Electronic supplementary information

Polyacrylic acid coated carbon nanotube-paper composites for humidity and moisture sensing

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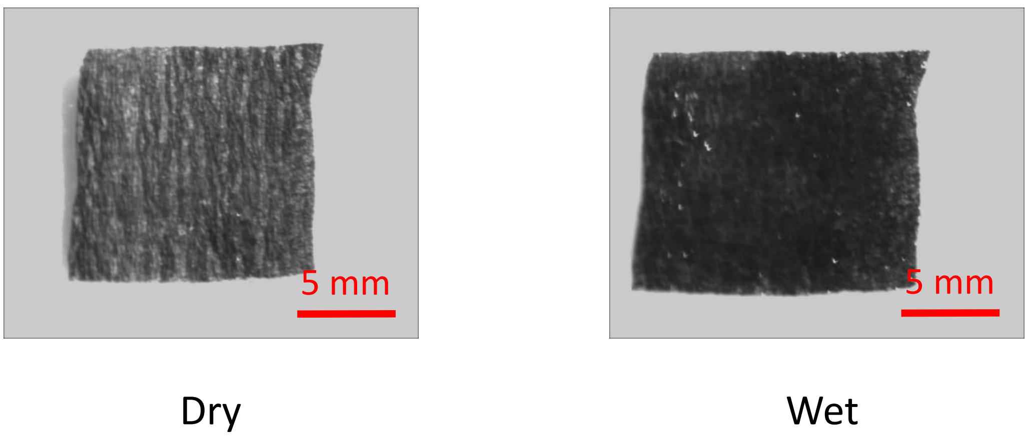

Fig. S1 Microscope images of hygroexpansion of PAA-coated CPC specimen before and after immersion in water. The average dimensions changed from 11.9×11.4 mm^2 to 14.1×12.0 mm^2. The resistance changed from 986 Ω to 1766 Ω.

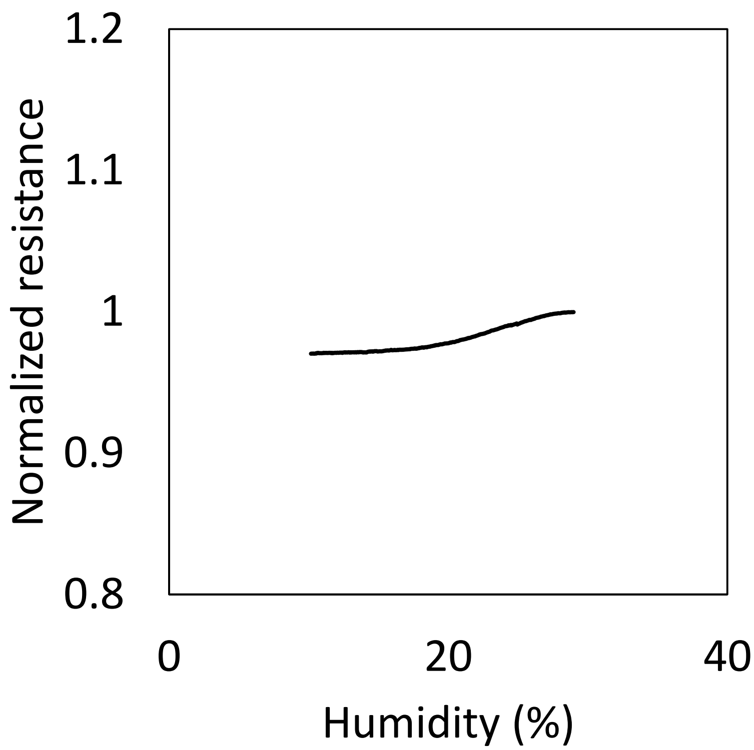

Fig. S2 Humidity test results for PAA treated CPC for RH 10~30%. The sensor is placed on a hot plate at 40°C to control low RH.

