Electronic Supplementary Material (ESI) for Journal of Materials Chemistry A.

Supplementary Information for

Cross-linking Structure of Self-aligned P-Type SnS Nanoplates for Highly Sensitive NO_2 Detection at Room Temperature

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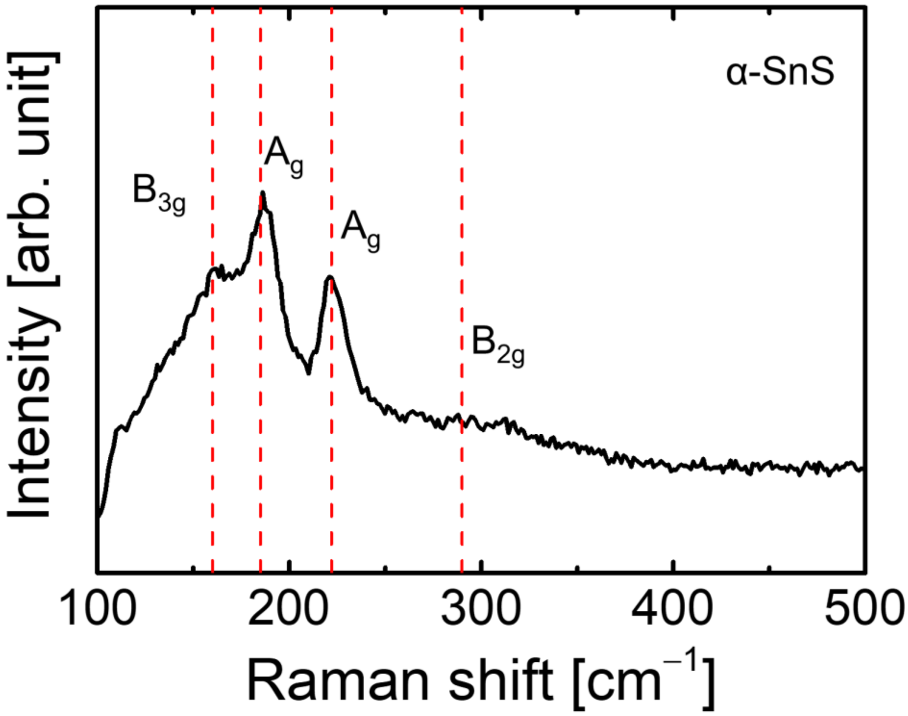


Figure S1. Raman spectrum of SnS nanoplates grown on SiO_2 nanorods.

