Electronic Supplementary Material (ESI) for Analyst

Supplementary information

A high-performance H_2S detection by redox reactions in semiconducting carbon nanotube-based devices

Hyun Young Jung,* Young Lae Kim, Sora Park, Aniket Datar, Hyung–June Lee, Jun Huang, Sivasubramanian Somu, Ahmed Busnaina, Yung Joon Jung, and Young–Kyun Kwon*

*To whom correspondence should be addressed. E-mail: hjung@coe.neu.edu,

ykkwon@khu.ac.kr

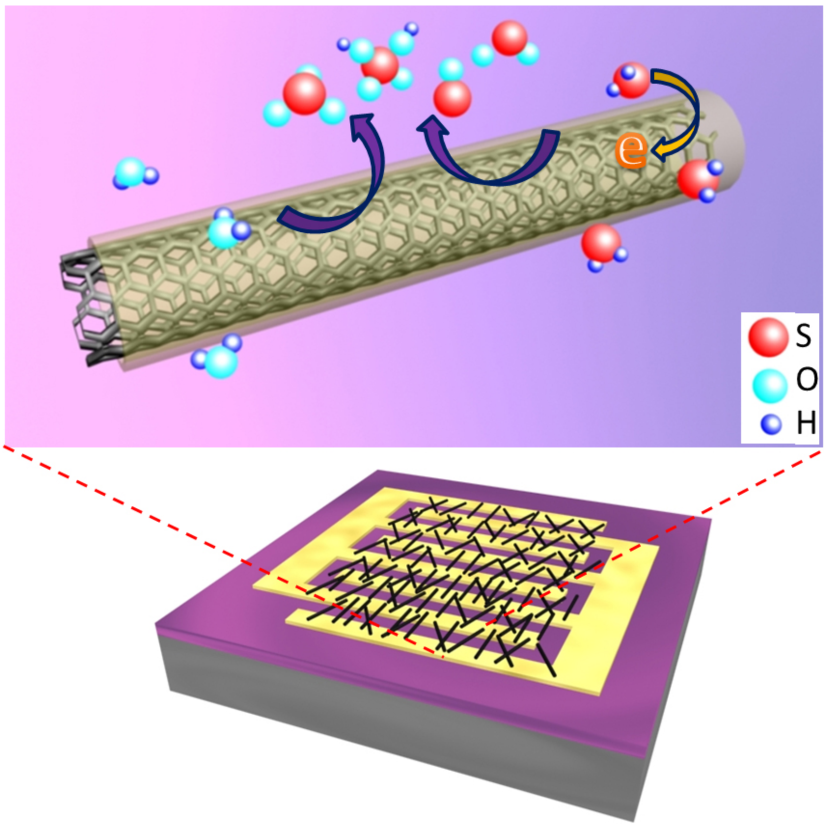

Fig. S1 Device schematic and the behavior of H_2S and H_2O molecules on SWCNTs functionalized by TEMPO.

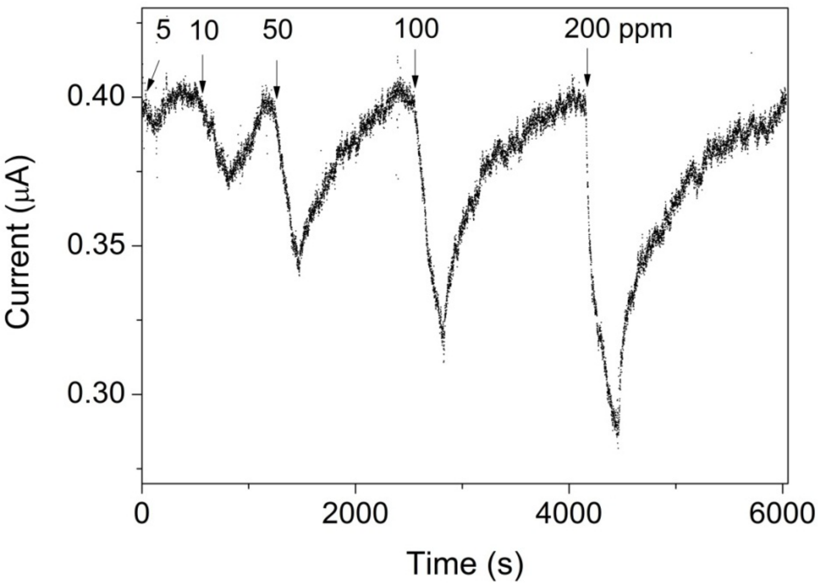

Fig. S2 Real time current changes of bare s-SWCNT device exposed to H_2S gas of 5, 10, 50, 100, and 200 ppm in dry N_2.