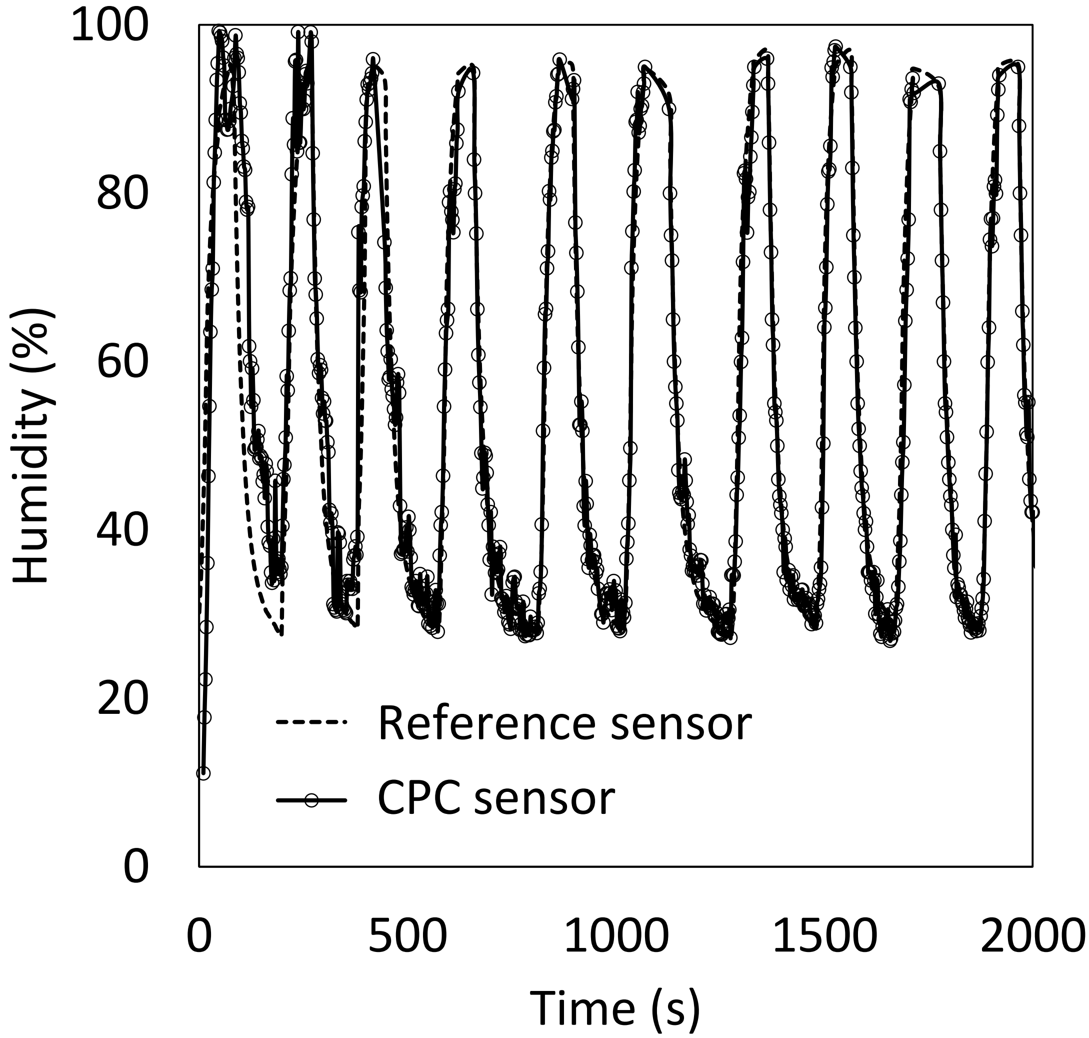

Fig. S3 Humidity test for 10 cycles of RH between 30 and 95%. Comparison of the RH data measured from the commercial humidity sensor and the RH measured from a PAA-treated CPC humidity sensor. The resistance change of the CPC sensor is converted into the humidity using the empirical equation.

