Supplementary information

A high-performance H$_2$S detection by redox reactions in semiconducting carbon nanotube-based devices

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Fig. S1 Device schematic and the behavior of H$_2$S and H$_2$O molecules on SWCNTs functionalized by TEMPO.
**Fig. S2** Real time current changes of bare s-SWCNT device exposed to H$_2$S gas of 5, 10, 50, 100, and 200 ppm in dry N$_2$.

**Fig. S3** The sensitivity of a bare m-SWCNT device as function of the H$_2$S concentrations in dry N$_2$. 
**Fig. S4** Real-time current measurement of a bare s-SWCNT device as a function of RH. The current reaches almost its saturation value.
Fig. S5 (a) Sensing of H$_2$O vapor by a bare m-SWCNT device, (b) real-time current changes in a H$_2$S gas detection of bare m-SWCNT device under different RH (20, 40 and 60 %). Here in the range of current reduction, red and green area mean injection of H$_2$S and H$_2$O molecules respectively, and increase of current indicates recovery into the initial current value of each RH. (c) Comparison of sensitivity as function of the RH in H$_2$O and H$_2$O+H$_2$S detection.
**Fig. S6** Real-time current drop of the s-SWCNT device without TEMPO (a) and with TEMPO (b) observed when only water vapor was introduced.

**Fig. S7** Real-time current measurement of s-SWCNT device functionalized with TEMPO as a function of RH. The current reaches almost its saturation value.
Fig. S8 (a) Sensing of H₂O vapor by an m-SWCNT device functionalized with TEMPO, (b) real-time current changes in a H₂S gas detection of the m-SWCNT+TEMPO device under different RH (20, 40 and 60 %). Here in the range of current reduction, red and green area mean injection of H₂S and H₂O molecules respectively, and increase of current indicates recovery into the initial current value of each RH. (c) Comparison of sensitivity as function of the RH in H₂O and H₂O+H₂S detection.
Fig. S9 (a) Sensing of H$_2$S gas (500 to 1500 ppm) by an SWCNT device functionalized with TEMPO in air, N$_2$, and LPG. (b) Sensing of H$_2$S (10 to 100 ppm) in air, hexane and water vapor. The TEMPO-SWCNTs sensor does not have any reaction with LPG, hexane, N$_2$, and air. The response time in water vapor is faster than in other ambient gas.
Table S1. Standard electrode reduction and oxidation potential values of the redox reactions necessary for the H₂S detection. These potential values are measured under standard condition, and relative to the standard hydrogen electrode as a reference electrode.¹²

<table>
<thead>
<tr>
<th>Anodic - exhibits greater tendency to lose electrons</th>
<th>Oxidation Reaction</th>
<th>E° (V)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reduction Reaction</td>
<td>TEMPO → TEMPO⁺ + e⁻</td>
<td>0.88</td>
</tr>
<tr>
<td>TEMPO⁺ + e⁻ → TEMPO</td>
<td>-0.88</td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Cathodic - exhibits greater tendency to gain electrons</th>
<th>Reduction Reaction</th>
<th>E° (V)</th>
</tr>
</thead>
<tbody>
<tr>
<td>S + 2H⁺ + 2e⁻ → H₂S</td>
<td>0.14</td>
<td></td>
</tr>
<tr>
<td>H₂S → S + 2H⁺ + 2e⁻</td>
<td>-0.14</td>
<td></td>
</tr>
<tr>
<td>2H₂O + O₂ + 4e⁻ → 4OH⁻</td>
<td>0.40</td>
<td></td>
</tr>
<tr>
<td>4OH⁻ → 2H₂O + O₂ + 4e⁻</td>
<td>-0.40</td>
<td></td>
</tr>
</tbody>
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