation

$$C_{sc,sp,v} = 4 \times \frac{C_{sc}}{V_{el}}$$

Where, $C_{sc,sp,v}$ is the volume specific capacitance of the supercapacitor, $C_{sc}$ is the discharge capacitance of the supercapacitor, $V_{el}$ is the total volume of two supercapacitor electrodes (the volumes of separator with electrolyte is not considered).

**Method S6: Calculation of volume specific energy density of CNPs/UCF supercapacitor.**

The volume specific energy density of the supercapacitor is calculated by using the equation

$$E_{sc,sp,v} = \frac{C_{sc,sp,v} \times (\Delta E)^2}{2 \times 3600}$$

Where $E_{sc,sp,v}$ is the volume specific energy density and all other variables as defined above.

**Method S7: Calculation of volume specific power density of CNPs/UCF supercapacitor.**

The volume specific power density of the supercapacitor is calculated by using the equation

$$P_{sc,sp,v} = \frac{E_{sc,sp,v} \times 3600}{t_{dis}}$$

Where $P_{sc,sp,v}$ is the volume specific power density and all other variables are defined above.

**Method S8: Calculation of gravimetric capacitance of CNPs/UCF supercapacitor.**

The gravimetric capacitance of the supercapacitor is calculated by using the equation

$$C_{sc,sp,m} = \frac{I \times t_{dis}}{M \times (\Delta E)} = \frac{C_{sc}}{M}$$

Where, ‘M’ is the total mass of CNPs in the two electrodes of the supercapacitor (excluding the mass of UCFs, separator, and electrolyte), and other variables are discussed above.
Supplementary Figures:

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**Fig. S3.** EDS spectra of oxidized, nickel-coated UCFs.
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![Plot of variations in the volumetric capacitance of CNPs/UCF supercapacitor cell at different current densities.](image)

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![Digital image of the two electrode cell set-up used for the testing of CNPs/UCF supercapacitor at various bending angles.](image)
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**Fig. S7.** Plot of percentage retention in the gravimetric capacitance of CNPs/UCF supercapacitor cell at different bending angles.
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![Gravimetric Energy Density Plot](image1)

**Fig. S11.** Plots of percentage retentions in the volume specific and gravimetric energy densities of CNPs/UCF supercapacitor cell at different bending angles.

![Volume Specific and Gravimetric Density Retention Plots](image2)
**Fig. S12.** Plots of percentage retentions in the volume specific and gravimetric power densities of CNPs/UCF supercapacitor cell at different bending angles.

**References:**