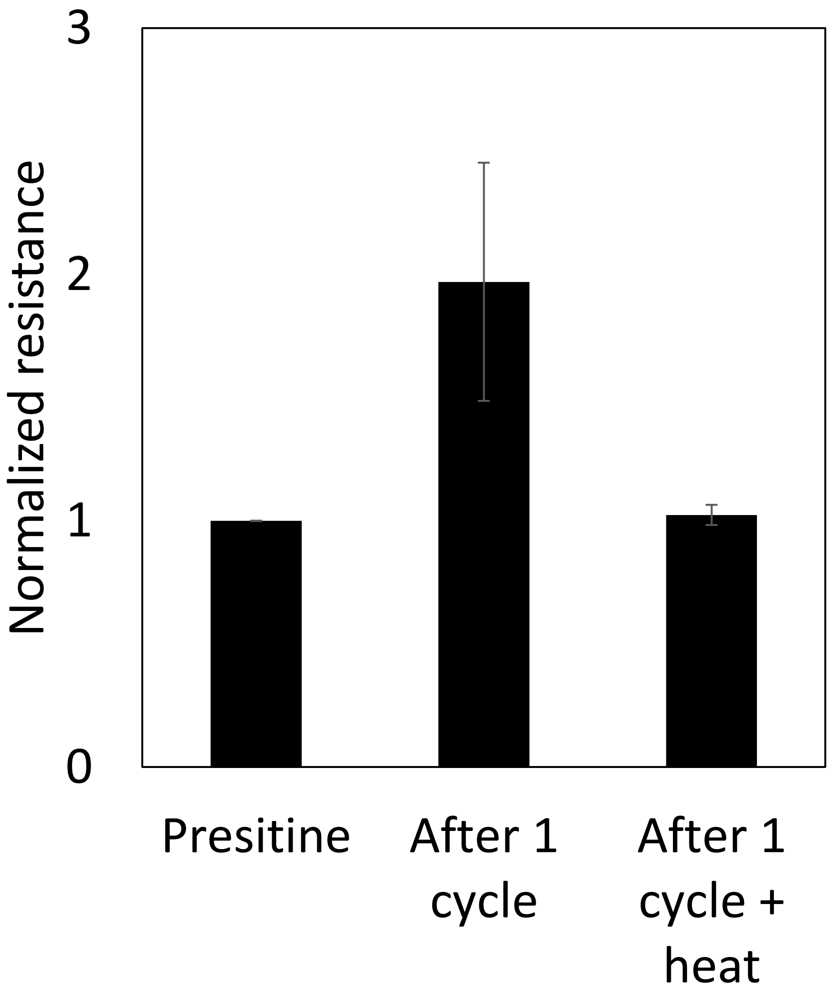

Fig. S4 Normalized resistance change with applied heat (N=3).

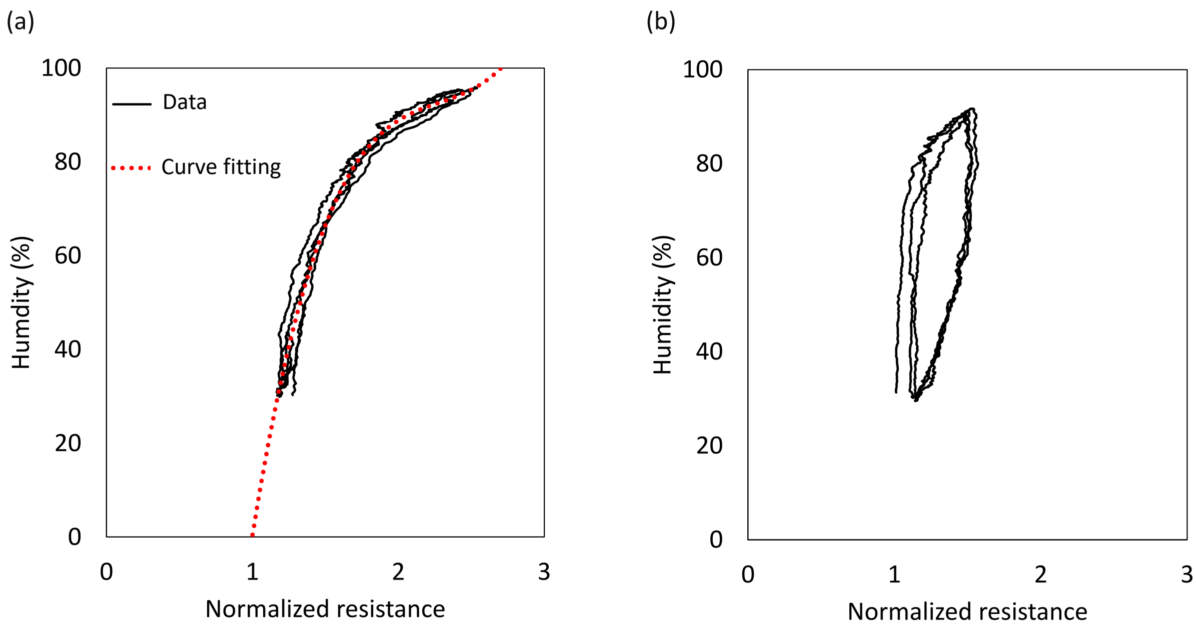

Fig. S5 (a) Humidity test and curve fitting result of a CPC humidity sensor where only a CPC part is exposed to humidity. (b) Humidity test for a CPC humidity sensor where only the interface between the silver electrodes and CNTs is exposed to humidity.

