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Supplementary information

High-performance Gas Sensor Array for Indoor Air Quality Monitoring: The Role of Au Nanoparticles in WO_3, SnO_2, and NiO-based Gas Sensors

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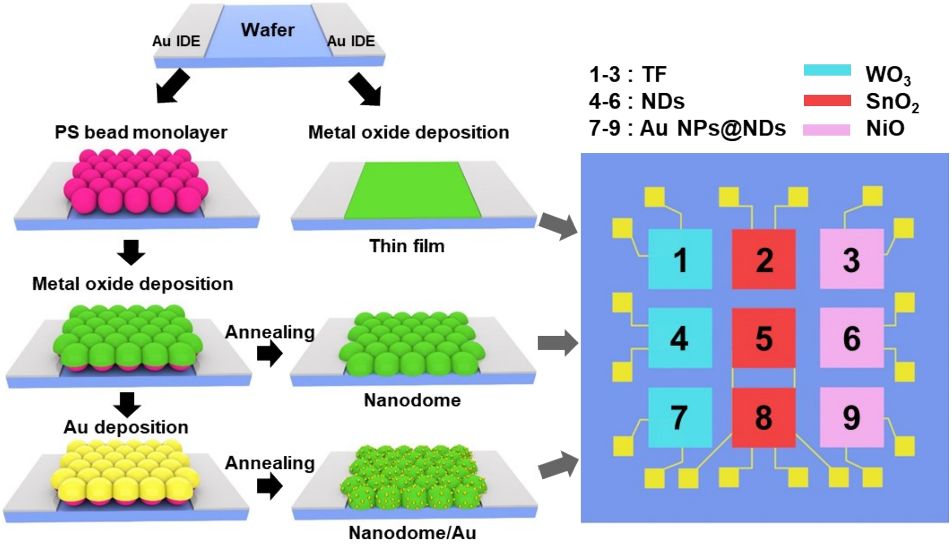

Fig. S1 Fabrication process of 3x3 gas sensor array

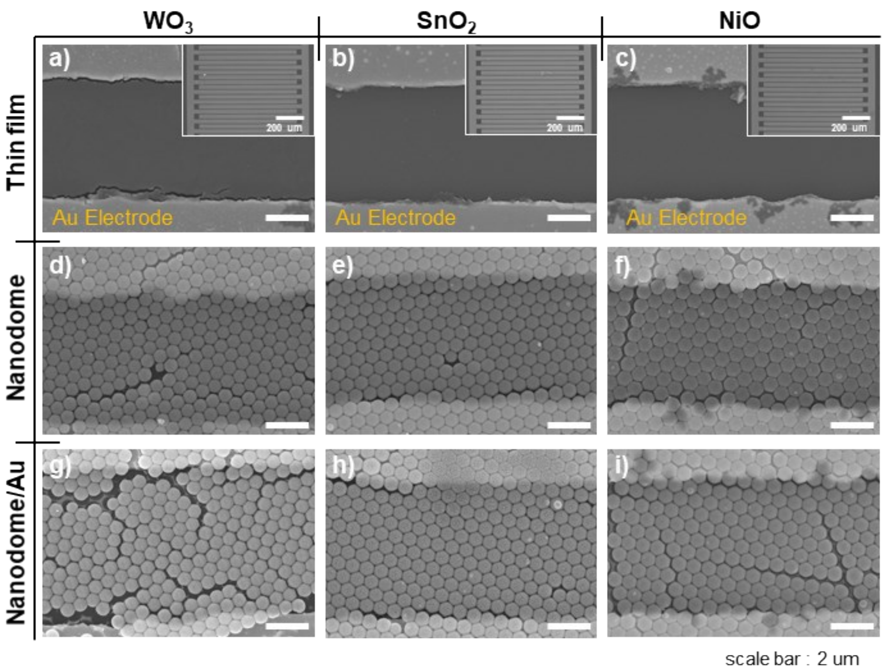

Fig. S2 SEM micrographs of the a-c) TF, d-f) NDs, g-i) Au NPs@WO_3, SnO_2 and NiO NDs. The inset image show the whole IDE substrate.

