Electronic Supplementary Information

Designed synthesis of Ag-functionalized Ni-doped In_2O_3 nanorods for high sensitive detection of formaldehyde gas

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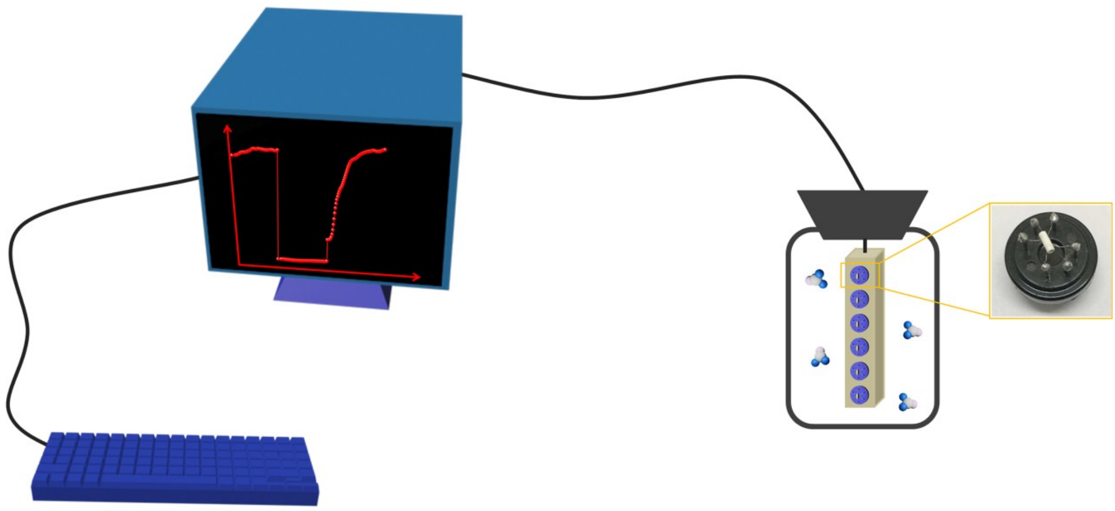

Fig. S1 The schematic illustration of formaldehyde testing assembly.