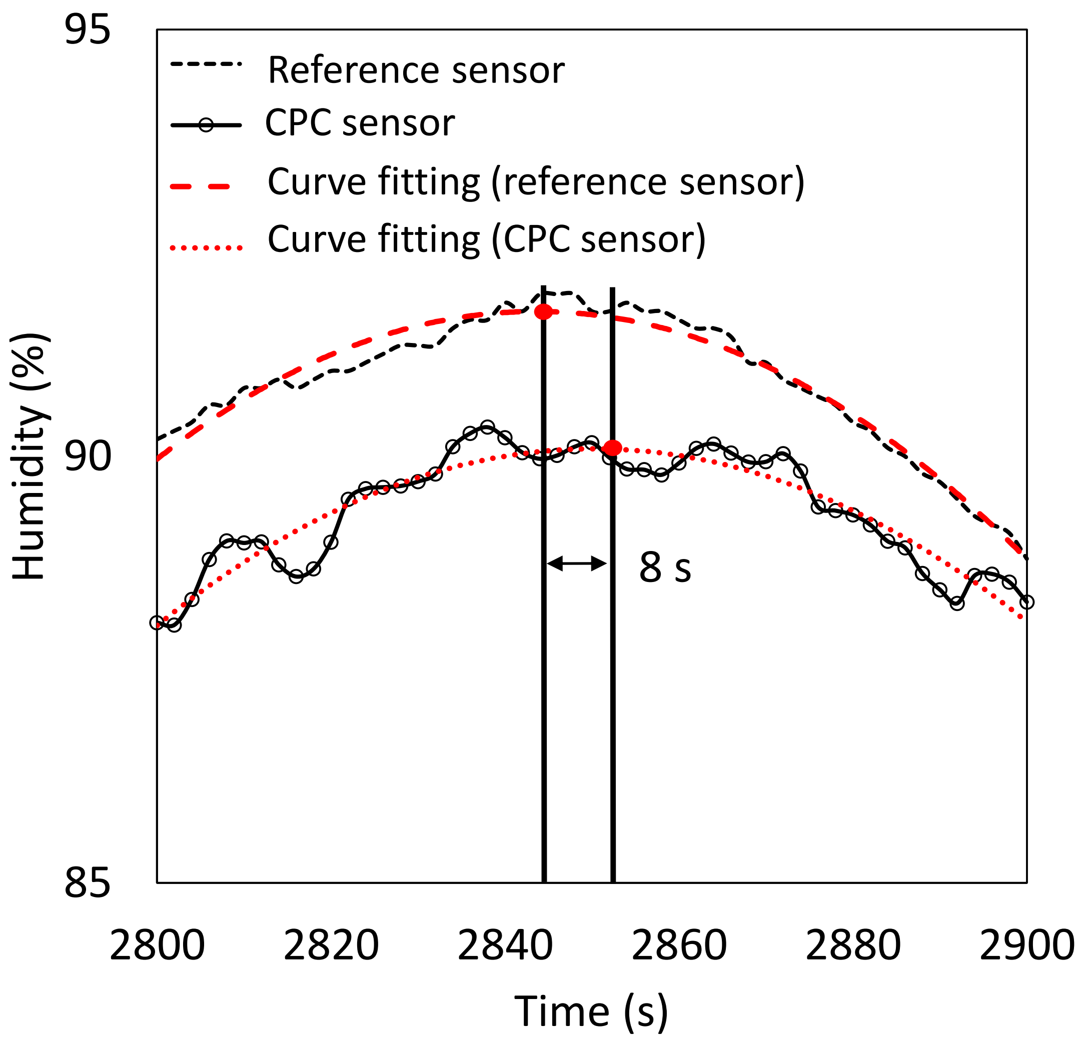

Fig. S6 Response time of a CPC sensor to humidity changes. The response time of a CPC sensor is compared to a commercial sensor during humidity variation; the sensor response is 8.0±1.6 seconds based on responses of 6 RH cycles after stablization.

