Well-dispersed Pd nanoparticles on porous ZnO nanoplates via surface ion exchange for chlorobenzene-selective sensor

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Figure legends

Fig. S1. TEM images and EDS spectra of 1% Pd2+@ZnO, 3% Pd2+@ZnO, 5% Pd2+@ZnO, and 10% Pd2+@ZnO, and HRTEM image of porous ZnO nanoplate

Fig. S2. Pd 3d XPS spectra of 5% Pd2+@ZnO and 5% Pd@ZnO

Fig. S3. Response/recovery curves of 5% Pd@ZnO and pure ZnO sensors towards chlorobenzene

Fig. S4. Responses of 5% Pd@ZnO sensor toward chlorobenzene in different relative humidity

Fig. S5. Responses of 5% Pd@ZnO and pure ZnO sensors toward chlorobenzene, 1,2-dichlorobenzene, and 1,3-dichlorobenzene

Fig. S6. Nitrogen adsorption-desorption isotherms of 5% Pd@ZnO and pure porous ZnO nanoplates with BJH pore size distribution insets

Table S1. Chlorobenzene-sensing comparation among results obtained in this work and reported in the literature

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Fig. S1. (a), (c), (d), (e), and (f) represent TEM images of the pure ZnO, 1% Pd$^{2+}@$ZnO, 3% Pd$^{2+}@$ZnO, 5% Pd$^{2+}@$ZnO, and 10% Pd$^{2+}@$ZnO nanoplates, respectively. (b) shows HRTEM image of the pure ZnO nanoplate. (g), (h), (i), and (j) represent EDS spectra of the 1% Pd$^{2+}@$ZnO, 3% Pd$^{2+}@$ZnO, 5% Pd$^{2+}@$ZnO, and 10% Pd$^{2+}@$ZnO, respectively.
Fig. S2. Pd 3d XPS spectra of the obtained materials: (a) 5% Pd$^{2+}$@ZnO and (b) 5% Pd@ZnO.
Fig. S3. Response/recovery curves of 5% Pd@ZnO and pure ZnO sensors towards chlorobenzene with 100 ppm at 440 °C.
Fig. S4. Responses of 5% Pd@ZnO sensor toward 100 ppm chlorobenzene in different relative humidity at 440 °C. The response is defined as the ratio of sensor resistance ($R_{\text{hum-air}}$) in humid air to that ($R_{\text{hum-gas}}$) in humid air with 100 ppm chlorobenzene.
Fig. S5. Responses of 5% Pd@ZnO (black) and pure ZnO (red) sensors towards 100 ppm chlorobenzene compounds (gases) including chlorobenzene, 1,2-dichlorobenzene and 1,3-dichlorobenzene at 440 °C.
Fig. S6. Nitrogen adsorption-desorption isotherms with BJH pore size distribution insets of (a) pure porous ZnO nanoplates, (b) 5% Pd@ZnO. According to the IUPAC classification, the hysteresis loops corresponding to H3 type reveal the feature of mesoporous material. The specific surface areas of (a) and (b) are 23.28±0.01 and 12.94±0.01 m²/g, respectively.
Table S1. Chlorobenzene-sensing comparation among results obtained in this work and reported in the literature.

<table>
<thead>
<tr>
<th>Sensor materials</th>
<th>Initial response temperature (°C)</th>
<th>Detection limit</th>
<th>Selectivity study</th>
<th>Response/recovery time (s)</th>
<th>Ref.</th>
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<tr>
<td>Pd@ZnO</td>
<td>240</td>
<td>1 ppm</td>
<td>Yes</td>
<td>19/7</td>
<td>This work</td>
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<td>Prussian blue film</td>
<td>25</td>
<td>24 ppm</td>
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<td>Pt-decorated porous single-crystalline ZnO nanosheets</td>
<td>200</td>
<td>30 ppb</td>
<td>Yes</td>
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<td>In-doped coral-like SnO2 nanostructures</td>
<td>170</td>
<td>0.2 ppm</td>
<td>-</td>
<td>6.7/25.8</td>
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<td>In$_2$O$_3$ nanorods and nanoparticles</td>
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<td>-</td>
<td>-</td>
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<td>260</td>
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<td>-</td>
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<td>Porous ZnO nanoplates</td>
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<td>-</td>
<td>-</td>
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</table>

Based on different equipment and testing conditions, various gas-sensing materials show their features in chlorobenzene detection. The sensor materials in this work have enhanced response and selectivity compared to controlled ZnO sample, which also have acceptable chlorobenzene-sensing performance compared to results reported in the literature.

References: