Supporting Information

Covalent Grafting of P-phenylenediamine Molecule onto “Bubble-like” Carbon Surface for High Performance Asymmetric Supercapacitors

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Fig. S1. SEM images of the (a, b) SiO$_2$, (c) BC-0, (d) BC-0.25, (e) BC-0.5, (f) BC-1.
Fig. S2. (a, b) Nitrogen adsorption-desorption isotherms and relative pore size distributions of BC-0.
Fig. S3. XRD patterns of BC-x (x=0, 0.25, 0.5, 1).
Fig. S4. Raman spectra of BC-x (x=0, 0.25, 0.5, 1).
Fig. S5. FTIR spectra of PPD.
Fig. S6. High-resolution N 1s spectra of the PPD-BC.
Fig. S7. Electrochemical performance of BC-x (x=0, 0.25, 0.5, 1). (a) CV curves at 20 mV s⁻¹.
(b) Specific capacitance as a function of scan rate. (c) Nyquist plots. (d) Bode plots
Fig. S8. CV curves of the BC-0.5 at the scan rates from 2 to 100 mV s$^{-1}$
Fig. S9. (a) CV curves of the AC, GO, and BC-0.5 at 20 mV s$^{-1}$ (b) CV curves of the PPD-AC, PPD-GO, and PPD-BC at 20 mV s$^{-1}$. 
Fig. S10. The electrochemical performances of the BC-0.5 and PPD-BC using a three-electrode cell in 1 M H₂SO₄ electrolyte within a potential window of -0.2 to 0.8 V (vs. SCE). CV curves of the (a) BC-0.5 and (b) PPD-BC at different scan rates. (c) CV curves of the BC-0.5 and PPD-BC at 20 mV s⁻¹. (d) Galvanostatic charge/discharge curves of the BC-0.5 and PPD-BC at 2 A g⁻¹. (e) Specific capacitances of the BC-0.5 and PPD-BC at different scan rates from 2 to 100 mV s⁻¹. (f) Nyquist plots with inset showing the zoom-in views of the high-frequency region.
**Fig. S11.** (a, b) SEM and TEM images of the Ni(OH)$_2$. (d) XRD patterns of Ni(OH)$_2$. 
Fig. S12. Electrochemical performance of Ni(OH)$_2$. (a) CV curves at different scan rates from 2 to 50 mV s$^{-1}$. (b) Specific capacitance at different scan rates from 2 to 50 mV s$^{-1}$. 
Fig. S13. Galvanostatic charge/discharge curves of the PPD-BC//Ni(OH)$_2$ ASC at various current densities from 0.5 to 10 A g$^{-1}$. 
Fig. S14. Electrochemical performance of the PPD-BC//PPD-BC symmetric supercapacitor in 1 M H$_2$SO$_4$ electrolyte. (a) CV curves in various operating voltage. (b) CV curves at different scan rates. (c) Ragone plots. (d) Cycling stability at 50 mV s$^{-1}$. 
Table S1. Comparison of the performances for previously reported ASCs.

<table>
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<tr>
<th>Electrode materials</th>
<th>Voltage (V)</th>
<th>Electrolyte</th>
<th>Energy density (Wh kg⁻¹)</th>
<th>Power density (W kg⁻¹)</th>
<th>Ref</th>
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<tr>
<td>hexagonal boron nitride</td>
<td>1.45</td>
<td>2 M KOH</td>
<td>17</td>
<td>245</td>
<td>47</td>
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<tr>
<td>NiCo₂O₄</td>
<td>1.4</td>
<td>2 M KOH</td>
<td>24.5</td>
<td>175</td>
<td>45</td>
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<tr>
<td>MnOOH/NiAl-LDH</td>
<td>1.6</td>
<td>6 M KOH</td>
<td>26.8</td>
<td>800</td>
<td>46</td>
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<tr>
<td>PFPFC-NiO</td>
<td>1.5</td>
<td>6 M KOH</td>
<td>32.2</td>
<td>281.3</td>
<td>49</td>
</tr>
<tr>
<td>NiCo₂O₄ nitrogen-doped porous carbon</td>
<td>1.4</td>
<td>2 M KOH</td>
<td>32</td>
<td>700.4</td>
<td>48</td>
</tr>
<tr>
<td>HPC-2/MnO₂ honeycomb porous carbon</td>
<td>2</td>
<td>1 M Na₂SO₄</td>
<td>58.8</td>
<td>210.7</td>
<td>50</td>
</tr>
<tr>
<td>Ni(OH)₂</td>
<td>1.6</td>
<td>2 M KOH</td>
<td>94</td>
<td>423</td>
<td>This work</td>
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