Electronic Supplementary Information

Enhanced gas-sensing response by gamma ray irradiation: Ag/Ag_2SnO_3 nanoparticle-based sensor to ethanol, nitromethane and acetic acid†

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1. Hydrothermal Process to $Na_2Sn(OH)_6$.

To obtain Ag_2SnO_3, $Na_2Sn(OH)_6$ needed to be synthesized firstly. In a typical procedure, 0.263 g $SnCl_4$ and 0.375 g PVP were simultaneously dissolved in 50 mL ethanol/water (4:1, by V/V) solution. Then 10 mL NaOH (12.5 M) aqueous solution was added dropwise under vigorous stirring. The resulting slurry was transferred into a Teflon-lined stainless steel autoclave with a capacity of 100 mL. The hydrothermal synthesis was performed at 180 °C for 24 h; then the vessel was cooled to room temperature. The resultant $Na_2Sn(OH)_6$ was cleaned by ethanol and collected by centrifugation.[S1,S2]

2. The synthesis of Ag_2SnO_3.

Herein, the two-step process plays an important role in the synthesis of Ag_2SnO_3, which is based on the following reactions.

$$SnCl_4 + 4NaOH \rightarrow Sn(OH)_4 + 4NaCl \quad (1)$$

$$Sn(OH)_4 + 2NaOH \rightarrow Na_2Sn(OH)_6 \quad (2)$$

$$Na_2Sn(OH)_6 + 2AgNO_3 \rightarrow Ag_2SnO_3 + 2NaNO_3 + 3\ H_2O \quad (3)$$

A hydrothermal reaction was carried out in an ethanol/water solution to obtain crystalline $Na_2Sn(OH)_6$. The following reaction with the $AgNO_3$ aqueous solution resulted in a brown powdery product that can be confirmed as Ag_2SnO_3 by the XRD pattern. The reaction is basically a diffusion-controlled ion-exchange process in which Ag^+ ions in the $AgNO_3$ aqueous solution replace the Na^+ of $Na_2Sn(OH)_6$ as the reaction proceeds, driven by the ion concentration gradient. The ion-exchange reaction was completed within 50 min, and then the resultant Ag_2SnO_3 was filtered, washed with ethanol, and dried at 60 ^oC.

3. The XRD pattern and SEM image of Ag_2SnO_3.

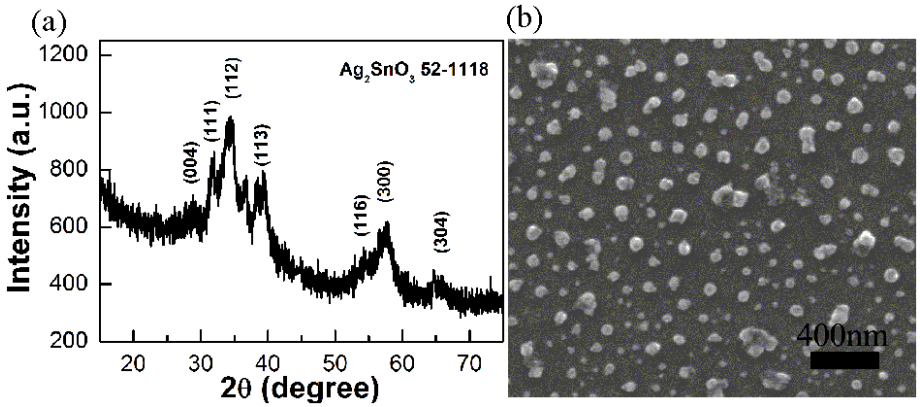

Fig. S1 XRD pattern and SEM image of Ag_2SnO_3 nanoparticles.

Fig. S1a shows the XRD pattern of Ag_2SnO_3, which is in accordance with the standard data (JCPDS. No 52-1118). From the XRD pattern, it could be found that the crystallinity of Ag_2SnO_3 is not good.

