Tuning the size and morphology of zeolitic imidazolate framework-8 in a membrane dispersion reactor

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Characterization

Scanning electron micrographs of PES ultrafiltration membranes and as-synthesized ZIF-8 were taken with HitachiS4800 scanning electron microscope (SEM) instrument. X-ray power spectra were recorded using a Bruker D8-Advance diffractometer with Cu-Kα radiation. Each XRD pattern was acquired from 3° to 45° at a rate of 1°/min. Nitrogen physisorption isotherms were measured at 77 K on an automatic volumetric adsorption apparatus (ASAP 2020). Dynamic light scattering (DLS) measurements were performed on ALV/DLS/SLS-5022F.

![SEM image of the surface of PES membrane. The pore size and thickness of the PES ultrafiltration membrane: 25 nm.](image)

<table>
<thead>
<tr>
<th>Sample</th>
<th>BET Surface Area (m²/g)</th>
<th>Langmuir Surface Area (m²/g)</th>
<th>t-Plot micropore volume (cm³/g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>T 0.02</td>
<td>883</td>
<td>1142</td>
<td>0.40</td>
</tr>
<tr>
<td>T 0.04</td>
<td>966</td>
<td>1252</td>
<td>0.43</td>
</tr>
<tr>
<td>T 0.06</td>
<td>1365</td>
<td>1790</td>
<td>0.61</td>
</tr>
<tr>
<td>T 0.08</td>
<td>1146</td>
<td>1473</td>
<td>0.51</td>
</tr>
</tbody>
</table>
The size distribution of as-synthesized ZIF-8 under different trans-membrane pressure was shown in Fig. S2 and Table S2. The nanocrystal dispersions were filtered through 0.45 μm syring filters before dynamic light scattering (DLS) measurements. Hydrodynamic radius distributions of ZIF-8 decreased initially and then increased with the increase of trans-membrane pressure. Only at the trans-membrane pressure of 0.06 MPa, ZIF-8 particles with small crystal size (~79.8 nm) and narrow size distribution (hydrodynamic radius distribution was about 0.36) was obtained. Although T 0.02 had small crystal size (~92 nm), it had broad size distribution (hydrodynamic radius distribution was about 1.1).
Fig. S3 XRD patterns of as-synthesized ZIF-8 prepared by MDR method under the transmembrane pressure of 0.06 MPa

Fig. S4 SEM images of as-synthesized ZIF-8 prepared by MDR method under the transmembrane pressure of 0.06MPa: (a) without stirring (b) gentle stirring (c) vigorous stirring

Table S3 BET of T 0.06 T 0.06 (a) without stirring (b) gentle stirring (c) vigorous stirring

<table>
<thead>
<tr>
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<tr>
<td>a</td>
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<td>0.42</td>
</tr>
<tr>
<td>b</td>
<td>1365</td>
<td>1790</td>
<td>0.61</td>
</tr>
<tr>
<td>c</td>
<td>58</td>
<td>81</td>
<td>0.02</td>
</tr>
</tbody>
</table>
DLS (Fig. S5 and Table S4) showed that there was broader hydrodynamic radius distribution of ZIF-8 with vigorous stirring than others. The ZIF-8 samples with gentle stirring had the smallest hydrodynamic radius (79.80) and narrow hydrodynamic radius distribution (0.36).