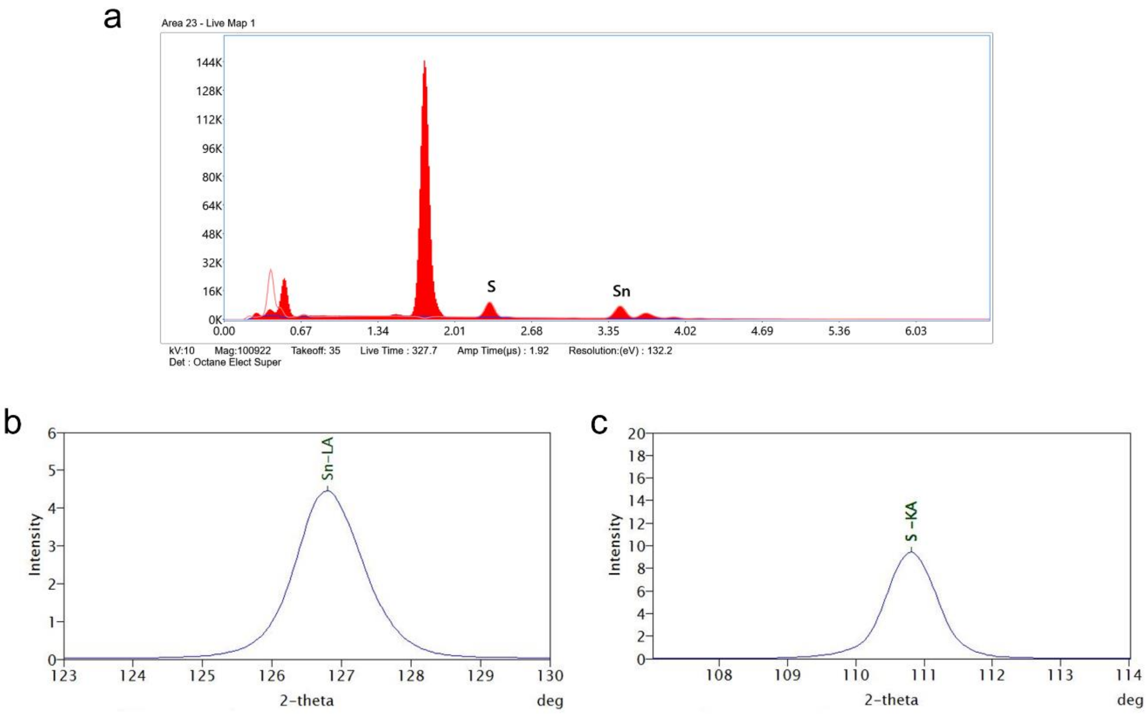


Figure S2. (a) Energy-dispersive spectra of SnS nanoplates formed on SiO_2 nanorods obtained from SEM analysis. Variation in the peak intensity of (b) Sn and (c) S elements obtained from wavelength-dispersive x-ray fluorescence.