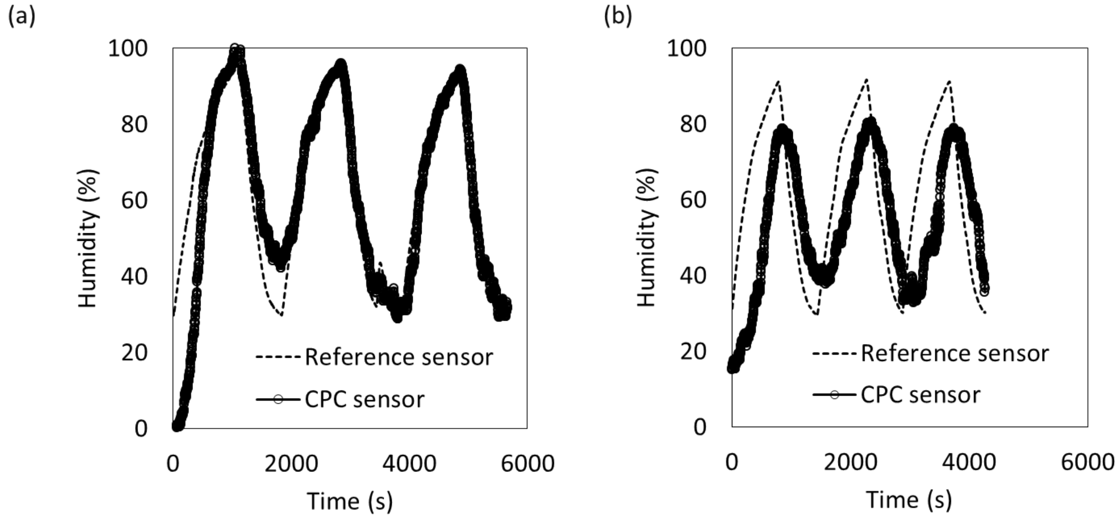

Fig. S7 Comparison of a commercial humidity sensor with a PAA-coated CPC sensor. (a) Humidity measurement of a CPC region in comparison to a reference sensor (a) Humidity measurement of a CPC/silver interface region in comparison to a reference sensor.

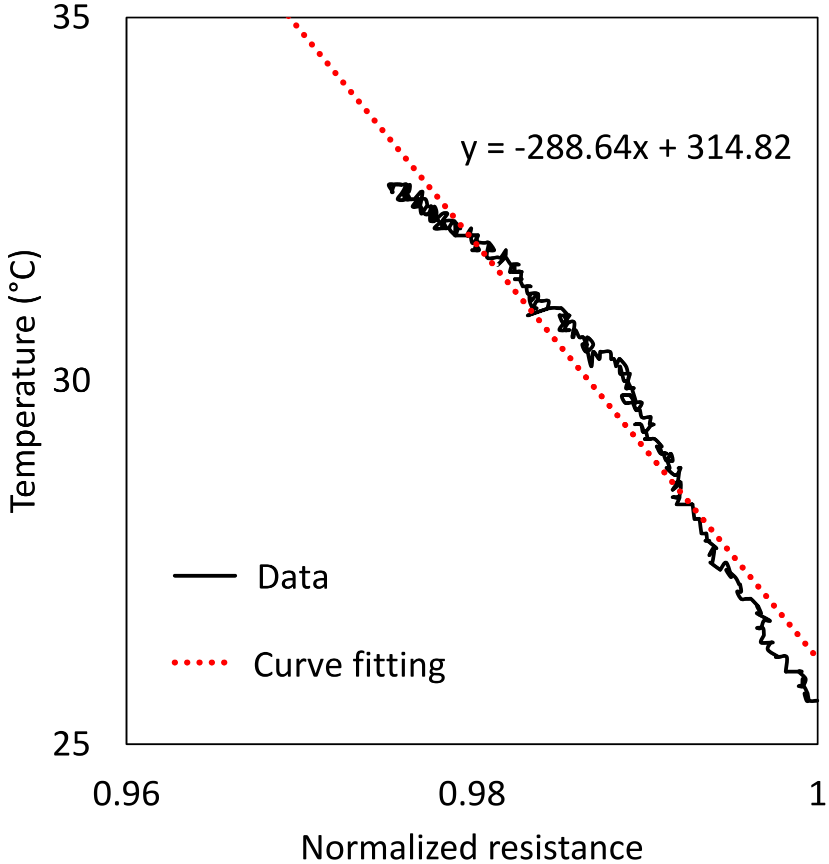

Fig. S8 Temperature calibration curve of a CPC sensor.