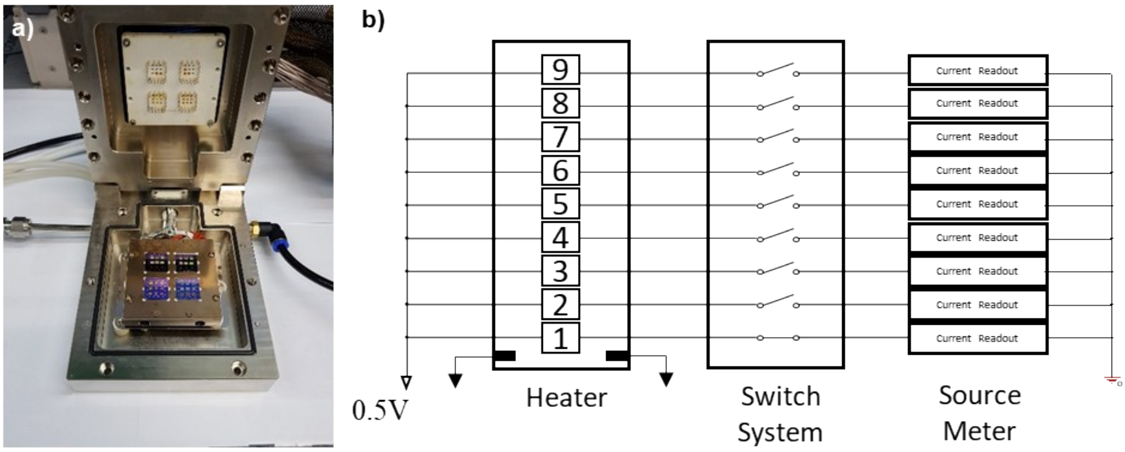

Fig. S3 a) Digital image of the gas response measurement setup and the b) interface circuitry for the gas sensing measurements of the 3x3 sensor array.