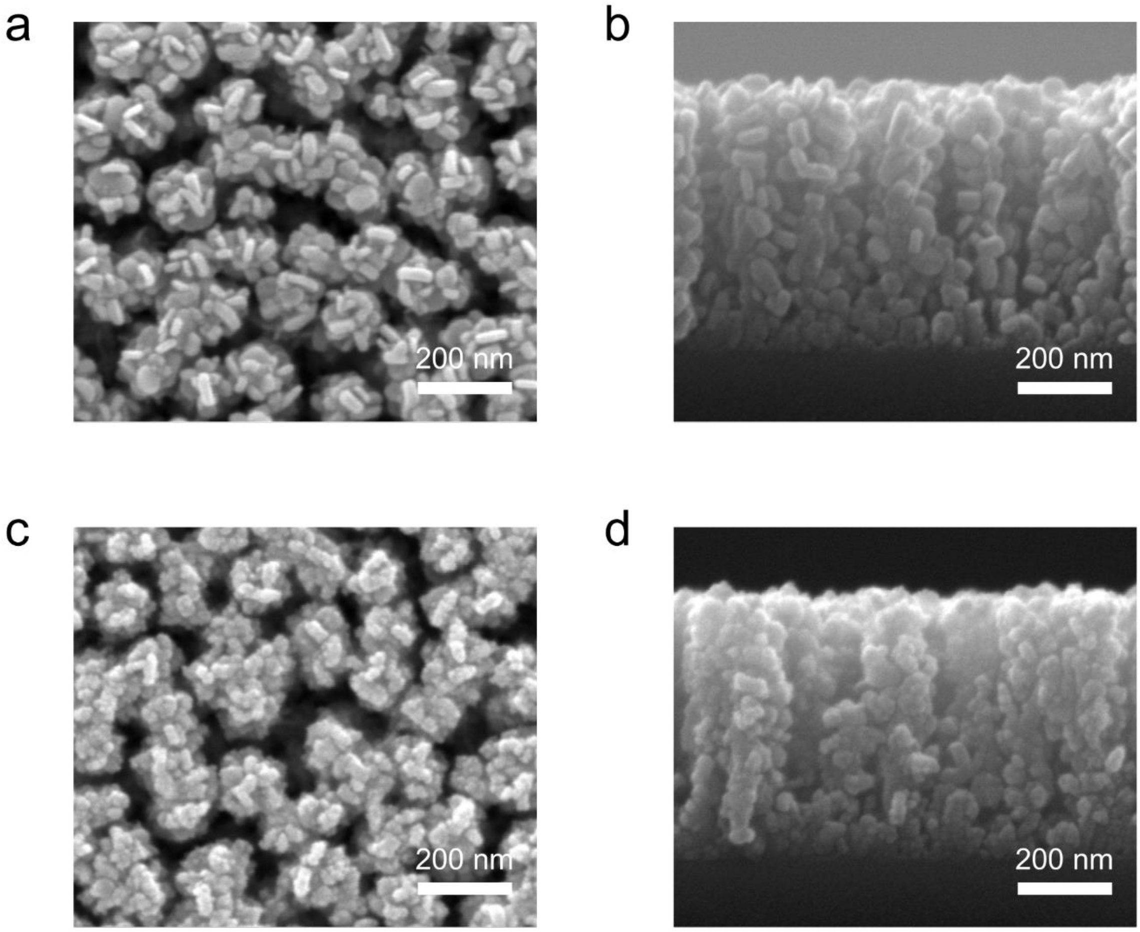


Figure S3. (a) Plan-view and (b) cross-sectional SEM images of SnS nanoplates on SiO_2 nanorods. (c) Plan-view and (d) cross-sectional SEM images of the structure after solvent cleaning using acetone, ethanol, and deionized water.

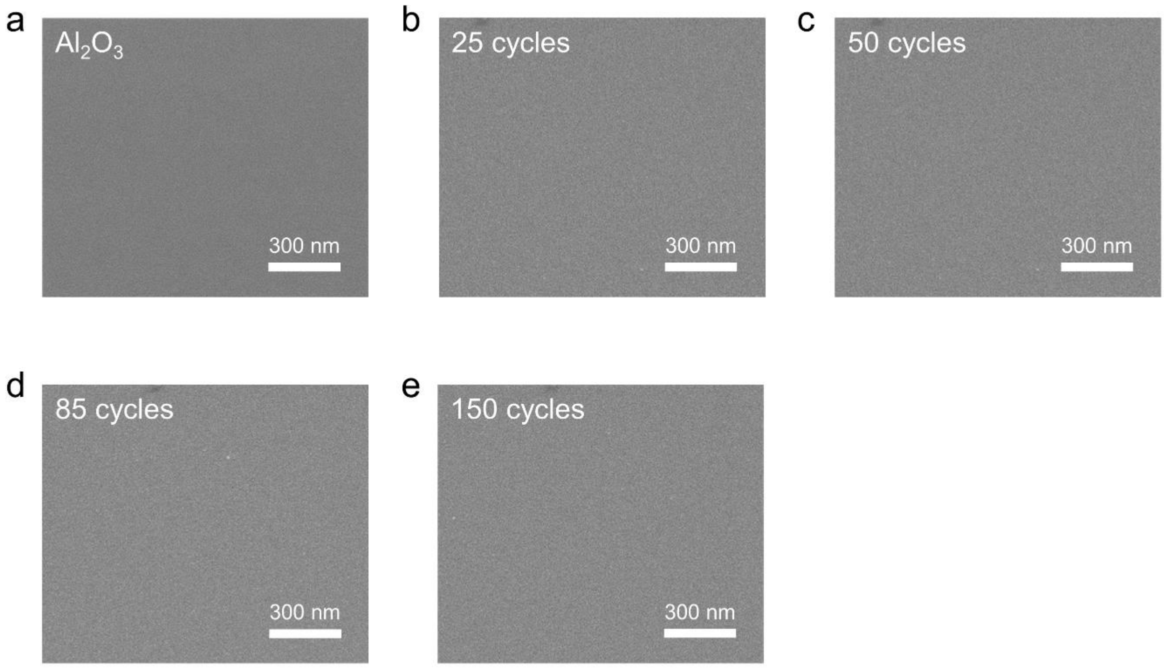
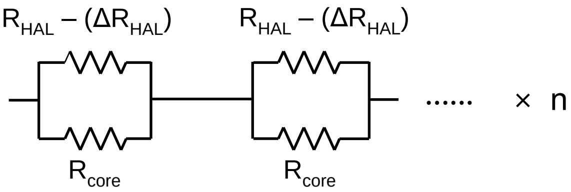


Figure S4. Plan-view SEM images of ALD-grown SnS on Al_2O_3 for (a) 0, (b) 25, (c) 50, (d) 85, and (e) 150 cycles.