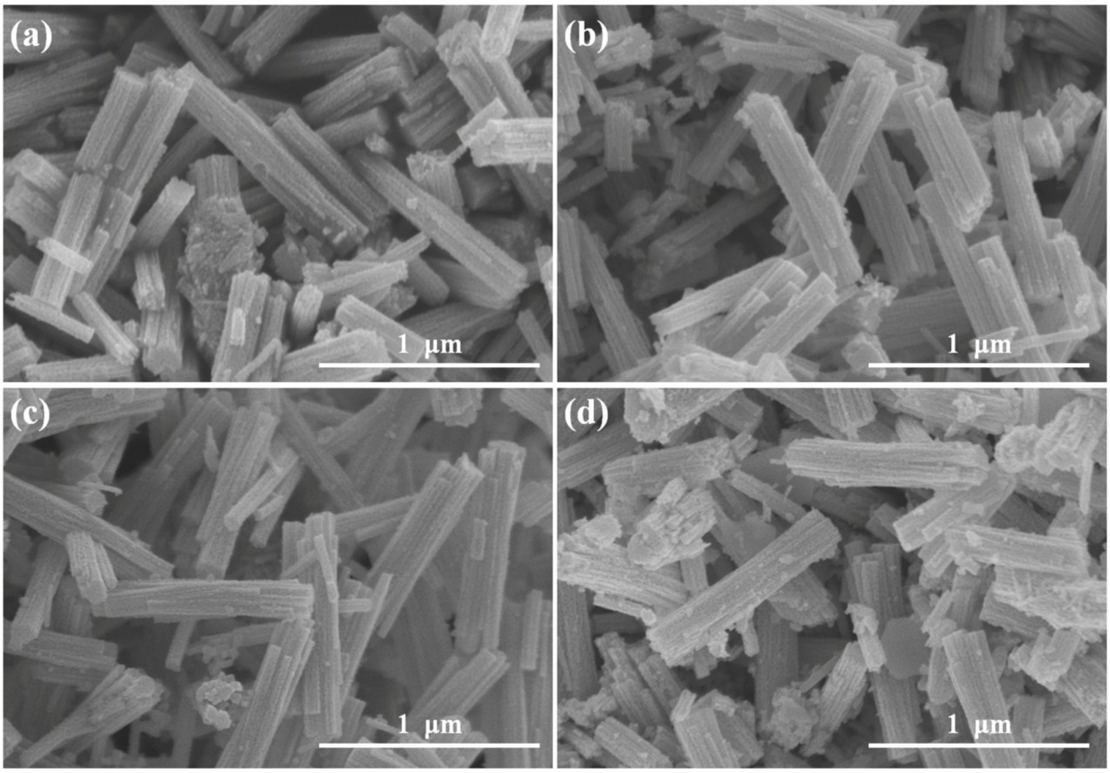

Fig. S2 SEM images of (a) $Ni_{2.5}In$, (b) $Ni_{7.5}In$, (c) 3%-Ag/$Ni_{5.0}In$ and (d) 9%-Ag/$Ni_{5.0}In$ samples.

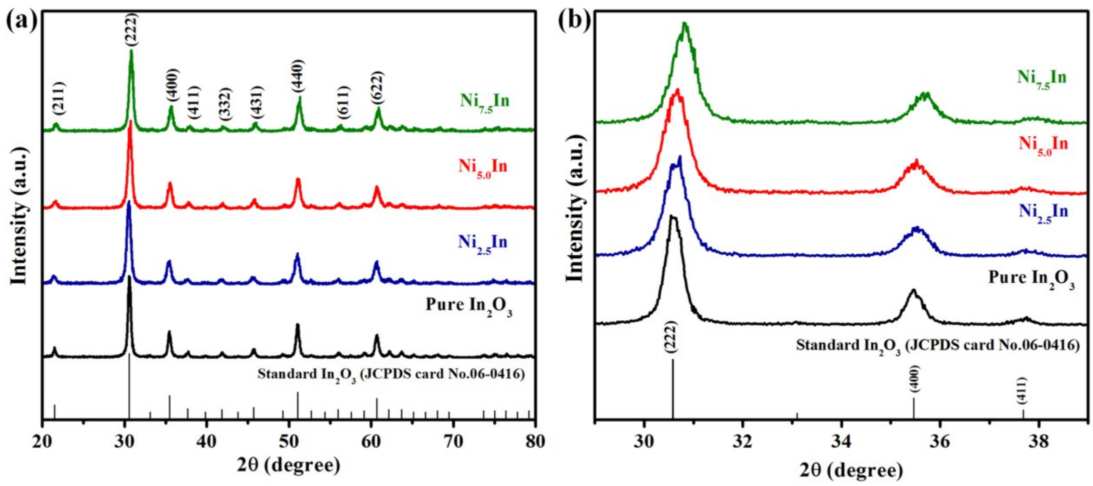

Fig. S3 (a) XRD patterns of pure In_2O_3, $Ni_{2.5}In$, $Ni_{5.0}In$ and $Ni_{7.5}In$. (b) A partially enlarged view of the (222) and (400) segments of the XRD patterns.