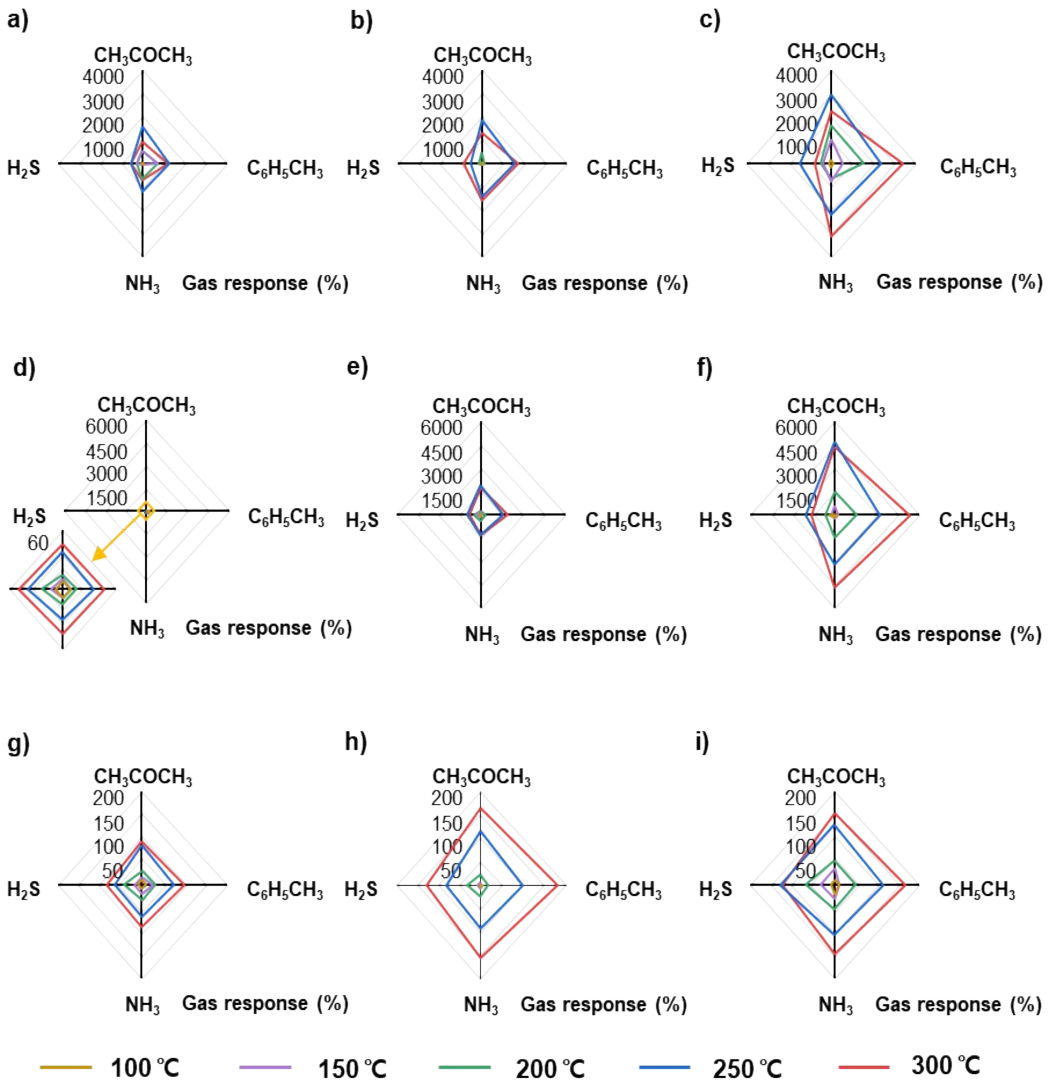

Fig. S4 Polar plot of gas responses for a-c) WO_3, d-f) SnO_2, g-i) NiO TFs, NDs, and Au NPs@NDs as a function of temperature.

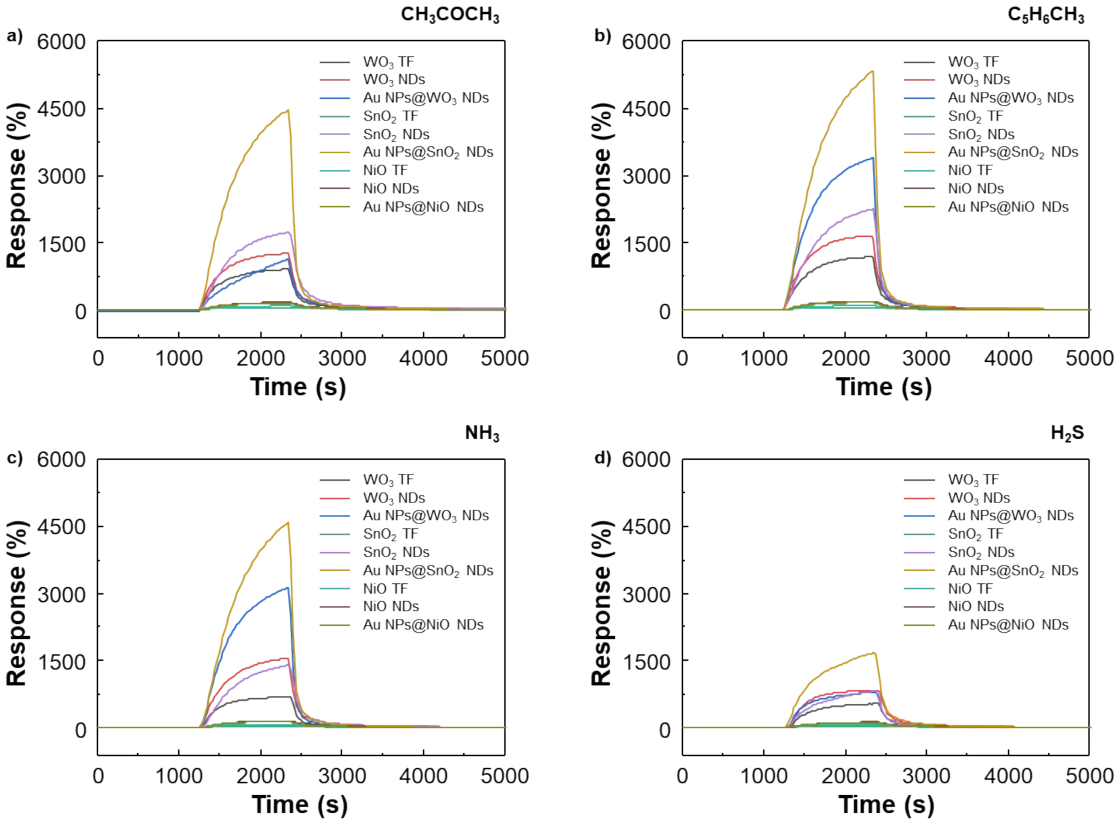

Fig. S5 Real-time response of the sensor array to 10 ppm a) CH_3COCH_3, b) $C_6H_5CH_3$, c) NH_3 and d) H_2S at 300 °C.