Note S1



The resistance of the single SnS grain in the absence and presence of NO_2 can be expressed as $\frac{R_{core}\times R_{HAL}}{R_{core}+R_{HAL}}$ and $\frac{R_{core}\times(R_{HAL}-\Delta R_{HAL})}{R_{core}+(R_{HAL}-\Delta R_{HAL})}$, respectively, because R_{HAL} and R_{core} are connected in parallel. The R_{core} value is assumed to be a constant since the change in the R_{core} value under exposure to NO_2 is negligible. The SnS sensor was considered in the form of n grains connected in series. R_a and R_g of the SnS sensor is regarded as n times the resistance of each SnS grain.

Considering the resistance values, the response of the SnS sensor to NO_2 is developed as follows;

$$\text{Response} = \frac{R_a}{R_g} - 1 = \frac{\left(\frac{R_{core}\times R_{HAL}}{R_{core}+R_{HAL}}\right)\times \cancel{n}}{\left(\frac{R_{core}\times(R_{HAL}-\Delta R_{HAL})}{R_{core}+(R_{HAL}-\Delta R_{HAL})}\right)\times \cancel{n}} - 1$$

$$= \frac{\cancel{R_{core}}\times R_{HAL}(R_{core}+R_{HAL}-\Delta R_{HAL})}{\cancel{R_{core}}(R_{HAL}-\Delta R_{HAL})(R_{core}+R_{HAL})} - 1$$

$$= \frac{R_{core}\Delta R_{HAL}}{(R_{HAL}-\Delta R_{HAL})(R_{core}+R_{HAL})}$$

$$= \frac{1}{(\frac{R_{HAL}}{\Delta R_{HAL}}-1)(1+\frac{R_{HAL}}{R_{core}})}$$

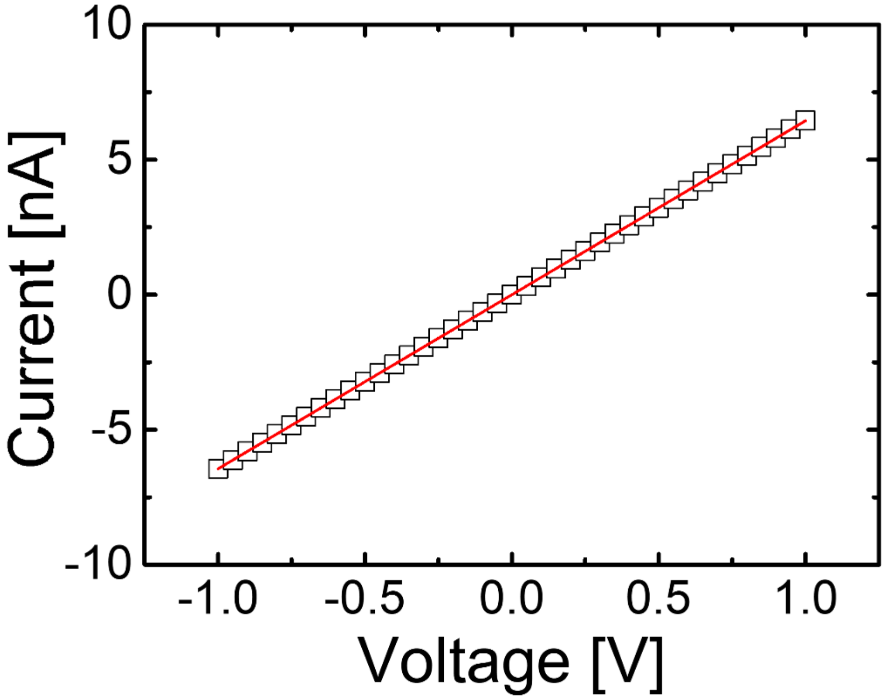


Figure S5. I-V curve of SnS nanoplates (75 ALD cycles) grown on SiO_2 nanorods.

