Supporting Information

Seed-assisted smart construction of high mass loading Ni-Co-Mn hydroxide nanoflakes for supercapacitor application

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Figure S1 (a) XRD patterns of Ni(OH)$_2$ nanorod seeds, Ni foam supported sample and powder collected form the CBD solution and (b) XPS spectrum for Ni 2p of Ni(OH)$_2$ nanorod seeds (c) N$_2$ gas adsorption–desorption curves and (d) pore size distribution curves of Ni(OH)$_2$ nanorod arrays and NCMH.

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Figure S2 (a) SEM image and (b) TEM image of non-seed-assisted NCMH

Figure S3 SEM images in different magnifications of Ni supported Ni(OH)$_2$ nanorod arrays reacting with control solution
Figure S4 GCD curves of (a) Ni(OH)$_2$ nanorod seeds and (b) non-seed-assisted NCMH in different current densities: (from right to left) 2.5, 5.0, 7.5, 10 and 15 mA cm$^{-2}$

Figure S5 EIS Nyquist plots of NCMH, Ni(OH)$_2$ nanorod arrays seeds and non-seed-assisted NCMH in a frequency range from 0.01 Hz to 100000 Hz. The inset shows the enlarged high frequency region.

In the two-electrode set-up, mass ratio of positive and negative active materials are calculated as follows:
For the negative carbon based material:
$$Q_- = C_- \times \Delta V \times m_-$$
Where $C_-$ represents the specific capacitance of electrode (F g$^{-1}$), $\Delta V$ is the potential range, and $m_-$ is the weight of the RGO material (g).
For the “battery-type” positive materials:
$$Q_+ = C'_+ \times m_+$$
Where $C'_+$ represents the specific capacity of electrode (mAh g$^{-1}$) and $m_+$ is the weight of NCMH (g).
To obtain $Q_+=Q_-$, the mass balance will be expressed as following equation:
\[
\frac{m_+}{m_-} = \frac{C_- \times \Delta V_-}{C'^+}
\]

Figure S6 (a) GCD curves in 1, 2, 3, 4, 5 A g\(^{-1}\) and (b) CV curves in 1, 2, 5, 10, 20 mV s\(^{-1}\) for activated carbon.

Figure S7 Rate performance of the device.
Table S1  Supercapacitor electrodes materials with Ni/Co/Mn elements in previous studies, the units are converted to “F” for the convenience of comparison.

<table>
<thead>
<tr>
<th>Sample</th>
<th>Specific Capacitance</th>
<th>Test Condition</th>
<th>Mass Loading</th>
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</thead>
<tbody>
<tr>
<td>This study</td>
<td>7.51 F cm^{-2} (1445 F g^{-1})</td>
<td>2.5 mA cm^{-2}</td>
<td>5.2 mg cm^{-2}</td>
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<tr>
<td>Ni–Co–Mn hydroxide nanoneedle</td>
<td>520 F g^{-1}</td>
<td>1 mA cm^{-2}</td>
<td>0.6 mg cm^{-2}</td>
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<td>Ni–Co–Mn oxide nanoneedle</td>
<td>2023 F g^{-1}</td>
<td>1 mA cm^{-2}</td>
<td>0.5 mg cm^{-2}</td>
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<tr>
<td>Co Mn co-doped NiO nanocrystalline</td>
<td>673 F g^{-1}</td>
<td>0.5 A g^{-1}</td>
<td>0.5 mg cm^{-2}</td>
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<tr>
<td>Ni(OH)_{2} nanoflake/ZnO nanowire</td>
<td>1830 F g^{-1}</td>
<td>2 A g^{-1}</td>
<td>0.15 mg cm^{-2}</td>
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<td>MnO_{2}/Ni(OH)_{2} networks</td>
<td>843 F g^{-1}</td>
<td>1 A g^{-1}</td>
<td>1.0 mg cm^{-2}</td>
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<tr>
<td>Co_{2}O_{2}/Co(OH)_{2} nanoflake</td>
<td>0.458 F cm^{-2}</td>
<td>2 mV s^{-1}</td>
<td>2.0 mg cm^{-2}</td>
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<td>Co_{2}MnO_{4}/rGO</td>
<td>1089.3 F g^{-1}</td>
<td>1 A g^{-1}</td>
<td>1.08 mg cm^{-2}</td>
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<td>NiCo_{2}O_{4} nanoflakes</td>
<td>3.51 F cm^{-2}</td>
<td>1.8 mA cm^{-2}</td>
<td>1.2 mg cm^{-2}</td>
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References