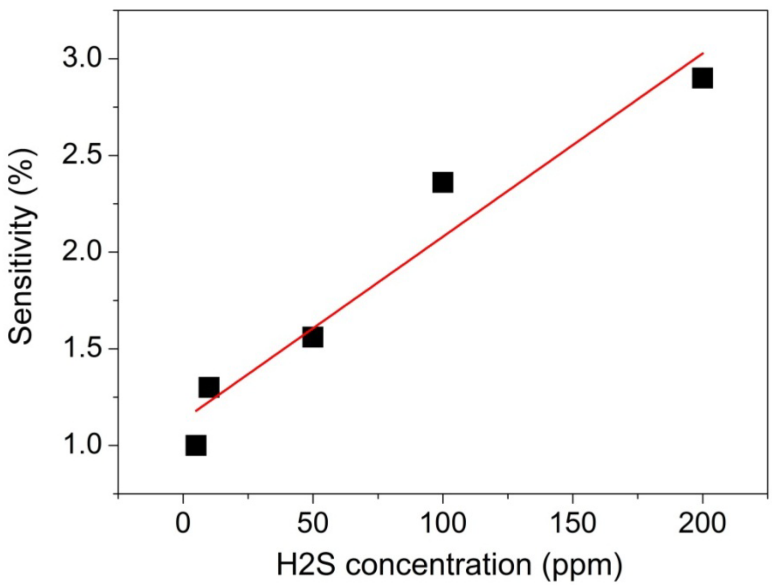

Fig. S3 The sensitivity of a bare m-SWCNT device as function of the H_2S concentrations in dry N2.