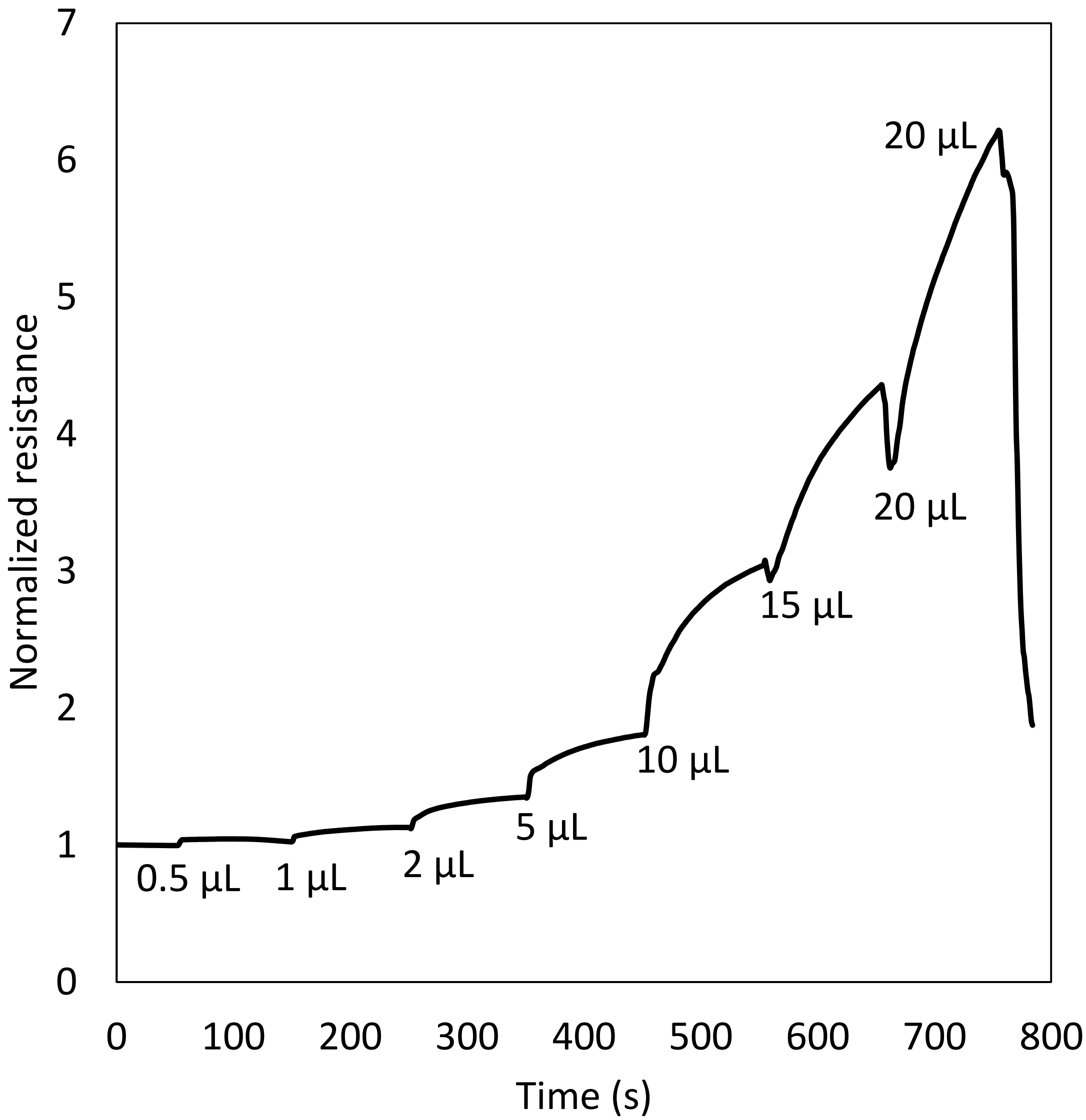

Fig. S9 Detection of small water quantities (0.5 ~ 20 μL) with a PAA-treated CPC sensor.