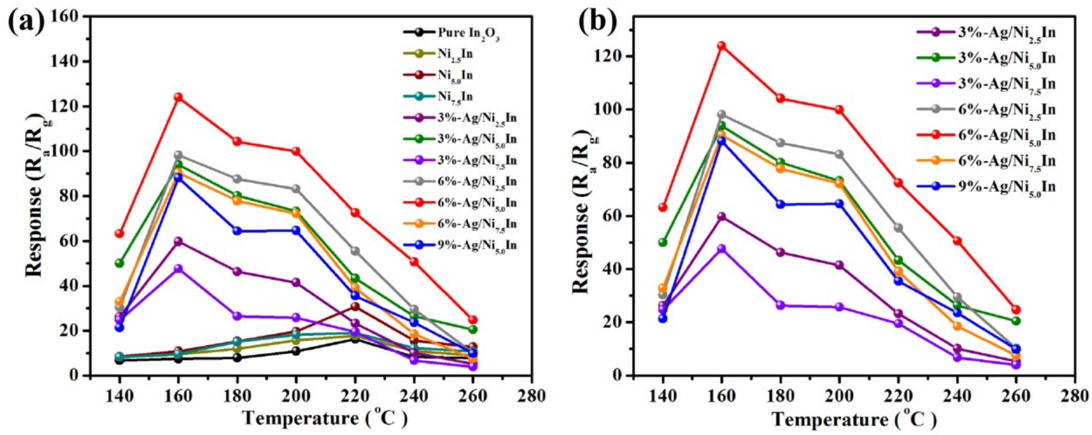

Fig. S4 (a) Response of the sensors to 100 ppm formaldehyde at the temperature range of 140-260 °C based on pure In_2O_3, $Ni_{2.5}In$, $Ni_{5.0}In$, $Ni_{7.5}In$, 3%-Ag/$Ni_{2.5}In$, 3%-Ag/$Ni_{5.0}In$, 3%-Ag/$Ni_{7.5}In$, 6%-Ag/$Ni_{2.5}In$, 6%-Ag/$Ni_{5.0}In$, 6%-Ag/$Ni_{7.5}In$ and 9%-Ag/$Ni_{5.0}In$ samples. (b) Response of the sensors to 100 ppm formaldehyde at the temperature range of 140-260 °C based on the obtained composites with different Ag loading rates.

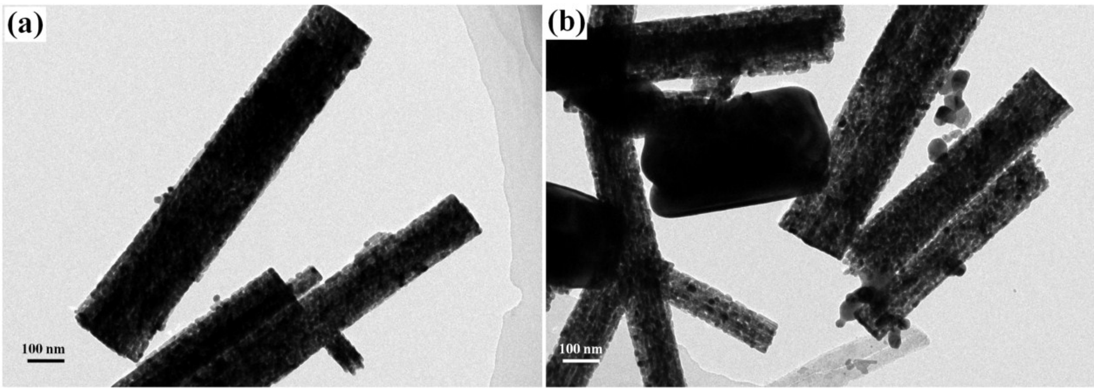

Fig. S5 (a) TEM image of CS1 after 1 h of chemical reduction. (b) TEM image of CS2 after 5 h of chemical reduction.