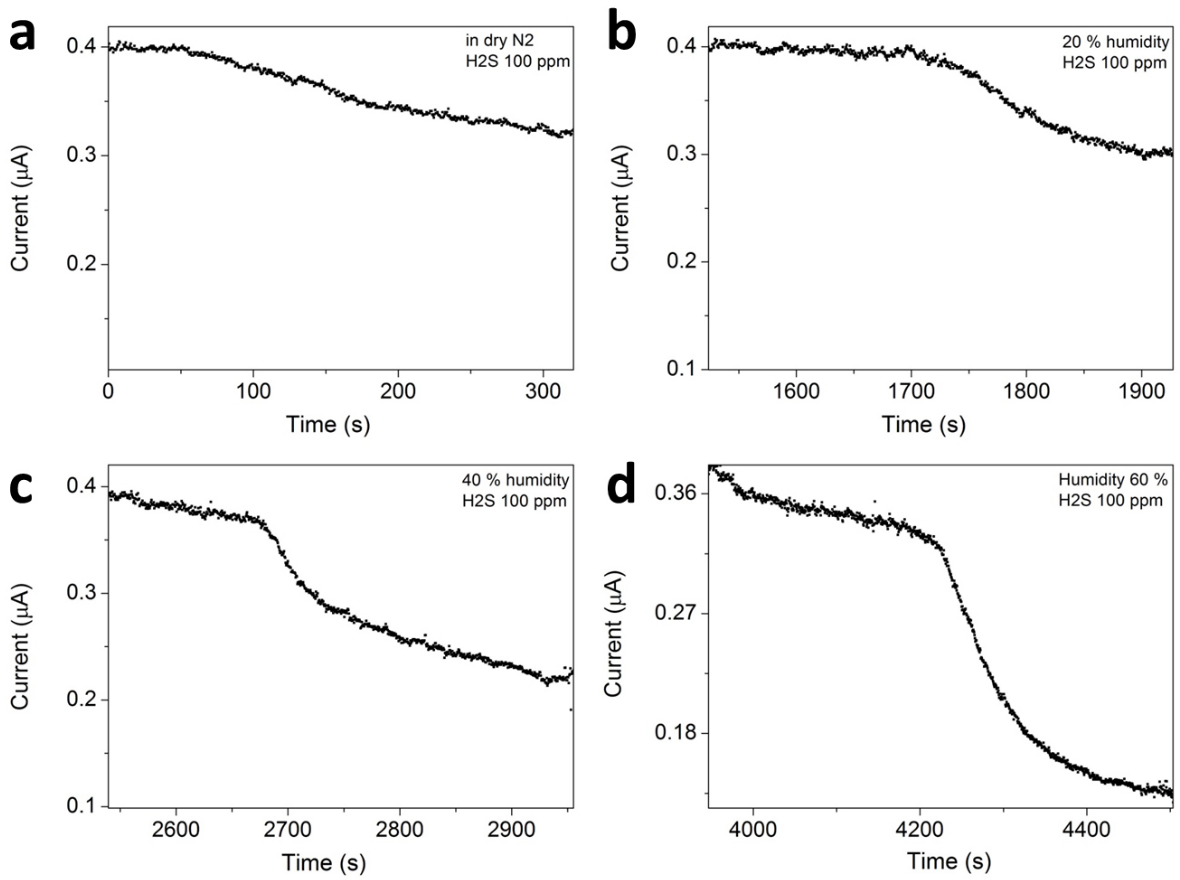

Fig. S4 Real-time current measurement of a bare s-SWCNT device as a function of RH. The current reaches almost its saturation value.

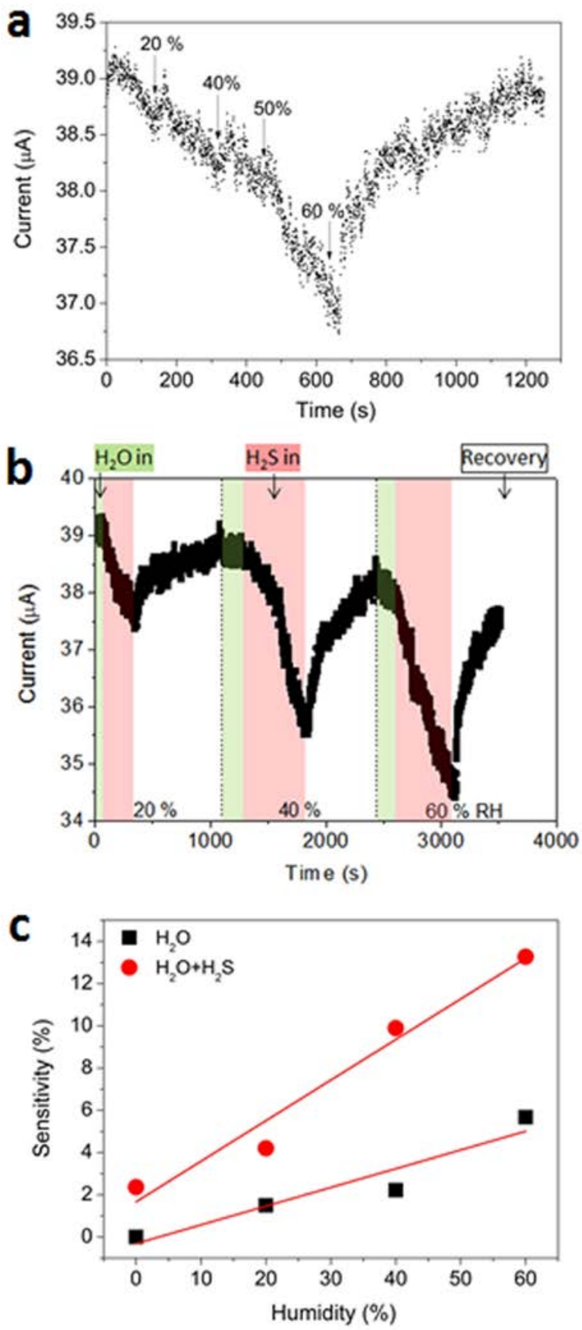

Fig. S5 (a) Sensing of H_2O vapor by a bare m-SWCNT device, (b) real-time current changes in a H_2S gas detection of bare m-SWCNT device under different RH (20, 40 and 60 %). Here in the range of current reduction, red and green area mean injection of H_2S and H_2O molecules respectively, and increase of current indicates recovery into the initial current value of each RH. (c) Comparison of sensitivity as function of the RH in H_2O and H_2O+H_2S detection.

