Supporting information

In-situ synergistic crystallization-induced synthesis of novel Au nanostar-encrusted ZnO mesocrystals with high-quality heterojunctions for high-performance gas sensors

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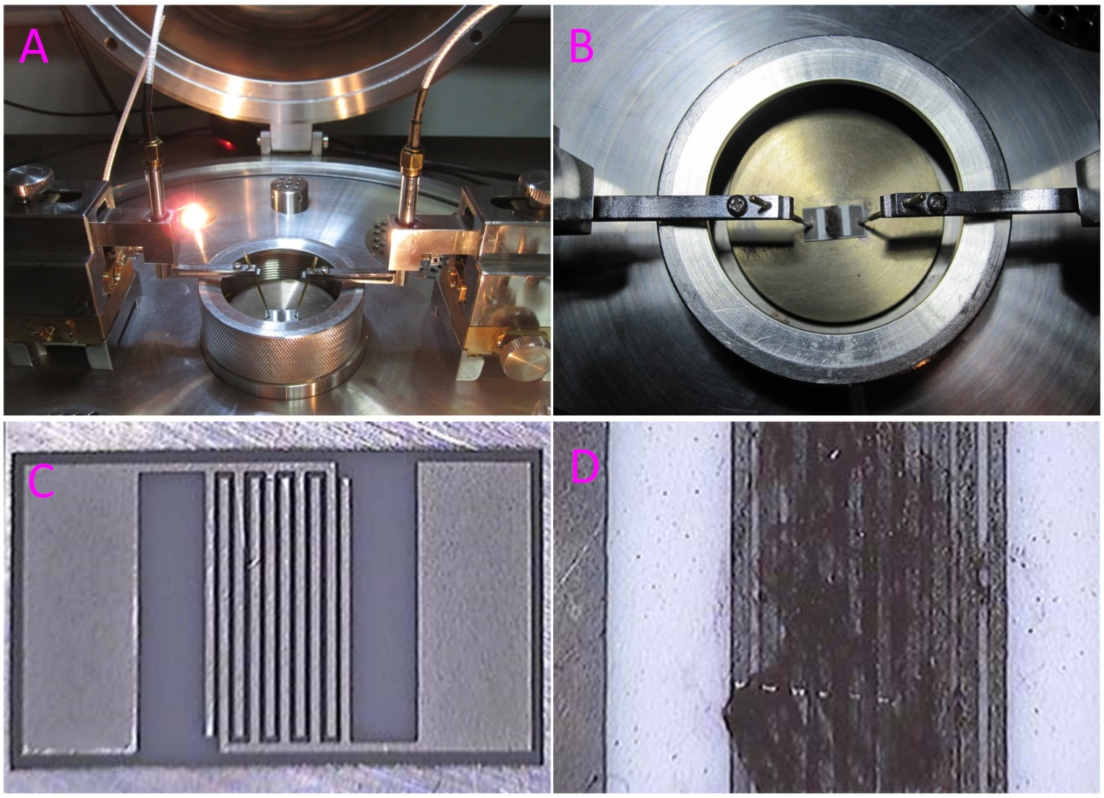


Fig. S1 Digital photographs of the intelligent gas sensing analysis system (CGS-1TP) used for sensor evaluation in current work. (A) Side view; (B) Top view; (C) The blank interdigital electrode; (D) The interdigital electrode coated with a film containing the synthesized Au NS/ZnO MC heterostructures.