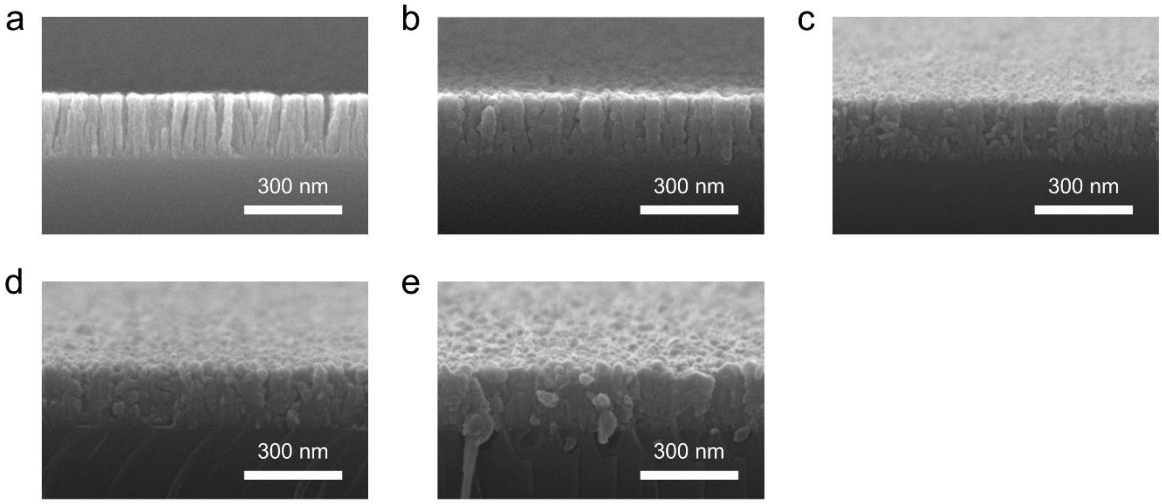


Figure S6. Cross-sectional SEM images of SnS grown on SiO_2 for (a) 0, (b) 25, (c) 50, (d) 85, and (e) 150 cycles.

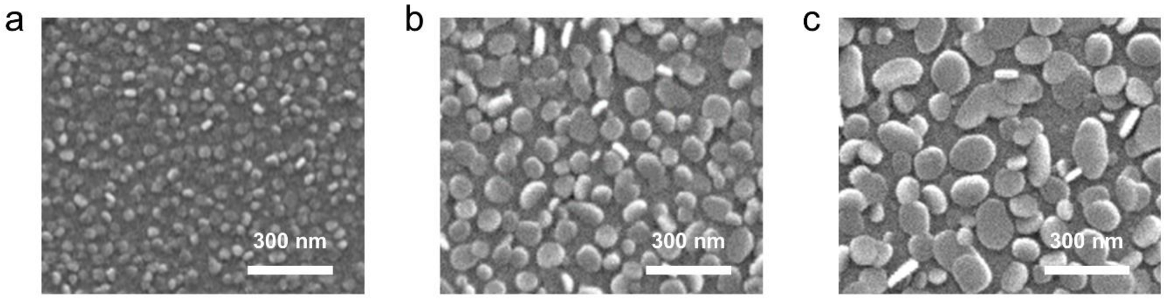


Figure S7. Plan-view SEM images of SnS grown on planar SiO_2 for (a) 25, (c) 85, and (e) 150 cycles.