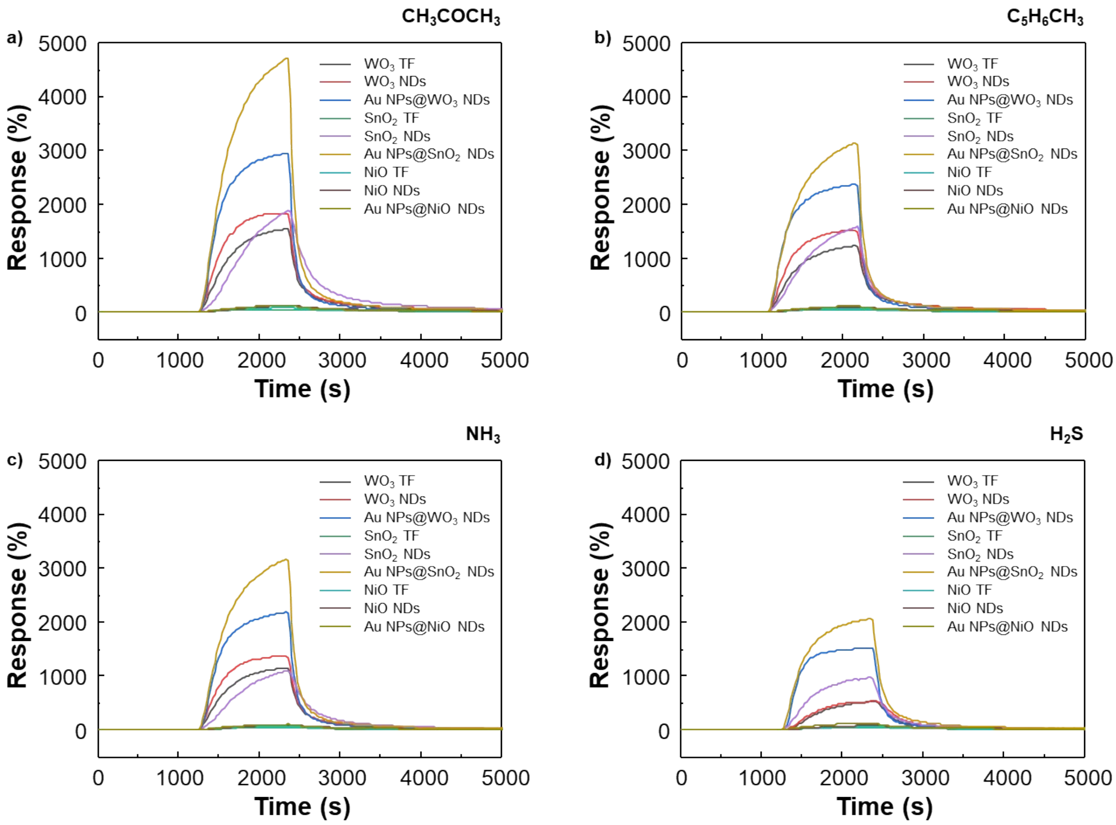

Fig. S6 Real-time response of the sensor array to 10 ppm a) CH_3COCH_3, b) $C_6H_5CH_3$, c) NH_3 and d) H_2S at 250 °C.