Scanning electron microscopy (SEM) images were taken on a FEI-quanta 200 scanning electron microscope with accelerating voltage of 30 kV. The SEM image (Fig. S1b) shows that Ag_2SnO_3 is agglomerated each other with the average diameter of 100 nm.

4. The gas sensitivity of Ag/Ag_2SnO_3 to CH_3NO_2.

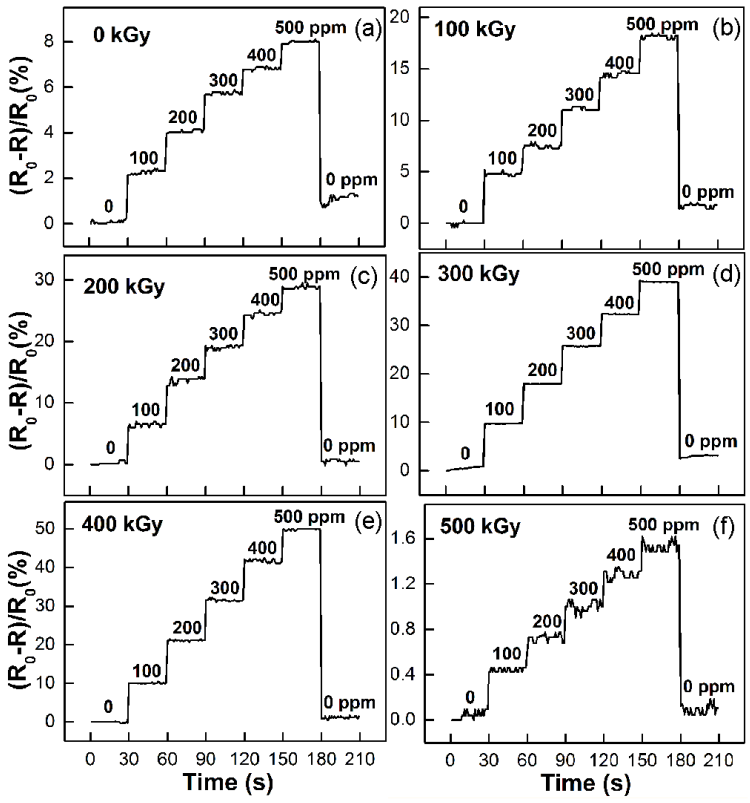

Fig. S2 Response of six different gamma ray dose irradiated sensors upon exposure to various concentrations of CH_3NO_2.

5. Gas responses of six irradiated products to CH_3NO_2.

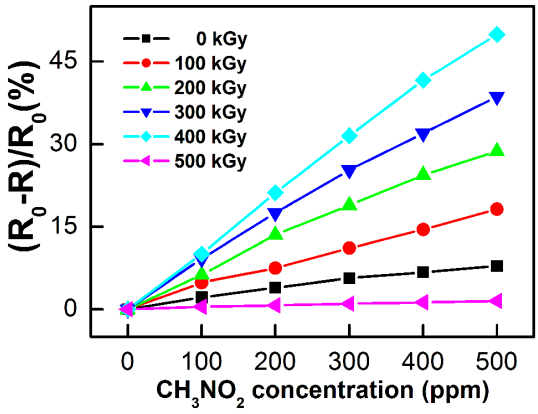

Fig. S3 The relationship between gas responses of six irradiated products and concentration of CH_3NO_2.