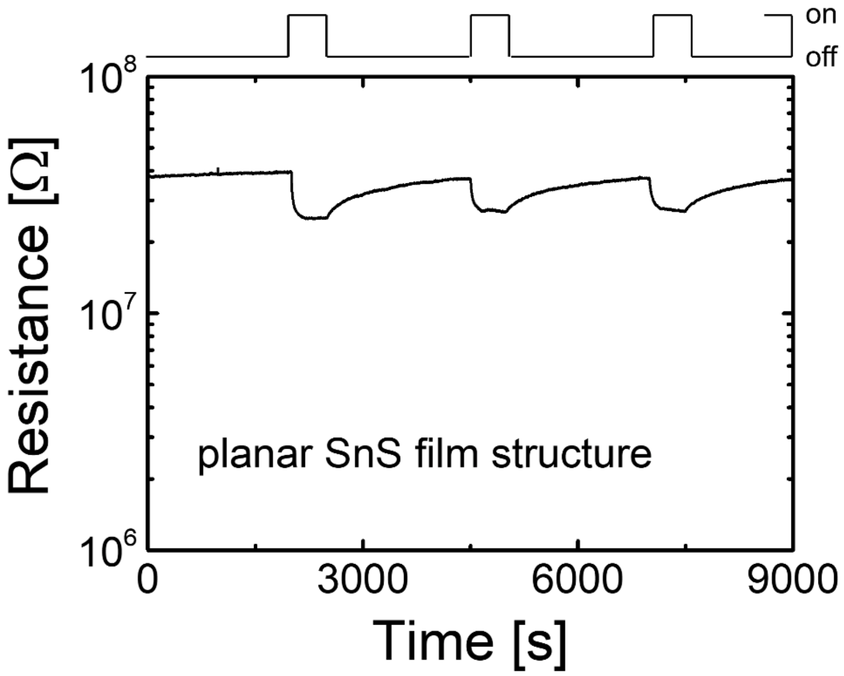


Figure S8. Variation in the resistance of the SnS planar film structured sensor grown for 900 cycles to 5 ppm NO_2.

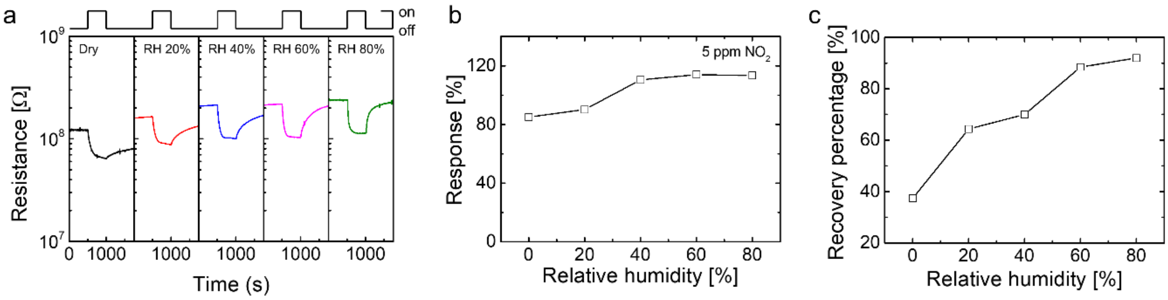


Figure S9. Variations in (a) the resistance and (b) the response of the SnS nanoplates on SiO_2 nanorods to 5 ppm NO_2 in the RH range from 0 to 80%. (c) Variation in the recovery percentage of the resistance after 500 s from the start of recovery.

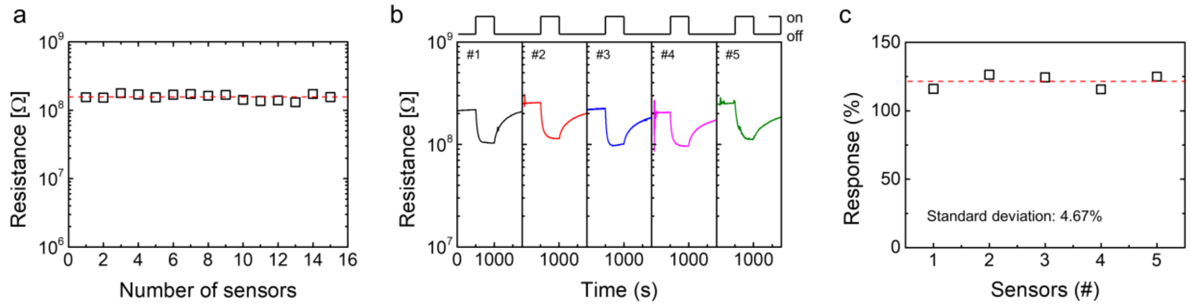


Figure S10. (a) Variation in the base resistance of 15 different SnS sensors grown on SiO_2 nanorods for 75 ALD cycles. (b) Variations in the resistance and (c) the response of five different SnS sensors under ambient condition of 60% RH at room temperature upon exposure to 5 ppm NO_2.