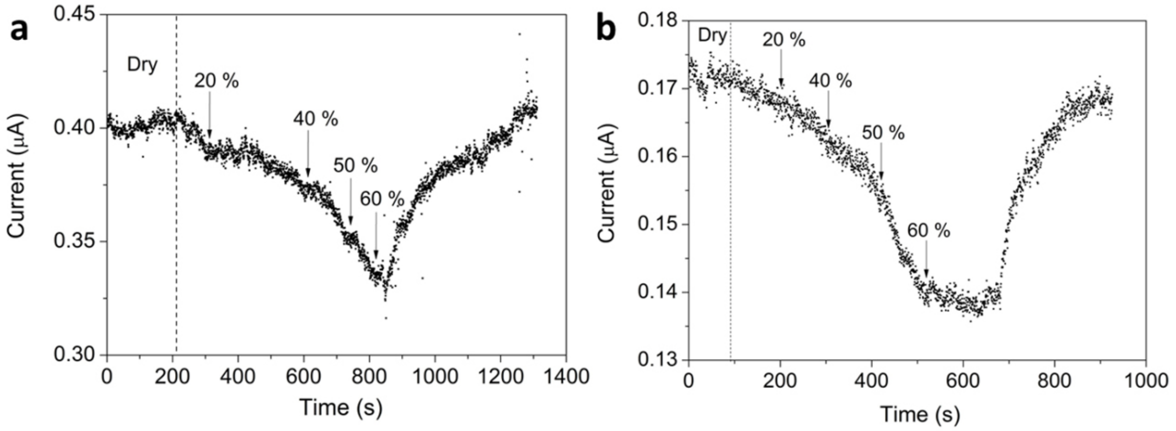

Fig. S6 Real-time current drop of the s-SWCNT device without TEMPO (a) and with TEMPO (b) observed when only water vapor was introduced.