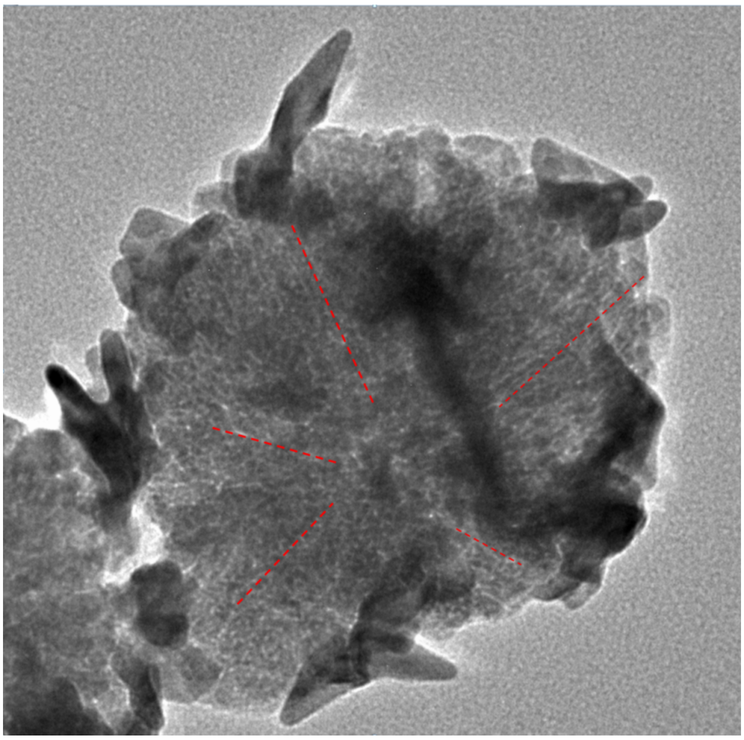


Fig. S2 The magnified TEM image of a single Au NS/ZnO MC heterostructure. The red dot line indicates the nanochannels consisting of interstitial pores formed by the oriented aligning of ZnO primary nanoparticles.

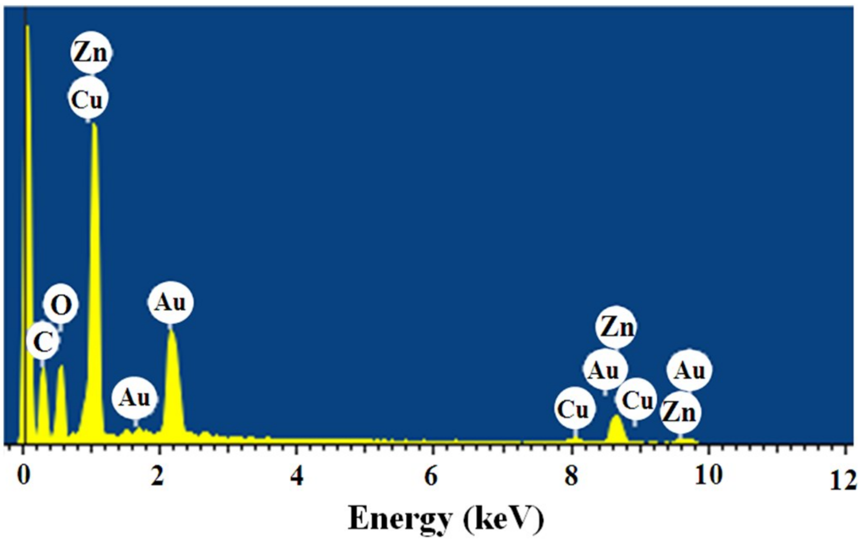


Fig. S3 EDS spectrum of the Au NS/ZnO MC heterostructures. The Cu and C elements in the spectrum are derived from copper grids and carbon film substrates used in the measurements, respectively.

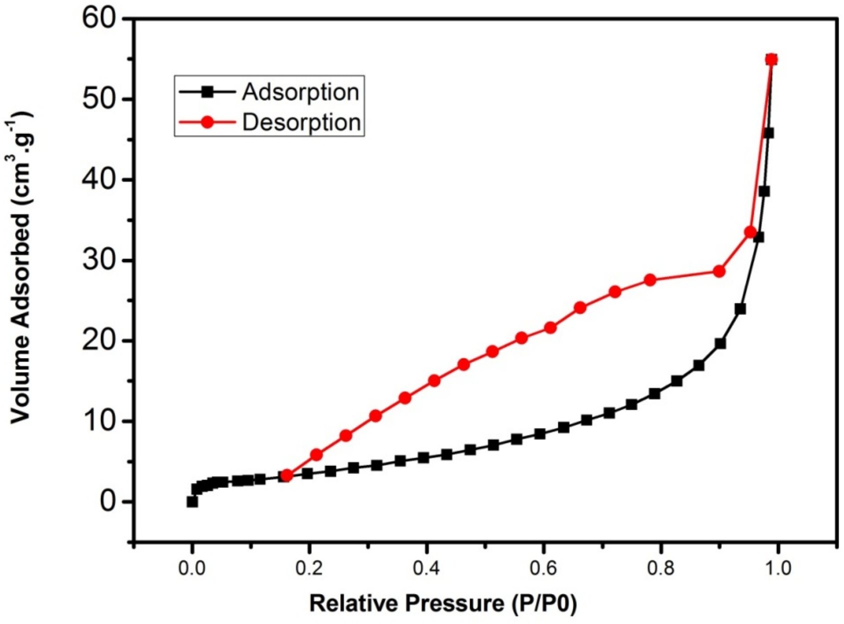


Fig. S4 The nitrogen adsorption-desorption isotherm curves of the Au NS/ZnO MC heterostructures at 200°C.

