Electronic supplementary information

Polyacrylic acid coated carbon nanotube-paper composites for humidity and moisture sensing
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Fig. S1 Microscope images of hygroexpansion of PAA-coated CPC specimen before and after immersion in water. The average dimensions changed from 11.9\ times 11.4 mm\textsuperscript{2} to 14.1\times 12.0 mm\textsuperscript{2}. The resistance changed from 986 \textOmega to 1766 \textOmega.
Humidity test results for PAA treated CPC for RH 10~30%. The sensor is placed on a hot plate at 40°C to control low RH.
Fig. S3 Humidity test for 10 cycles of RH between 30 and 95%. Comparison of the RH data measured from the commercial humidity sensor and the RH measured from a PAA-treated CPC humidity sensor. The resistance change of the CPC sensor is converted into the humidity using the empirical equation.
Fig. S4 Normalized resistance change with applied heat (N=3).
Fig. S5 (a) Humidity test and curve fitting result of a CPC humidity sensor where only a CPC part is exposed to humidity. (b) Humidity test for a CPC humidity sensor where only the interface between the silver electrodes and CNTs is exposed to humidity.
Fig. S6 Response time of a CPC sensor to humidity changes. The response time of a CPC sensor is compared to a commercial sensor during humidity variation; the sensor response is 8.0±1.6 seconds based on responses of 6 RH cycles after stabilization.
Fig. S7 Comparison of a commercial humidity sensor with a PAA-coated CPC sensor. (a) Humidity measurement of a CPC region in comparison to a reference sensor (a) Humidity measurement of a CPC/silver interface region in comparison to a reference sensor.
Fig. S8 Temperature calibration curve of a CPC sensor.
**Fig. S9** Detection of small water quantities (0.5 ~ 20 µL) with a PAA-treated CPC sensor.
Fig. S10 Normalized resistance of PAA-treated CPCs immersed in aqueous solutions at pH 4, 7, and 10.
**Table S1** Comparison of sensitivities of carbon nanotube-paper composites for relative humidity (RH).

<table>
<thead>
<tr>
<th>Sensing materials</th>
<th>Sensing mechanism</th>
<th>Sensitivity</th>
<th>Dynamic range for RH (%)</th>
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</thead>
<tbody>
<tr>
<td>MWCNT-printer paper¹</td>
<td>resistive</td>
<td>0.35, where sensitivity=$\frac{\Delta I}{I_0}$/$\Delta$ (%RH), where (\Delta I) is the current difference at different acquisition time. (I_0) is the initial current</td>
<td>11-95</td>
</tr>
<tr>
<td>SWCNT-cellulose paper²</td>
<td>resistive</td>
<td>-0.90, where sensitivity=$\frac{\Delta c}{c_0}$/$\Delta$ (%RH). (\Delta c) is the conductance difference at different acquisition time and (c_0) is the initial conductance</td>
<td>10-75</td>
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<tr>
<td>MWCNT sheet³</td>
<td>resistive</td>
<td>0.75, where sensitivity=$\frac{\Delta R}{R_0}$/$\Delta$ (%RH). (\Delta R) is the resistance difference at different acquisition time. (R_0) is the initial resistance</td>
<td>10-90</td>
</tr>
<tr>
<td>KC-MWCNT⁴</td>
<td>resistive</td>
<td>1.0, where sensitivity=$\frac{\Delta R}{R_0}$/$\Delta$ (%RH). (\Delta R) is the resistance difference at different acquisition time</td>
<td>20-90</td>
</tr>
<tr>
<td>MWCNT-stainless steel⁵</td>
<td>capacitive</td>
<td>36, where sensitivity=$\frac{\Delta C}{C_0}$/$\Delta$ (%RH). (\Delta C) is the capacitance difference at different acquisition time. (C_0) is the initial capacitance</td>
<td>50-85</td>
</tr>
<tr>
<td>chemically treated MWCNT⁶</td>
<td>resistive</td>
<td>1.3, where sensitivity=$\frac{\Delta R}{R_0}$/$\Delta$ (%RH). (\Delta R) is the resistance difference at different acquisition time. (R_0) is the initial resistance</td>
<td>11-98</td>
</tr>
<tr>
<td>Polyimide-MWCNT⁷</td>
<td>resistive</td>
<td>0.47, where sensitivity=$\frac{\Delta R}{R_0}$/$\Delta$ (%RH). (\Delta R) is the resistance difference at different acquisition time. (R_0) is the initial resistance</td>
<td>10-95</td>
</tr>
<tr>
<td>Polyimide-MWCNT⁸</td>
<td>capacitive</td>
<td>0.22, where sensitivity=$\frac{\Delta C}{C_0}$/$\Delta$ (%RH). (\Delta C) is the capacitance difference at different acquisition time. (C_0) is the initial capacitance.</td>
<td>30-90</td>
</tr>
<tr>
<td>PAA treated CPC sensor (This paper)</td>
<td>resistive</td>
<td>90, where sensitivity=$\frac{\Delta R}{R_0}$/$\Delta$ (%RH). (\Delta R) is the resistance difference at different acquisition time. (R_0) is the initial resistance</td>
<td>30-95</td>
</tr>
</tbody>
</table>
References
5 J. Yeow and J. She, Nanotechnology, 2006, 17, 5441.