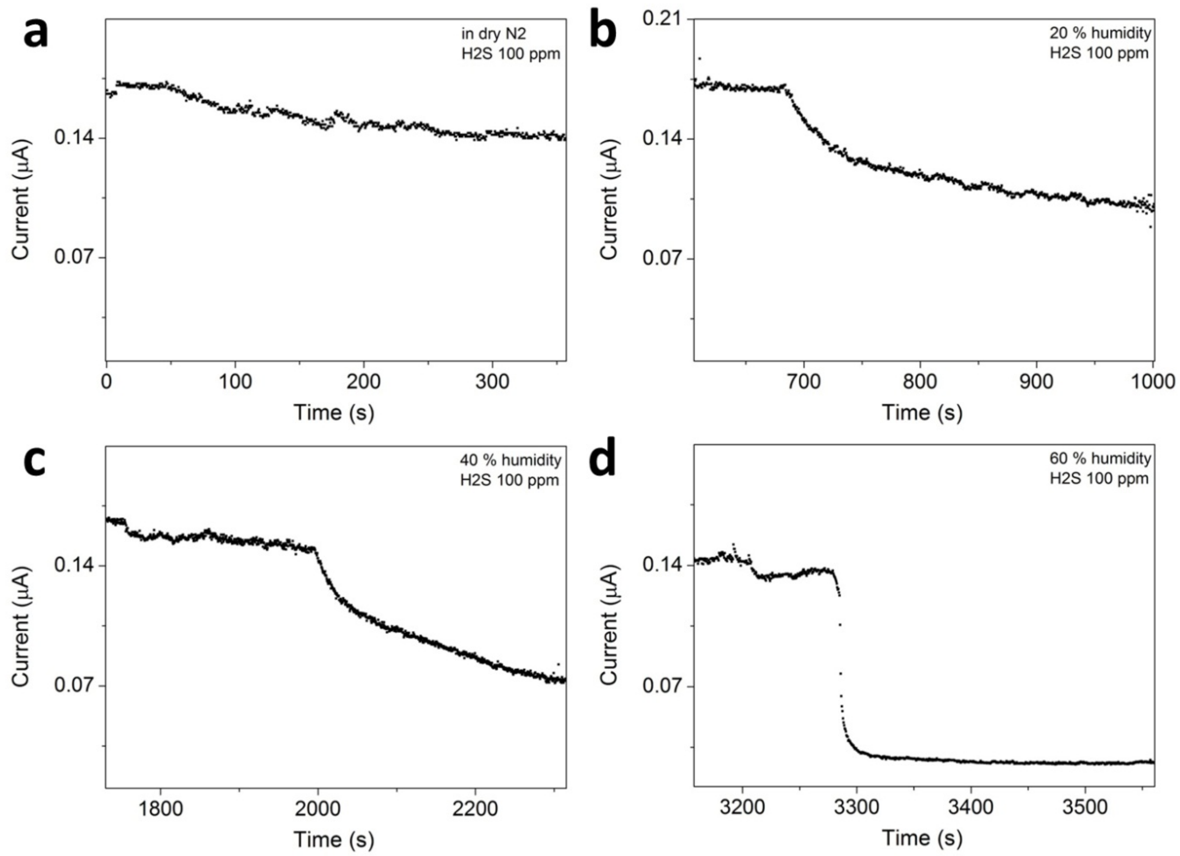

Fig. S7 Real-time current measurement of s-SWCNT device functionalized with TEMPO as a function of RH. The current reaches almost its saturation value.

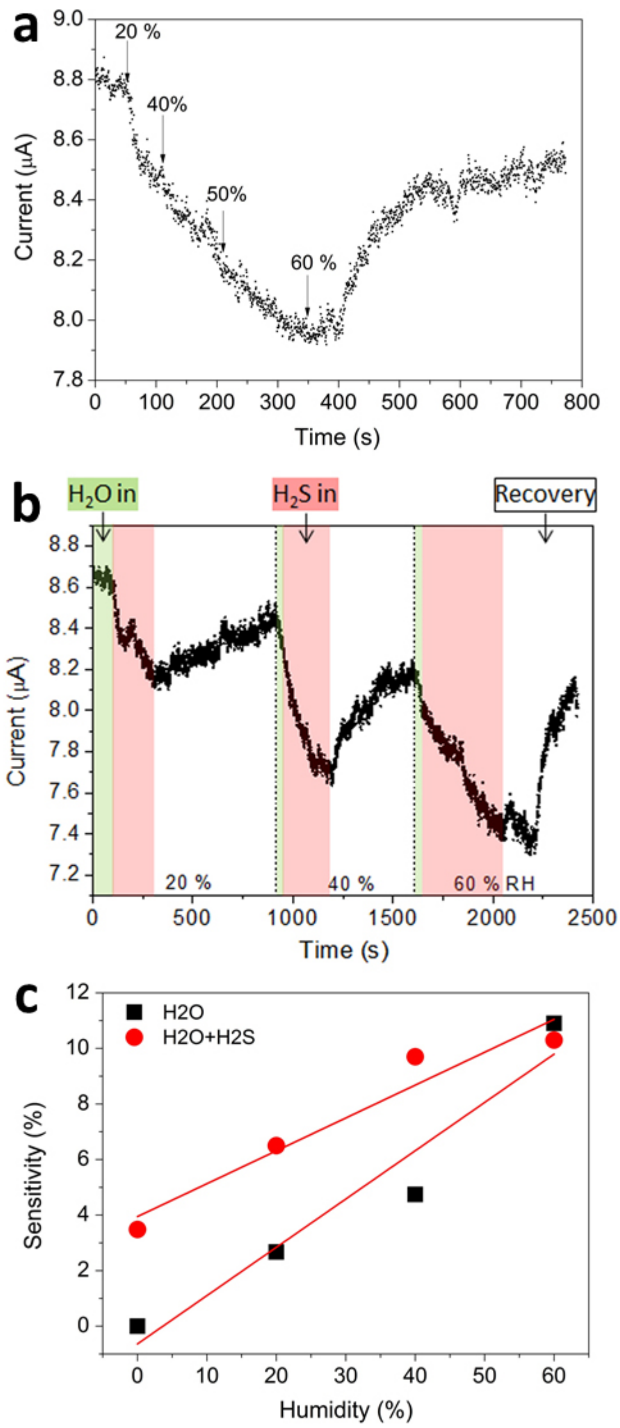

Fig. S8 (a) Sensing of H_2O vapor by an m-SWCNT device functionalized with TEMPO, (b) real-time current changes in a H_2S gas detection of the m-SWCNT+TEMPO device under different RH (20, 40 and 60 %). Here in the range of current reduction, red and green area mean injection of H_2S and H_2O molecules 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_2O and H_2O+H_2S detection.