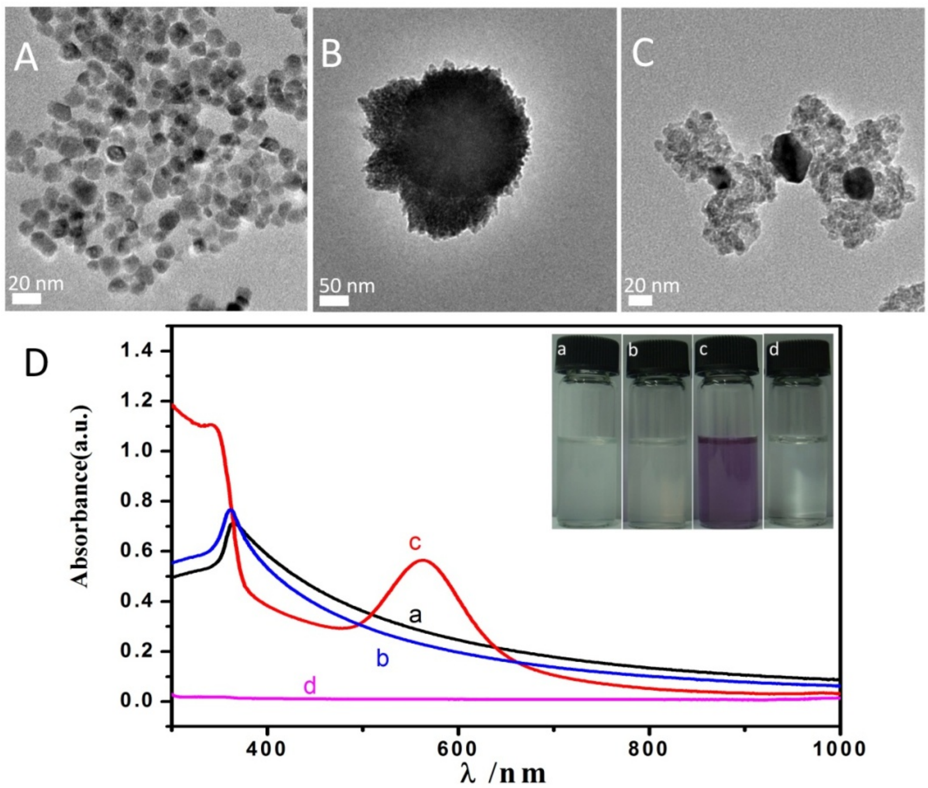


Fig. S5 TEM images (A-C) and UV-Vis absorption spectrum (D) of the products in control experiments with different reactant compositions: (A) DMF + $Zn(AC)_2$; (B) DMF + $Zn(AC)_2$ + HMTA; (C) DMF + $Zn(AC)_2$ + HMTA + $HAuCl_4$. Inset in (D) is the corresponding digital photographs of the product solutions.

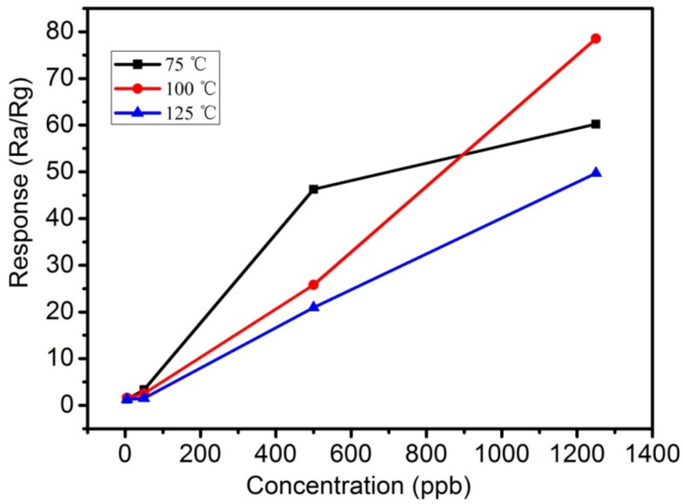


Fig. S6 Responses curves of the Au NS/ZnO MC sensor towards H_2S of different concentrations at 75°C, 100°C and 125°C, respectively.

