Electronic Supplementary Information

Electrodeposition of ultrathin nickel-cobalt double hydroxide nanosheets on nickel foam as high-performance supercapacitor electrodes

Junheng Xing\textsuperscript{a}, Shaoyan Wu\textsuperscript{a, b} and K. Y. Simon Ng\textsuperscript{a,*}

\textsuperscript{a} Department of Chemical Engineering and Materials Science, Wayne State University, Detroit, MI 48202, USA

\textsuperscript{b} Department of Bioengineering, Zhixing College of Hubei University, Wuhan, Hubei 430011, China

**Figure S1** SEM images of electrodeposited Ni-Co DH nanosheets in solution with different Ni/Co molar ratios: (a) 1/0, (b) 2/1 (c) 1/2, and (d) 0/1.

**Figure S2** EDS mapping images of Ni-Co DH nanosheets obtained in solution of Ni/Co (1/1): (a) Ni, (b) Co. The green color is Ni and the red color indicates Co.
Figure S3  XRD patterns of Ni foam supported Ni-Co DHs obtained in solution of Ni/Co (1/1).

Figure S4  Comparison of CV curves of (a) pristine Ni foam and HCl pretreated Ni foam and (b) Ni-Co DHs deposited in the solution of Ni/Co (1/1) on Ni foam substrates without and with HCl pretreatment.
Figure S5 Galvanostatic charge/discharge curves at different current density of Ni foam supported Ni-Co DHs formed with different Ni/Co feeding molar ratios: (a) 1/0, (b) 9/1, (c) 4/1, (d) 3/2, (e) 1/1, (f) 1/2, (g) 1/3, and (h) 0/1.
Figure S6 SEM images of Ni-Co DHs after 2000 cycles of charge/discharge tests: (a) Ni/Co (1/0), (b) Ni/Co (4/1), (c) Ni/Co (1/1), (d) Ni/Co (0/1).

Figure S7 Cycle performance of Ni-Co DHs formed in solution of Ni/Co (1/1) without immersing pretreatment.
Figure S8 SEM images of Ni-Co DHs formed in solution of Ni/Co (1/1) without pre-immersing process (a) before and (b) after 2000 cycles of galvanostatic charge-discharge tests.

Table S1 Comparison of maximum (at low current density) and minimum (at high current density) $C_s$, cycle stability, and maximum (at low power density) and minimum (at high power density) energy density based on active materials of some reported supercapacitor electrodes of Ni-based oxides/hydroxides

<table>
<thead>
<tr>
<th>Ref.</th>
<th>Electrode materials</th>
<th>$C_s$ (F g$^{-1}$)</th>
<th>Stability*</th>
<th>Energy density (Wh kg$^{-1}$)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Maximum</td>
<td>Minimum</td>
<td>Maximum</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Ni(OH)$_2$</td>
<td>3152 (4 A g$^{-1}$)</td>
<td>280 (16 A g$^{-1}$)</td>
<td>48% (after 300 cycles)</td>
</tr>
<tr>
<td>2</td>
<td>NiO</td>
<td>309 (1 A g$^{-1}$)</td>
<td>221 (40 A g$^{-1}$)</td>
<td>~ 91%**</td>
</tr>
<tr>
<td>3</td>
<td>Ni-Co LDHs***</td>
<td>2184 (1 A g$^{-1}$)</td>
<td>1494 (20 A g$^{-1}$)</td>
<td>88.5%</td>
</tr>
<tr>
<td>4</td>
<td>Ni-Co DH microspheres</td>
<td>2275.5 (1 A g$^{-1}$)</td>
<td>1007.8 (25 A g$^{-1}$)</td>
<td>~ 95%</td>
</tr>
<tr>
<td>5</td>
<td>Ni-Co LDHs/ZnO nanoflake</td>
<td>1624 (10 A g$^{-1}$)</td>
<td>1311 (50 A g$^{-1}$)</td>
<td>94%</td>
</tr>
<tr>
<td>6</td>
<td>NiCo(OH)$_2$/graphene/carbon nanotube</td>
<td>2360 (0.5 A g$^{-1}$)</td>
<td>2030 (20 A g$^{-1}$)</td>
<td>~ 81%</td>
</tr>
<tr>
<td>7</td>
<td>NiCo$_2$O$_4$ nanowire/Ni-Co DHs</td>
<td>--</td>
<td>--</td>
<td>~ 96 (~ 1 kW kg$^{-1}$)</td>
</tr>
<tr>
<td>8</td>
<td>Ni-Co LDHs</td>
<td>2682 (3 A g$^{-1}$)</td>
<td>1706 (20 A g$^{-1}$)</td>
<td>--</td>
</tr>
<tr>
<td>9</td>
<td>Ni-Mn LDHs</td>
<td>881 (1 A g$^{-1}$)</td>
<td>403 (10 A g$^{-1}$)</td>
<td>88% (after 500 cycles)</td>
</tr>
<tr>
<td></td>
<td>Material</td>
<td>Capacity (mAh g⁻¹)</td>
<td>Specific Capacity (mAh cm⁻³)</td>
<td>Cₙ Retention %</td>
</tr>
<tr>
<td>---</td>
<td>-----------------------------------</td>
<td>--------------------</td>
<td>------------------------------</td>
<td>----------------</td>
</tr>
<tr>
<td>10</td>
<td>Ni-Al LDHs/graphene</td>
<td>1255.8 (1 A g⁻¹)</td>
<td>755.6 (6 A g⁻¹)</td>
<td>~ 79%****</td>
</tr>
<tr>
<td>11</td>
<td>Ni-Al LDHs/graphene</td>
<td>1329 (3.6 A g⁻¹)</td>
<td>851 (18 A g⁻¹)</td>
<td>91%</td>
</tr>
<tr>
<td>12</td>
<td>Ni-Al LDH/carbon nanotube</td>
<td>1500 (1 A g⁻¹)</td>
<td>1054 (10 A g⁻¹)</td>
<td>50%</td>
</tr>
</tbody>
</table>

This work shows that Ni-Co DHs (electrodeposition) have a Cₙ retention ratio of 94% after 1500 cycles, based on the maximum Cₙ.

References