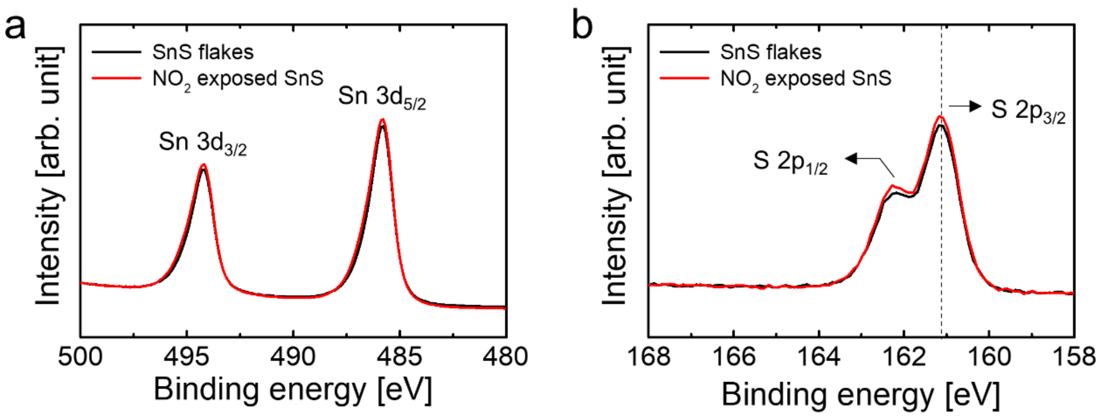


Figure S11. XPS spectra of (a) Sn 3d and (b) S 2p core levels in SnS nanoplates grown on SiO_2 nanorods before and after exposure to 100 ppm NO_2 for 5 min.

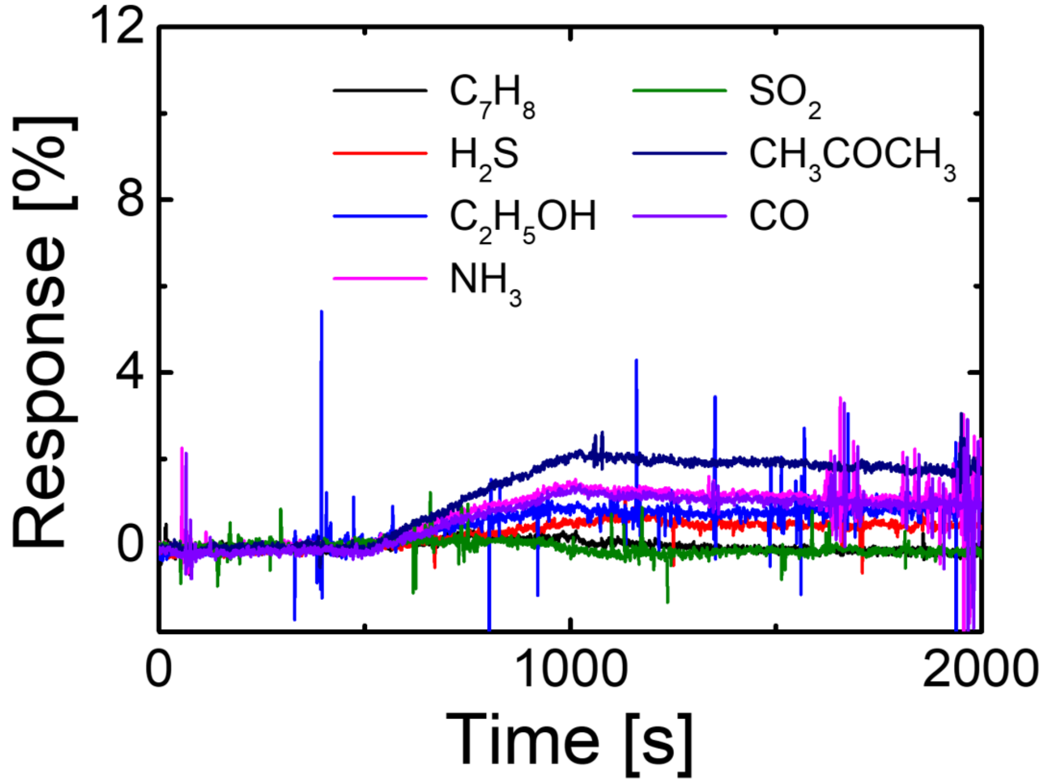


Figure S12. Variation in the response of the SnS sensor upon exposure to various gases (NO_2, C_7H_8, H_2S, C_2H_5OH, NH_3, SO_2, CH_3COOCH_3, and CO) with a concentration of 5 ppm.