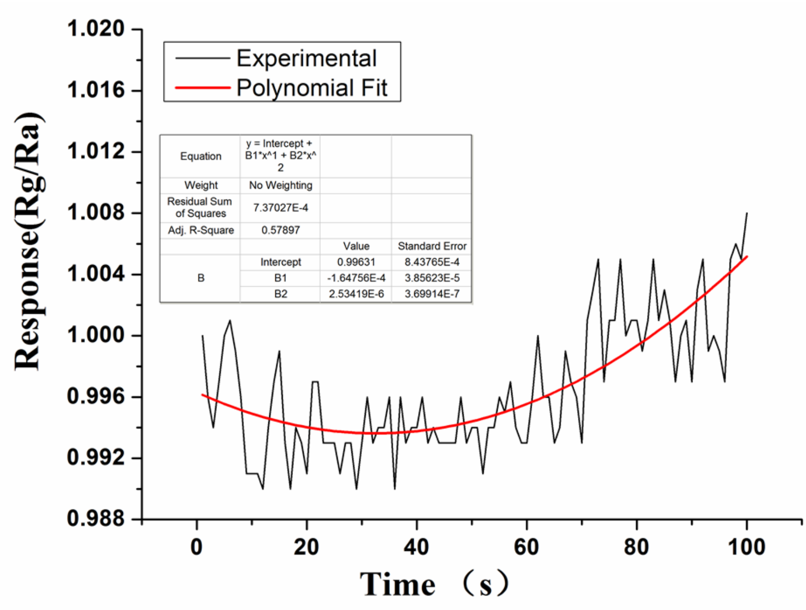


Fig. S7 The curve with detailed data obtained by polynomial fitting the first 100 response points in the response-time baseline of the Au NS/ZnO MC sensor before the injection of H_2S. The response values before and after fitting are recorded as R_E and R_F, respectively.