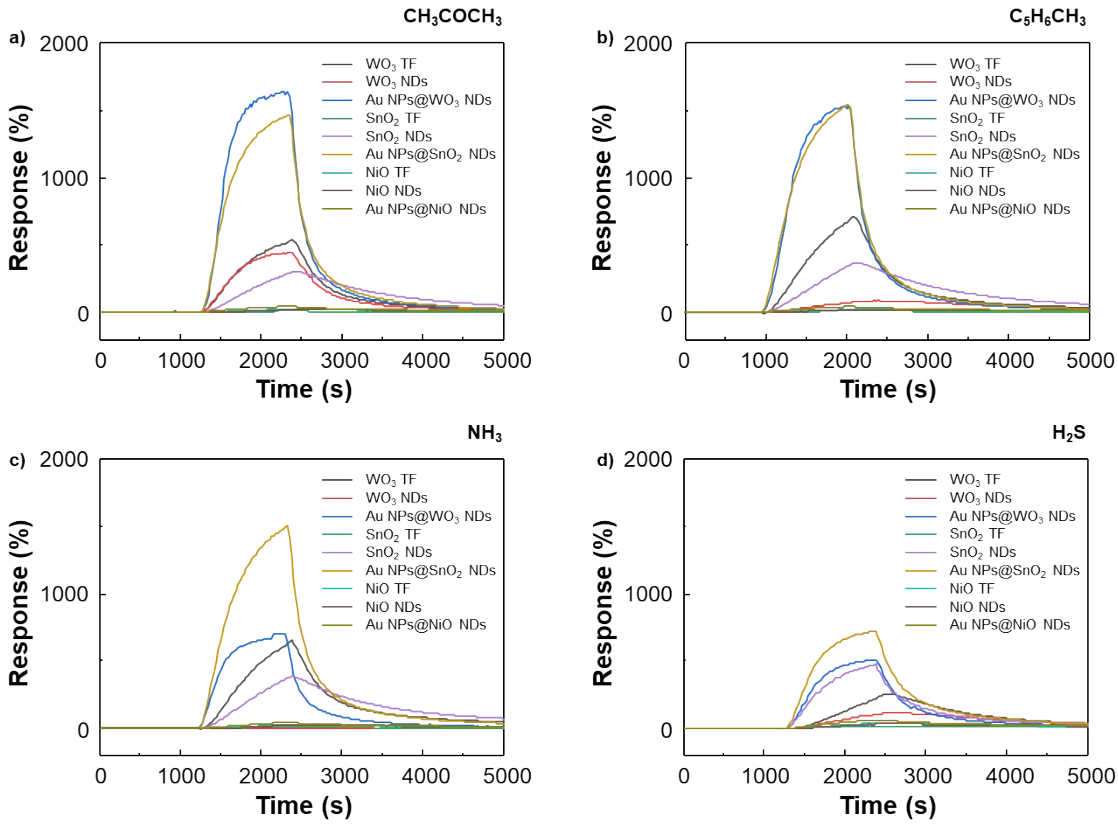

Fig. S7 Real-time response of the sensor array to 10 ppm a) CH_3COCH_3, b) $C_6H_5CH_3$, c) NH_3 and d) H_2S at 200 °C.

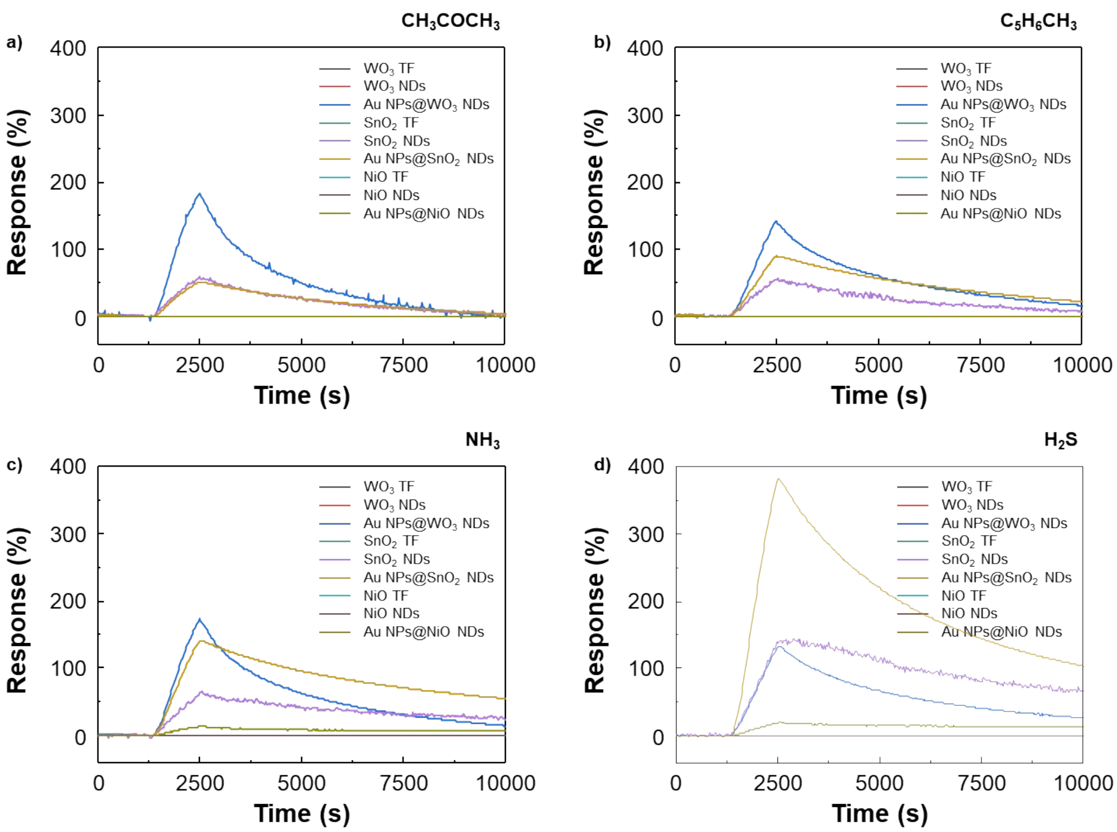

Fig. S8 Real-time response of the sensor array to 10 ppm a) CH_3COCH_3, b) $C_6H_5CH_3$, c) NH_3 and d) H_2S at 150 °C.