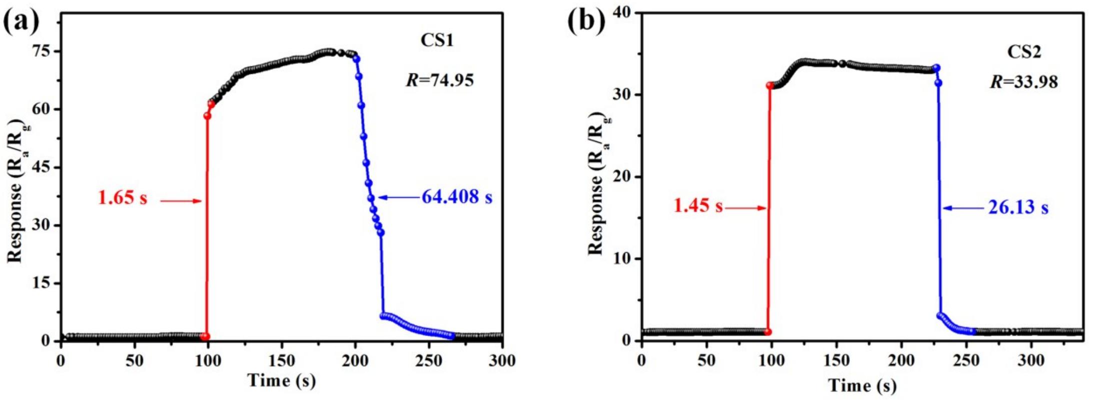

Fig. S6 (a-b) Response transients of sensors based on CS1 and CS1 samples toward 100 ppm formaldehyde at 160 °C.

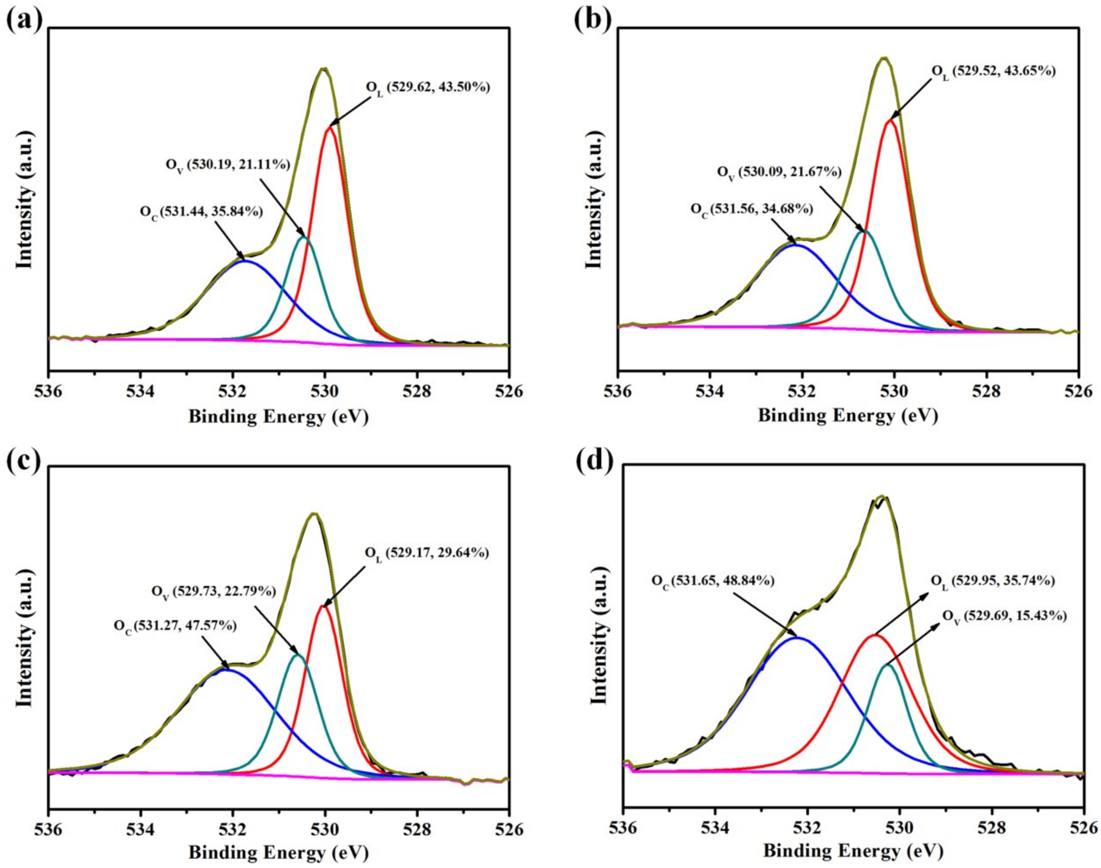

Fig. S7 O 1s XPS spectra of (a) $Ni_{2.5}In$, (b) $Ni_{7.5}In$, (c) 3%-Ag/$Ni_{5.0}In$ and (d) 9%-Ag/$Ni_{5.0}In$.

