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In_2O_3 Nanorod Decorated Reduced Graphene Oxide composite as High Response of NO_x Gas Sensors at Room Temperature

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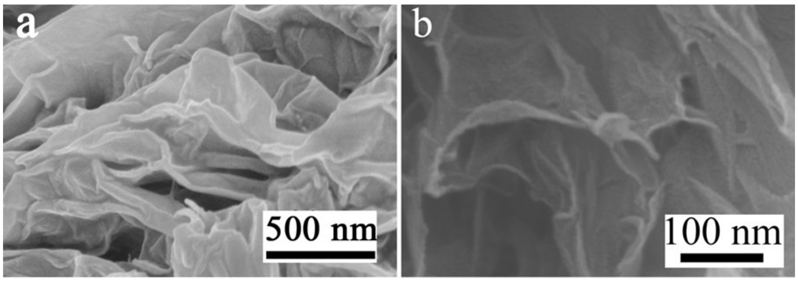

Fig. S1 The SEM images of (a) GO and (b) rGO.

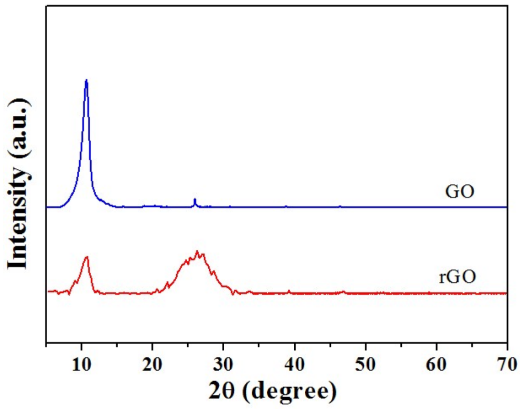

Fig. S2 The XRD patterns of GO and rGO.

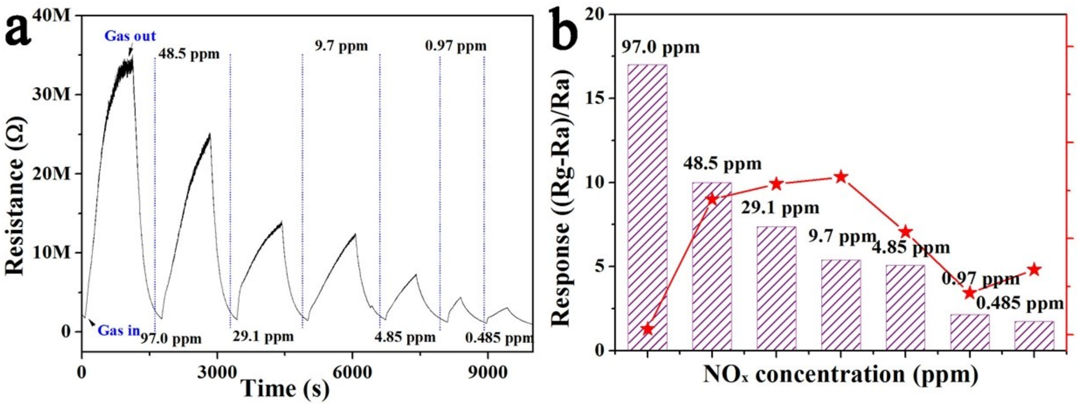

Fig. S3 The results of the gas response of In_2O_3 sensor to 97.0 ppm - 0.485 ppm NO_x operated at room temperature in air. (a) The representative response-recovery cyclic curves; (b) corresponding response and response time.

Table S1 The response-recovery results of the synthesized In_2O_3 sensor to NO_x at room temperature.

Volume concentration/ppm	97.0	48.5	29.1	9.7	4.85	0.97	0.485
Response	17.00	9.99	7.36	5.39	5.06	2.15	1.73
Response time/s	17.3	422.0	470.0	492.6	320.0	130.0	203.3

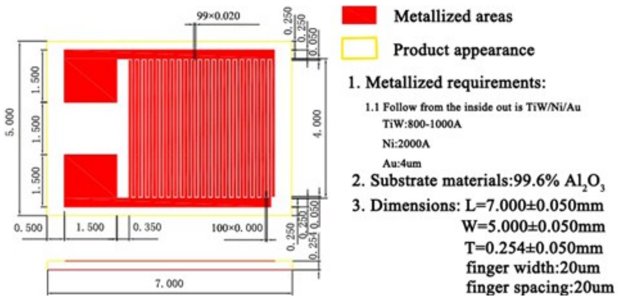

Fig. S4 The image of interdigitated gold electrode and its parameters.