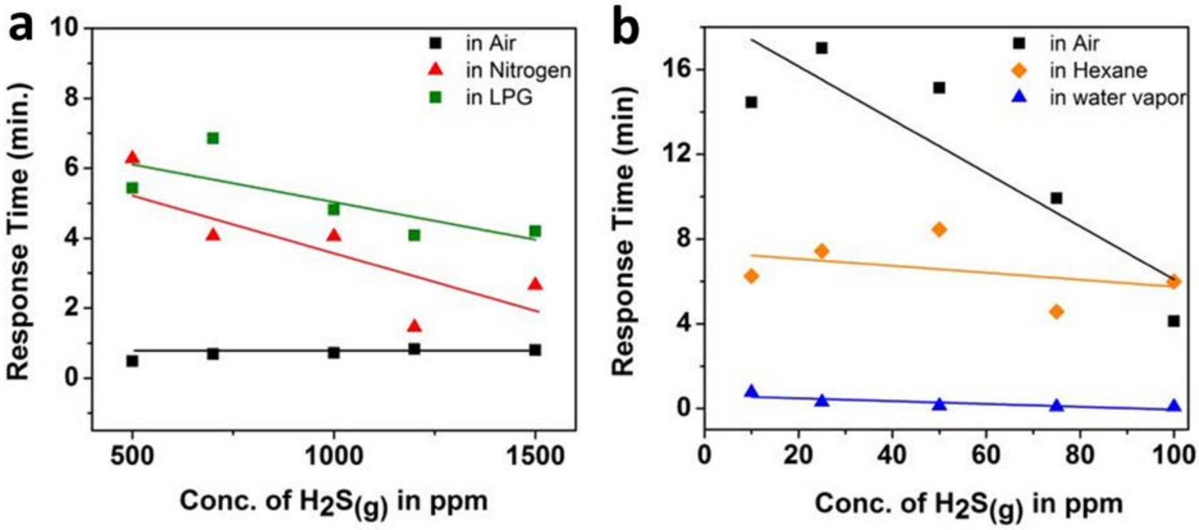

Fig. S9 (a) Sensing of H_2S gas (500 to 1500 ppm) by an SWCNT device functionalized with TEMPO in air, N_2, and LPG. (b) Sensing of H_2S (10 to 100 ppm) in air, hexane and water vapor. The TEMPO-SWCNTs sensor does not have any reaction with LPG, hexane, N_2, and air. The response time in water vapor is faster than in other ambient gas.

Table S1. Standard electrode reduction and oxidation potential values of the redox reactions necessary for the H_2S detection. These potential values are measured under standard condition, and relative to the standard hydrogen electrode as a reference electrode.[1,2]

Anodic - exhibits greater tendency to lose electrons			
Reduction Reaction	E° (V)	Oxidation Reaction	E° (V)
$TEMPO^+ + e^- \rightarrow TEMPO$	-0.88	$TEMPO \rightarrow TEMPO^+ + e^-$	0.88
Cathodic - exhibits greater tendency to gain electrons			
$S + 2H^+ + 2e^- \rightarrow H_2S$	0.14	$H_2S \rightarrow S + 2H^+ + 2e^-$	-0.14
$2H_2O + O_2 + 4e^- \rightarrow 4OH^-$	0.40	$4OH^- \rightarrow 2H_2O + O_2 + 4e^-$	-0.40

[1] Rychnovsky, S. D.; Vaidyanathan, R.; Beauchamp, T.; Lin, R.; Farmer, P. J. *J. Org. Chem.* **1999**, 64, 6745.
[2] Atkins, P. *Physical Chemistry, 6th edition* **1997**. (W.H. Freeman and Company, New York).