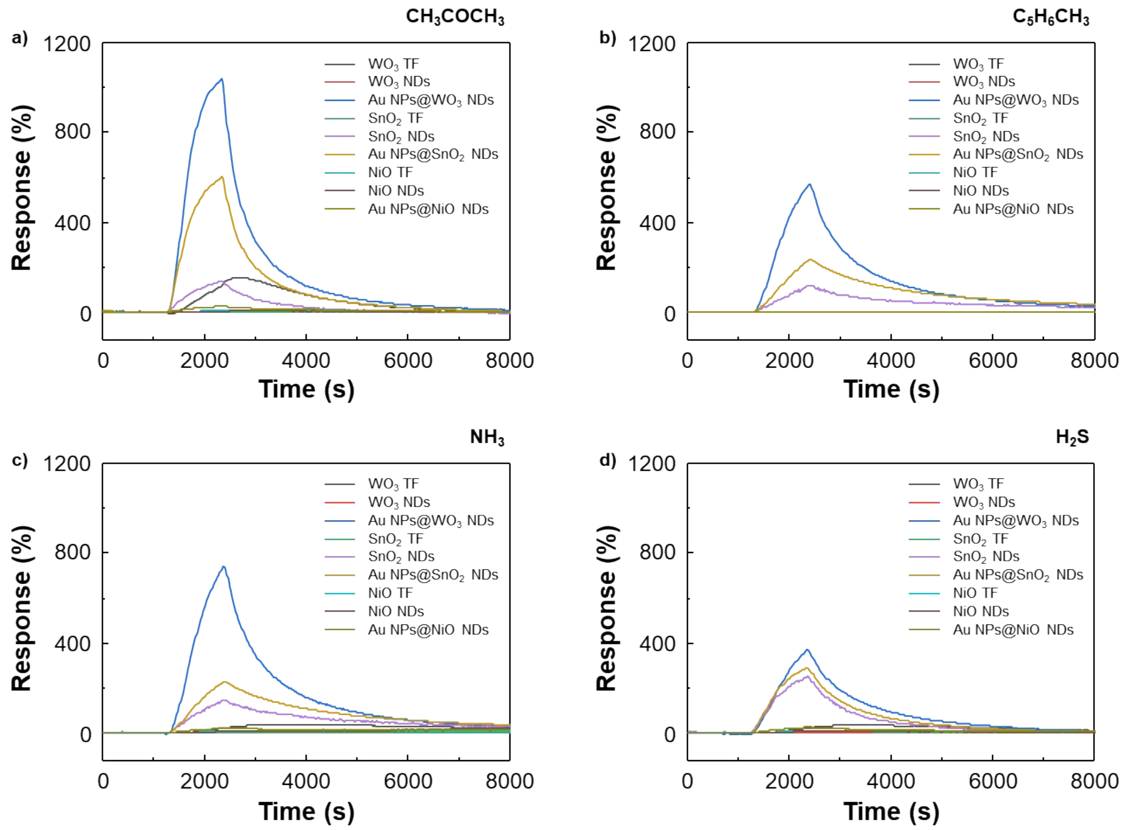

Fig. S9 Real-time response of the sensor array to 10 ppm a) CH_3COCH_3, b) $C_6H_5CH_3$, c) NH_3 and d) H_2S at 100 °C