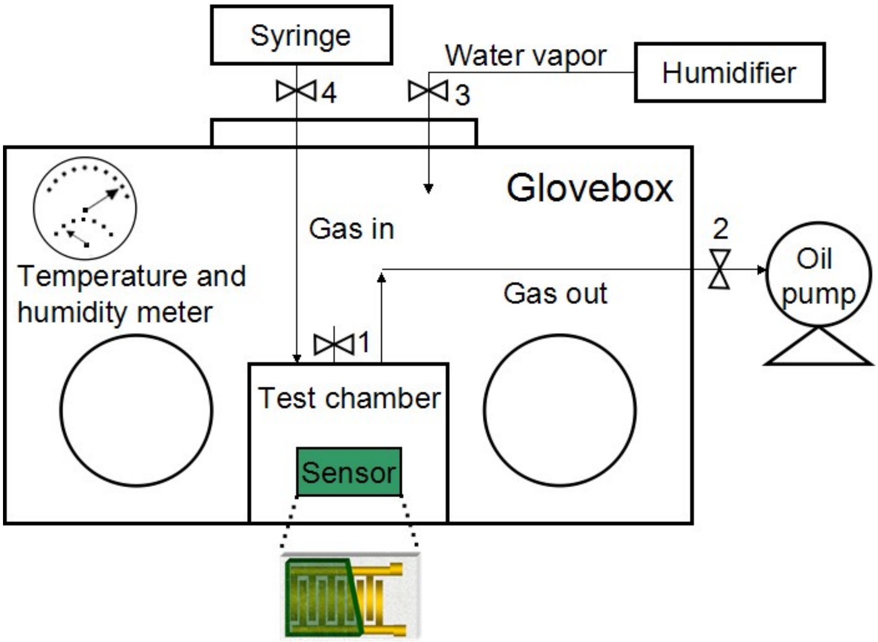

Fig. S5 A diagram of the gas delivery system for the gas sensing process.

The electrical resistance measurements of the sensor were carried out at room temperature (22 °C) and a relative humidity (RH) range of 26 ~ 28 %. A diagram of the gas delivery system for the gas sensing process is shown in Ref. S1. Firstly, the interdigitated Au electrode sensor was installed into the test chamber with an inlet valve 4 and an outlet valve 2 to the external environment. Keep the valve 1 open. The test chamber was flushed with air for 2 min to remove any contaminants from the chamber and glove box. Secondly, shut up the inlet valve 4, outlet valve 2 and valve 4. And a temperature and humidity meter has been placed in the glove box to monitor environment. Finally, open the valve 4, and inject certain volume of the NO_x gas. When the resistance is balanced, open the valve 2, and then the chamber was purged by an oil pump with air to recover the sensor resistance. One response-recover circle is finished, repeat the former three stages and then the second response-recovery circle is stated.

The definition of NO_x in our work is the mixture of NO and NO_2. As we all known, NO with very lively chemical properties is react easily with O_2 to form NO_2 in the air. The equation (1) as follows:

$$2NO+O_2 \rightleftharpoons 2NO_2 \qquad (1)$$

The concentration ratio of NO_2 and NO can be calculated by the following equation (2)

$$K=\frac{[NO_2]^2}{[NO]^2\times[O_2]} \qquad (2)$$

Where K is the chemical equilibrium constant 1.4×10^6 (T=298K), [Gas] is the molarity of gases (Gas=NO_2, NO and O_2).

The $[O_2]$ can be calculated by the following equation (3):

$$[O_2]=\frac{m(O_2)}{M(O_2)\times V_{total}}=\frac{21\%\times m_{air}}{M(O_2)\times V_{total}}=\frac{21\%\times V_{total}\times\rho_{air}}{M(O_2)\times V_{total}}=\frac{21\%\times\rho_{air}}{M(O_2)} \qquad (3)$$

Where ρ_{air} is the density of the air; M (O_2) is the molecular weight of O_2 According to equation (2) and (3), the concentration ratio of NO_2 and NO is 17:5. And, the synthesized sample was made into gas sensor to detect the mixture NO_x.

Table S2 The gas sensing performance of In_2O_3 sensors to NO_x gas.

	Material	**Operating temperature**	**Sensitivity**	**Response time**	**Lowest detectable limit (ppm)**	**year**
	In_2O_3 NR/rGOsens	Room temperature	1.45	25 s	0.97 ppm	Our work
[S2]	Zn-doped flower-like In_2O_3	300 °C	2.74	----	5 ppm	2014
[S3]	Pd-loaded In_2O_3 nanowire-like network	110 °C	9	28 s	5 ppm	2015
[S4]	In_2O_3 nanorod	150 °C	41	50 s	0.05 ppm	2016
[S5]	In_2O_3	150 °C	33.45	---	5 ppm	2015
[S6]	In_2O_3-rGO	Room temperature	8.25	4 min	----	2015

References

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