6. The gas sensitivity of Ag/Ag_2SnO_3 to CH_3COOH.

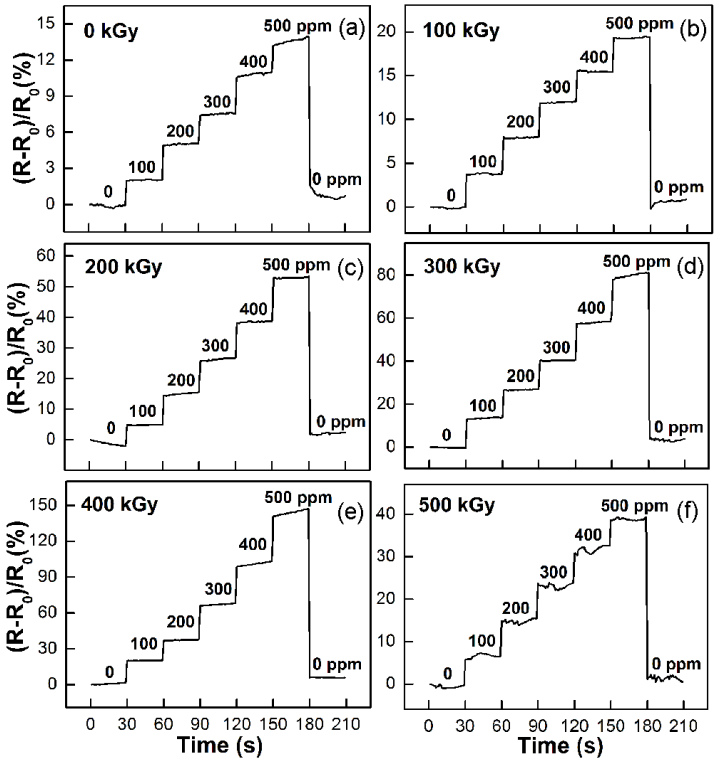

Fig. S4 Response of six different gamma ray dose irradiated sensors upon exposure to various concentrations of CH_3COOH.

7. The Brunauer-Emmett-Teller (BET) specific surface area of the irradiated products

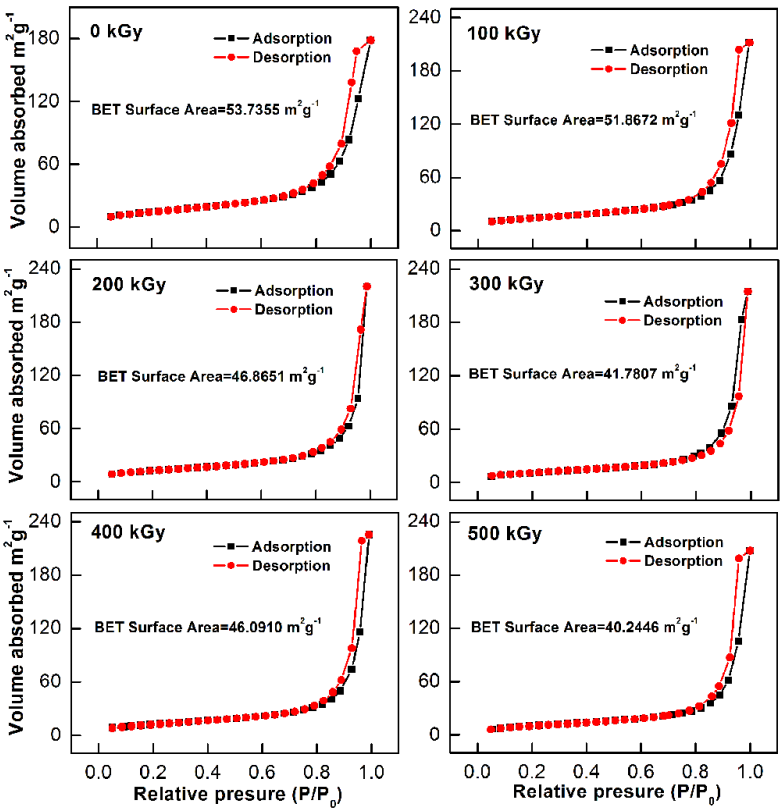

Fig. S5 The BET specific surface area of the products with different irradiation doses.

S1 Y. W. Tang, Y. Jiang, Z. Y. Jia, B. H. Li, L. J. Luo and L. Xu, *Inorg. Chem.*, 2006, **26**, 10774.

S2 K. Yin, M. W. Shao, Z. S. Zhang and Z. Q. Lin, *Mater. Resear. Bull.*, 2012, **47**, 3704.