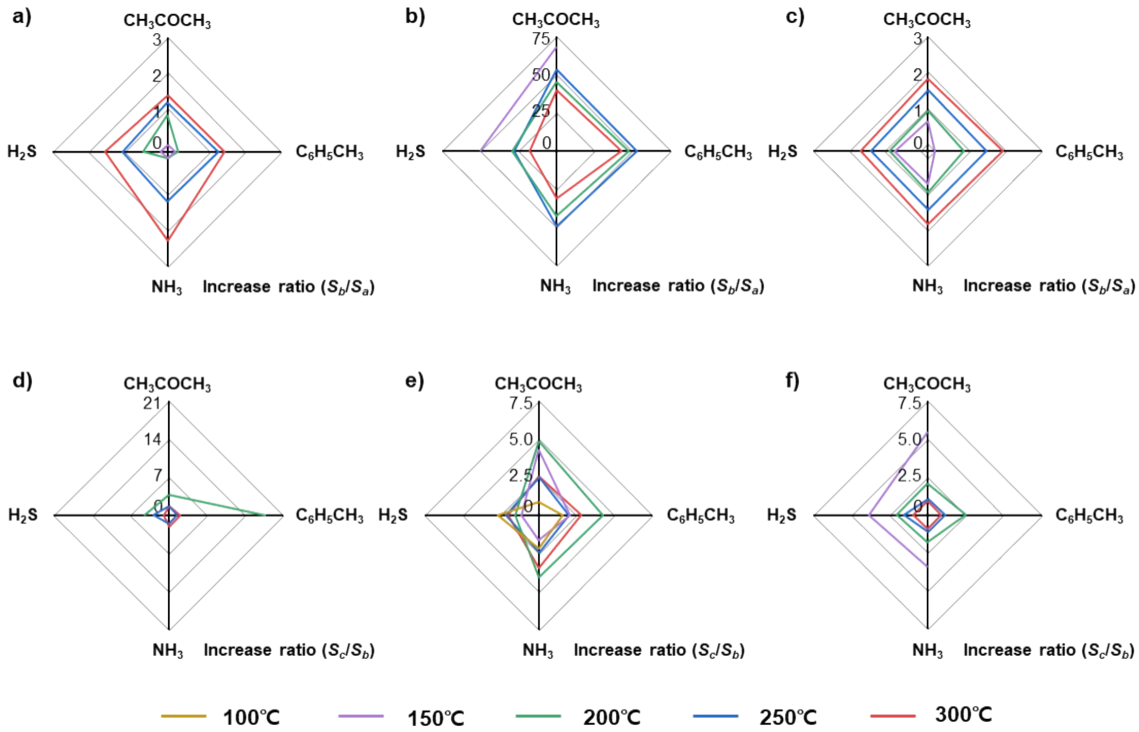

Fig. S10 Polar plots of the increase ratio (S_b/S_a) between the response of TFs and the NDs of a) WO_3, b) SnO_2, and c) NiO. Polar plots of the increase ratio (S_c/S_b) between the response of NDs and the Au NPs@NDs of d) WO_3, and e) SnO_2, f) NiO. S_a, S_b and S_c represent the responses of the TFs and NDs and Au NPs@NDs.

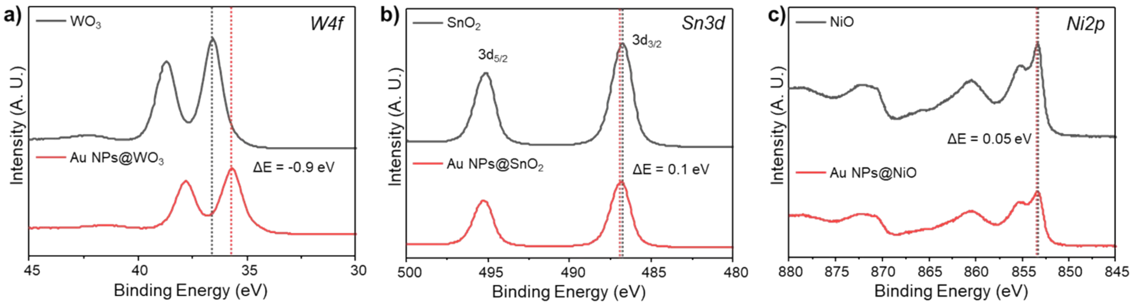

Fig. S11 XPS spectra for a) W4f of WO_3 and Au NPs@WO_3, b) Sn3d of SnO_2 and Au NPs@SnO_2 c) Ni2p of NiO and Au NPs@NiO.

