Electronic Supplementary Information

Ultra-Sensitive Humidity Sensors Based on ZnSb₂O₄ Nanoparticles

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Humidity Testing of ZnSb$_2$O$_4$ NPs-based humidity sensor:

The relative humidity is controlled by the concentration of sulfuric acid, the Specific humidity value and the corresponding concentration of sulfuric acid are shown in Tab. S1.[1-4] The I-V curves of ZnSb$_2$O$_4$ nanoparticles in different RH atmosphere are recorded after humidity sensor is placed in the chamber with different RH in N$_2$ for 30 mins. The dynamic testing scheme of humidity sensing properties is shown in Fig.S2.[1]

Calculation of the crystallite size of the particles by Scherrer Formula.

The particle sizes of ZnSb$_2$O$_4$ were estimated from XRD patterns according to Scherrer Formula:

$$D_{(hkl)} = \frac{K \lambda}{\beta \cos \theta}$$

Where $D_{(hkl)}$ is the average particle size corresponding to the $(hkl)$ crystalline plane, $\beta$ is the full width of the peak at half of the maximum (FWHM) intensity (rad), $\lambda$ the wavelength of X-ray radiation (1.54178Å), $K$ is a constant related to the crystallite shape, and $\theta$ is the the Bragg angle (deg).[5, 6] The calculation results are shown in Tab.S2.

<table>
<thead>
<tr>
<th>RH (%)</th>
<th>0</th>
<th>15</th>
<th>30</th>
<th>50</th>
<th>70</th>
<th>90</th>
<th>100</th>
</tr>
</thead>
<tbody>
<tr>
<td>The concentration of sulfuric acid (w.t.%)</td>
<td>100</td>
<td>68</td>
<td>57</td>
<td>45</td>
<td>36</td>
<td>15</td>
<td>0</td>
</tr>
</tbody>
</table>

Tab. S1 The specific humidity value and the corresponding concentration of sulfuric acid.

<table>
<thead>
<tr>
<th>Crystalline plane $(h k l)$</th>
<th>(200)</th>
<th>(211)</th>
<th>(220)</th>
<th>(310)</th>
<th>(202)</th>
<th>(330)</th>
<th>(411)</th>
<th>(420)</th>
<th>(213)</th>
<th>(332)</th>
</tr>
</thead>
<tbody>
<tr>
<td>crystallite size(Å)</td>
<td>534</td>
<td>528</td>
<td>487</td>
<td>533</td>
<td>518</td>
<td>561</td>
<td>493</td>
<td>570</td>
<td>543</td>
<td>532</td>
</tr>
</tbody>
</table>
Table. S2 The crystallite size of ZnSb$_2$O$_4$ calculated by the Scherrer Formula to different Crystalline planes.

Fig. S1 Schematic of the ZnSb$_2$O$_4$ NPs-based humidity sensor.

Fig. S2 Schematic for dynamic measurement of humidity sensing properties.
Fig. S3 A complete process of water molecules absorption-desorption. The response and recovery time under fast change of RH values between 0% RH in N₂ ("off" status) and 100% RH in N₂ ("on" status). The bias voltage between two electrodes was kept constantly at 2.0 V.

References


