Supporting information

Hollow-ZIFs-Templated Formation of ZnO@C-N-Co Core-Shell Nanostructure for Highly Efficient Pollutant Photodegradation

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Figure Captions

**Figure S1.** XRD patterns of the sample obtained by pyrolyzing the hollow Zn/Co-ZIF at 550 °C (denoted as Zn/Co-ZIF-550) and at 700 °C (denoted as Zn/Co-ZIF-700).

**Figure S2.** (a) Low- and (b) high-resolution TEM images, STEM image (c) and EDS mappings (d-h) of the sample prepared by pyrolyzing the hollow Zn/Co-ZIF at 550 °C.

**Figure S3.** (a) Low- and (b) high-resolution TEM images of the hollow carbon-cobalt-based structure obtained at 700 °C.

**Figure S4.** (a) and (b) TEM images of the as-prepared ZnO@C-N-Co.

**Figure S5.** (a) SEM image, (b) and (c) TEM images of ZIF-67. (d) SEM image, (e) and (f) TEM images of ZIF-67-600.

**Figure S6.** (a) SEM image, (b) and (c) TEM images of ZIF-8. (d) SEM image, (e) and (f) TEM images of ZIF-8-600.

**Figure S7.** (a) SEM image, (b) and (c) TEM images of ZnO.

**Figure S8.** TG curves of the as-sythesized ZIF-67, ZIF-8, and hollow Zn/Co-ZIF.

**Figure S9.** XPS survey spectrums of ZIF-67, ZIF-8, hollow Zn/Co-ZIF, and commercial pure ZnO.

**Figure S10.** A magnified TEM image of Figure 5b.

**Figure S11.** UV-vis absorption spectras of the photocatalytic degradation of MO in the presence of (a) ZnO@C-N-Co, (b) ZnO, (c) ZIF-8-600, and (d) ZIF-67-600, respectively. Inset of (a) shows the molecular structural formula of MO.

**Figure S12.** UV-vis absorption spectras of the photocatalytic degradation of MO in the absence of catalyst (a) and without light (b).

**Figure S13.** UV-Vis spectra of the adsorption of MO using the ZIF-8-600, ZnO@C-N-Co, ZIF-67-600, and pure ZnO as adsorbent.

Captions for Tables

**Table S1.** Physicochemical properties of ZnO@C-N-Co, ZIF-8-600 and ZIF-67-600.

**Table S2.** Experiment of degradation of MO.
Figure S1. XRD patterns of the samples obtained by pyrolyzing the hollow Zn/Co-ZIF at 550 °C (denoted as Zn/Co-ZIF-550) and at 700 °C (denoted as Zn/Co-ZIF-700).
Figure S2. (a) Low- and (b) high-resolution TEM images, STEM image (c) and EDS mappings (d-h) of Zn/Co-ZIF-550.
Figure S3. (a) Low- and (b) high-resolution TEM images of Zn/Co-ZIF-700.
Figure S4. (a) and (b) TEM images of the as-prepared ZnO@C-N-Co.
Figure S5. (a) SEM image, (b) and (c) TEM images of ZIF-67. (d) SEM image, (e) and (f) TEM images of ZIF-67-600.
Figure S6. (a) SEM image, (b) and (c) TEM images of ZIF-8. (d) SEM image, (e) and (f) TEM images of ZIF-8-600.
Figure S7. (a) SEM image, (b) and (c) TEM images of ZnO.
Figure S8. TG curves of the as-synthesized ZIF-67, ZIF-8, and hollow Zn/Co-ZIF.
Figure S9. XPS survey spectra of ZIF-67, ZIF-8, hollow Zn/Co-ZIF, and commercial pure ZnO.
Figure S10. A magnified TEM image of Figure 5b.
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Figure S12. UV-vis absorption spectra of the photocatalytic degradation of MO in the absence of catalyst (a) or without light (b).
Figure S13. UV-vis spectra of MO aqueous solution before and after adding various samples to compare their adsorption capability.
<table>
<thead>
<tr>
<th>Catalyst</th>
<th>Co loading&lt;sup&gt;a&lt;/sup&gt; (wt %)</th>
<th>Zn loading&lt;sup&gt;a&lt;/sup&gt; (wt %)</th>
<th>S&lt;sub&gt;BET&lt;/sub&gt;&lt;sup&gt;b&lt;/sup&gt; (m&lt;sup&gt;2&lt;/sup&gt;g&lt;sup&gt;-1&lt;/sup&gt;)</th>
<th>Pore volume&lt;sup&gt;c&lt;/sup&gt; (m&lt;sup&gt;3&lt;/sup&gt;g&lt;sup&gt;-1&lt;/sup&gt;)</th>
<th>Mesopore volume&lt;sup&gt;d&lt;/sup&gt; (m&lt;sup&gt;3&lt;/sup&gt;g&lt;sup&gt;-1&lt;/sup&gt;)</th>
<th>Mesopore size&lt;sup&gt;e&lt;/sup&gt; (nm)</th>
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</thead>
<tbody>
<tr>
<td>ZnO@C-N-Co</td>
<td>10.9</td>
<td>25.7</td>
<td>188</td>
<td>0.36</td>
<td>0.34</td>
<td>10.5</td>
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<tr>
<td>ZIF-8-600</td>
<td>/</td>
<td>29.4</td>
<td>728</td>
<td>0.43</td>
<td>0.04</td>
<td>13.8</td>
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<tr>
<td>ZIF-67-600</td>
<td>37.8</td>
<td>/</td>
<td>316</td>
<td>0.23</td>
<td>/</td>
<td>/</td>
</tr>
</tbody>
</table>

<sup>a</sup>Measured by AAS. <sup>b</sup>S<sub>BET</sub> is calculated by the Brunauer-Emmett-Teller equation. <sup>c</sup>Total pore volume is determined by using the adsorption branch of the N<sub>2</sub> isotherm at P/P<sub>0</sub>=0.99. <sup>d</sup>Msopore volume is obtained from the BJH cumulative specific absorption volume of pore 1.70-300.00 nm diameter. <sup>e</sup>Mesopore diameter is determined from the local maximum of the BJH distribution of pore diameters obtained in the adsorption branch of the N<sub>2</sub> isotherms.
Table S1. Experiment of degradation of MO.

<table>
<thead>
<tr>
<th>Items</th>
<th>C/C&lt;sub&gt;0&lt;/sub&gt;&lt;sup&gt;a&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>t=0 h</td>
</tr>
<tr>
<td>ZIF-67-600</td>
<td>1.000</td>
</tr>
<tr>
<td>ZIF-8-600</td>
<td>1.000</td>
</tr>
<tr>
<td>ZnO</td>
<td>1.000</td>
</tr>
<tr>
<td>ZnO@C-N-Co</td>
<td>1.000</td>
</tr>
<tr>
<td>Under light without catalyst</td>
<td>1.000</td>
</tr>
<tr>
<td>No ligth with ZnO@C-N-Co catalyst</td>
<td>1.000</td>
</tr>
</tbody>
</table>

<sup>a</sup>C and C<sub>0</sub> are the initial concentration after the equilibrium adsorption and the reaction concentration of methyl orange, respectively.