Gas	Metal oxide	Type	Resistance (Ω) Temperature (℃) 100	150	200	250	300
CH_3COCH_3	WO_3	TF	-	2.62 x10^{7}	2.05 x10^{7}	1.64 x10^{7}	4.60 x10^{6}
		NDs	-	-	9.07 x10^{7}	7.92 x10^{7}	2.48 x10^{7}
		Au NPs@NDs	5.86 x10^{7}	6.23 x10^{7}	5.29 x10^{7}	4.40 x10^{7}	1.04 x10^{7}
	SnO_2	TF	-	3.49 x10^{2}	3.71 x10^{2}	4.76 x10^{2}	4.70 x10^{2}
		NDs	2.45 x10^{6}	3.18 x10^{6}	1.69 x10^{4}	6.90 x10^{4}	5.10 x10^{4}
		Au NPs@NDs	1.62 x10^{3}	2.33 x10^{4}	7.42 x10^{4}	2.19 x10^{5}	1.96 x10^{5}
	NiO	TF	-	6.70 x10^{5}	9.43 x10^{4}	2.00 x10^{4}	7.39 x10^{3}
		NDs	-	2.94 x10^{7}	4.57 x10^{6}	6.33 x10^{5}	1.63 x10^{5}
		Au NPs@NDs	-	1.20 x10^{7}	1.36 x10^{6}	2.15 x10^{5}	6.11 x10^{4}
$C_6H_5CH_3$	WO_3	TF	-	-	4.25 x10^{7}	1.28 x10^{7}	5.26 x10^{6}
		NDs	-	-	4.09 x10^{6}	6.48 x10^{7}	2.73 x10^{7}
		Au NPs@NDs	8.05 x10^{7}	6.16 x10^{7}	5.38 x10^{7}	3.20 x10^{7}	2.47 x10^{7}
	SnO_2	TF	-	-	3.88 x10^{2}	4.51 x10^{2}	4.66 x10^{2}
		NDs	5.49 x10^{6}	8.20 x10^{6}	3.68 x10^{4}	2.33 x10^{5}	2.98 x10^{5}
		Au NPs@NDs	3.06 x10^{3}	5.05 x10^{3}	8.42 x10^{4}	1.41 x10^{5}	2.26 x10^{5}
	NiO	TF	-	6.42 x10^{6}	8.26 x10^{4}	2.34 x10^{4}	7.73 x10^{3}
		NDs	-	-	3.78 x10^{6}	7.69 x10^{5}	1.69 x10^{5}
		Au NPs@NDs	8.29 x10^{7}	-	1.21 x10^{6}	2.46 x10^{5}	6.42 x10^{4}
NH_3	WO_3	TF	-	7.50 x10^{6}	8.82 x10^{6}	5.00 x10^{6}	2.15 x10^{6}
		NDs	-	-	3.39 x10^{6}	2.56 x10^{6}	1.42 x10^{6}
		Au NPs@NDs	2.15 x10^{7}	2.15 x10^{7}	8.88 x10^{6}	4.56 x10^{6}	2.03 x10^{6}
	SnO_2	TF	-	-	3.86 x10^{2}	4.36 x10^{2}	4.72 x10^{2}
		NDs	3.87 x10^{6}	5.79 x10^{6}	2.41 x10^{4}	5.02 x10^{4}	6.15 x10^{4}
		Au NPs@NDs	3.06 x10^{3}	4.44 x10^{3}	7.30 x10^{4}	1.75 x10^{5}	2.59 x10^{5}
	NiO	TF	-	3.88 x10^{5}	1.06 x10^{5}	2.32 x10^{4}	7.69 x10^{3}
		NDs	-	1.62 x10^{7}	8.93 x10^{6}	7.89 x10^{5}	1.65 x10^{5}
		Au NPs@NDs	8.08 x10^{7}	5.39 x10^{6}	1.41 x10^{6}	2.55 x10^{5}	6.48 x10^{4}
H_2S	WO_3	TF	-	4.76 x10^{7}	3.57 x10^{7}	1.96 x10^{7}	8.54 x10^{6}
		NDs	-	-	1.20 x10^{7}	9.53 x10^{6}	6.23 x10^{6}
		Au NPs@NDs	4.29 x10^{7}	3.43 x10^{7}	1.35 x10^{7}	6.67 x10^{6}	3.05 x10^{6}
	SnO_2	TF	-	4.14 x10^{2}	4.48 x10^{2}	5.27 x10^{2}	5.20 x10^{2}
		NDs	1.40 x10^{7}	8.91 x10^{6}	1.03 x10^{7}	1.53 x10^{7}	9.26 x10^{6}
		Au NPs@NDs	9.60 x10^{3}	5.74 x10^{3}	9.38 x10^{3}	1.88 x10^{4}	1.51 x10^{4}
	NiO	TF	-	5.18 x10^{5}	8.51 x10^{4}	2.02 x10^{4}	8.32 x10^{3}
		NDs	-	1.97 x10^{7}	3.00 x10^{6}	5.48 x10^{5}	1.67 x10^{5}
		Au NPs@NDs	3.13 x10^{7}	6.61 x10^{6}	9.60 x10^{5}	1.94 x10^{5}	6.57 x10^{4}

Table S1 Resistance of each sensors with operating temperatrue.

Δ (E_{TF} - E_{NDs}) (kJ/mol)	WO_3	SnO_2	NiO
CH_3COCH_3	-15.9	4.67	-14.8
$C_6H_5CH_3$	-46.3	0.902	-28.9
NH_3	-14.2	-1.92	-13.2
H_2S	10.0	6.22	-12.1

Table S2 Difference in the activation energy between TF and NDs (E_{TF} - E_{NDs}) of each metal oxide and gas combination.