Table S1 Gas sensing properties of different sensing materials to formaldehyde, as reported in the literature and the present study.

sensing material	formaldehyde/con .(ppm)	temperature (°C)	response	res./rec. time (s)	referencce
rock-like ZnO	600	360	23.2	-	1
IrO_2-loaded $Ga_{1.4}In_{0.6}O_3$ nanofibers	10	280	46	2/9	2
Ag/Ag_2O functioned SnO_2 $/Sn_3O_4$	100	160	12.76	5/5	3
Ce-Sn_3O_4 microsphere	100	200	5.5	4/8	4
Tb-doped In_2O_3 nanotubes	50	160	75	2/12	5
SnO_2 microspheres	100	200	38.3	17/25	6
Er-doped In_2O_3 nanotubes	20	260	12	5/38	7
NiO/SnO_2 microflowers	100	100	39.2	28/115	8
SnO_2 hollow microspheres	50	300	6.4	-	9
Nd-doped In_2O_3	100	240	44.6	15/50	10
Porous NiO/SnO_2 microspheres	100	200	27.6	6/17	11
Li-doped ZnO nanoparticle	100	350	40.2	8/26	12
Ag functionalized Ni-doped In_2O_3 nanorods	100	160	123.97	1.45/58.2	This work

References

1. L. Zhu, W. Zeng, H. Ye, Y. Li, *Mater. Res. Bull.*, 2018, **100**, 259–264.

2. Q. Gao, S. Ao, H. Chen, X. Zou, C. Wei, G. Li, *J. Alloy. Compd.*, 2018, **732**, 856-862.

3. H. Yu, J. Li, Y. Tian, Z. Li, *J. Alloy. Compd.*, 2018, **765**, 624-634.

4. X. Ma, J. Shen, D. Hu, L. Sun, Y. Chen, M. Liu, C. Li, S. Ruan, *J. Alloy. Compd.*, 2017, **726**, 1092-1100.

5. H. Duan, Y. He, S. Li, L. Liu, S. Xu, Y. Li, H. Li, Y. Gong, Q. Liang, Y. Cheng, *J. Mater. Sci.-Mater. Electron.*, 2018, **29**, 19111-19122.

6. Y. Li, N. Chen, D. Deng, X. Xing, X. Xiao, Y. Wang, *Sens. Actuators B*, 2017, **238**, 264-273.

7. X. Wang, J. Zhang, L. Wang, S. Li, L. Liu, C. Su, L. Liu, *J. Mater. Sci. Technol.*, 2015, **31,** 1175-1180.

8. D. Meng, D. Liu, G. Wang, Y. Shen, X. San, M. Li, F. Meng, *Sens. Actuators B*, 2018, **273**, 418-428.

9. J. Yang, S. Wang, R. Dong, L. Zhang, Z. Zhu, X. Gao, *Mater. Lett.*, 2016, **184,** 9-12.

10. X. Wang, J. Zhang, Y. He, L. Wang, L. Liu, H. Wang, X. Guo, H. Lian, *Chem. Phys. Lett.*, 2016, **658**, 319-323.

11. C. Gu, Y. Cui, L. Wang, E. Sheng, J. Shim, J. Huang, *Sens. Actuators B*, 2017, **241**, 298-307.

12. J. Zhao, C. Xie, L. Yang, S. Zhang, G. Zhang, Z. Cai, *Appl. Surf. Sci.*, 2015, **330**, 126-133.