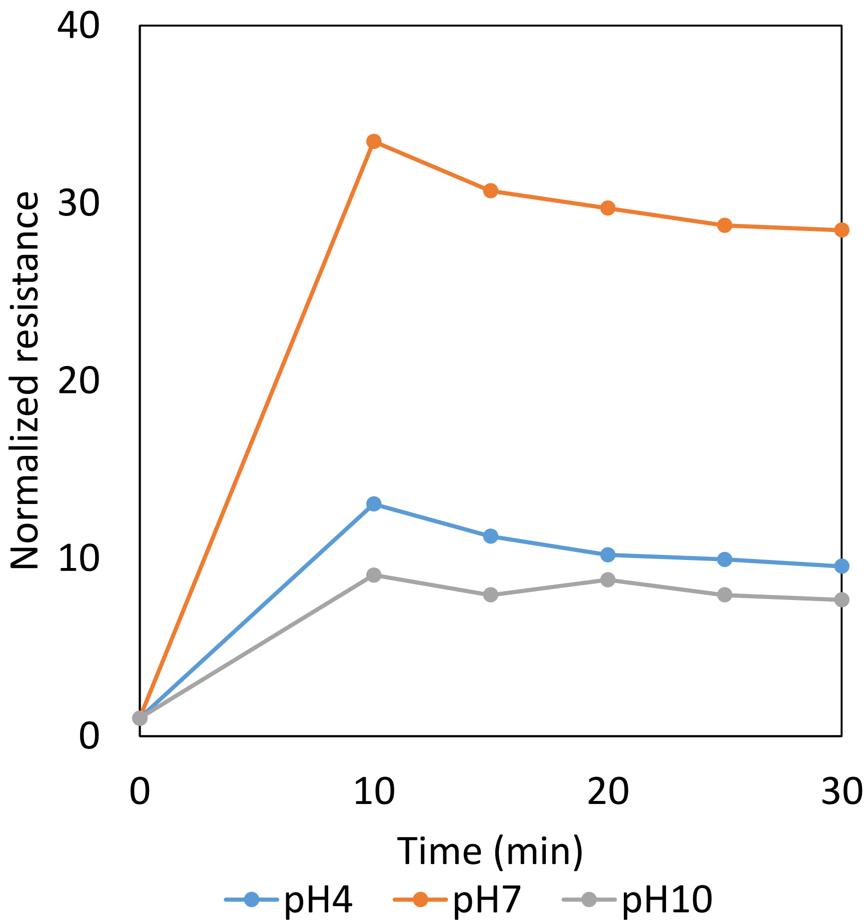

Fig. S10 Normalized resistance of PAA-treated CPCs immersed in aqueous solutions at pH 4, 7, and 10.

Table S1 Comparison of sensitivities of carbon nanotube-paper composites for relative humidity (RH).

Sensing materials	Sensing mechanism	Sensitivity	Dynamic range for RH (%)
MWCNT-printer paper[1]	resistive	0.35, where sensitivity=($\Delta I/I_0$)/Δ(%RH), where ΔI is the current difference at different acquisition time. I_0 is the initial current	11-95
SWCNT-cellulose paper[2]	resistive	-0.90, where sensitivity=($\Delta c/c_0$)/Δ(%RH). Δc is the conductance difference at different acquisition time and c_0 is the initial conductance	10-75
MWCNT sheet[3]	resistive	0.75, where sensitivity=($\Delta R/R_0$)/Δ(%RH). ΔR is the resistance difference at different acquisition time. R_0 is the initial resistance	10-90
KC-MWCNT[4]	resistive	1.0, where sensitivity=($\Delta R/R_0$)/Δ(%RH). ΔR is the resistance difference at different acquisition time, and R_0 is the initial resistance	20-90
MWCNT-stainless steel[5]	capacitive	36, where sensitivity=($\Delta C/C_0$)/Δ(%RH). ΔC is the capacitance difference at different acquisition time. C_0 is the initial capacitance	50-85
chemically treated MWCNT[6]	resistive	1.3, where sensitivity=($\Delta R/R_0$)/Δ(%RH). ΔR is the resistance difference at different acquisition time. R_0 is the initial resistance	11-98
Polyimide-MWCNT[7]	resistive	0.47, where sensitivity=($\Delta R/R_0$)/Δ(%RH). ΔR is the resistance difference at different acquisition time. R_0 is the initial resistance.	10-95
Polyimide-MWCNT[8]	capacitive	0.22, where sensitivity=($\Delta C/C_0$)/Δ(%RH). ΔC is the capacitance difference at different acquisition time. C_0 is the initial capacitance.	30-90
PAA treated CPC sensor (This paper)	resistive	90, where sensitivity= ($\Delta R/R_0$)/Δ(%RH). ΔR is the resistance difference at different acquisition time. R_0 is the initial resistance	30-95

References

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