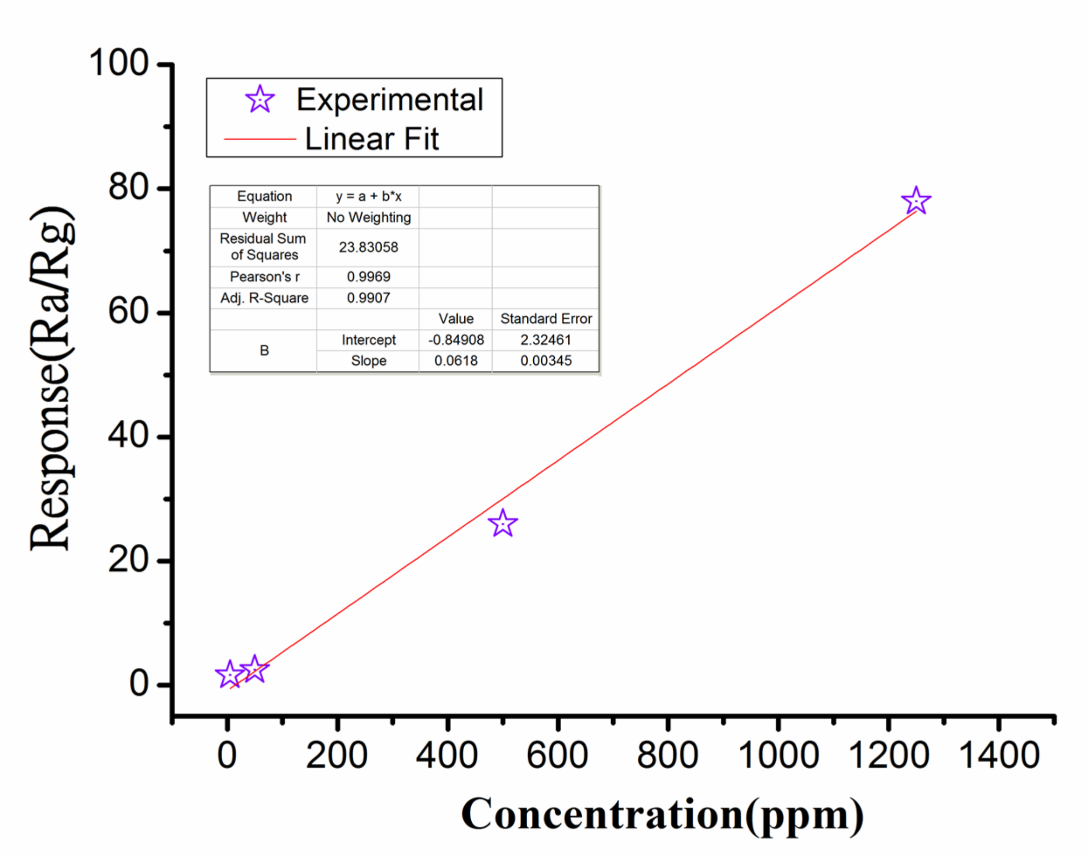


Fig. S8 The curve with detailed data obtained by linear fitting the response points in the H_2S sensing measurement of Fig. 6A. The equation is obtained after linear fitting: y= -0.84908 + 0.618x.

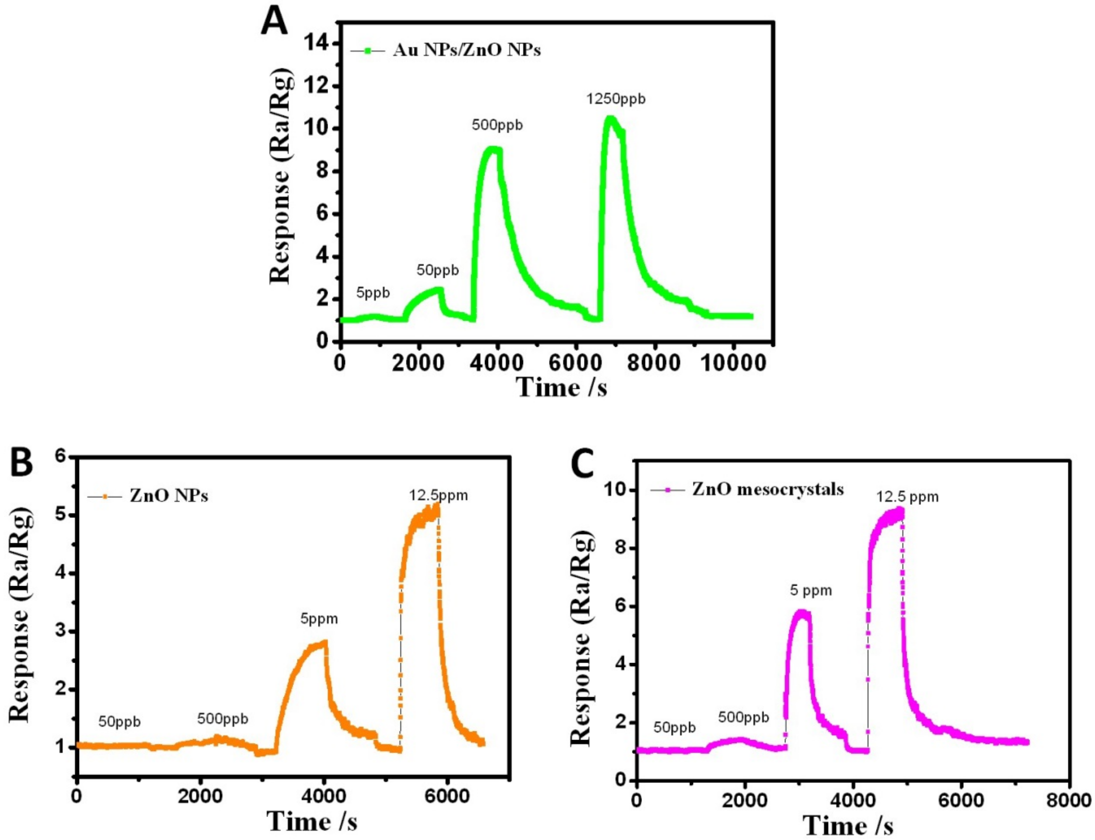
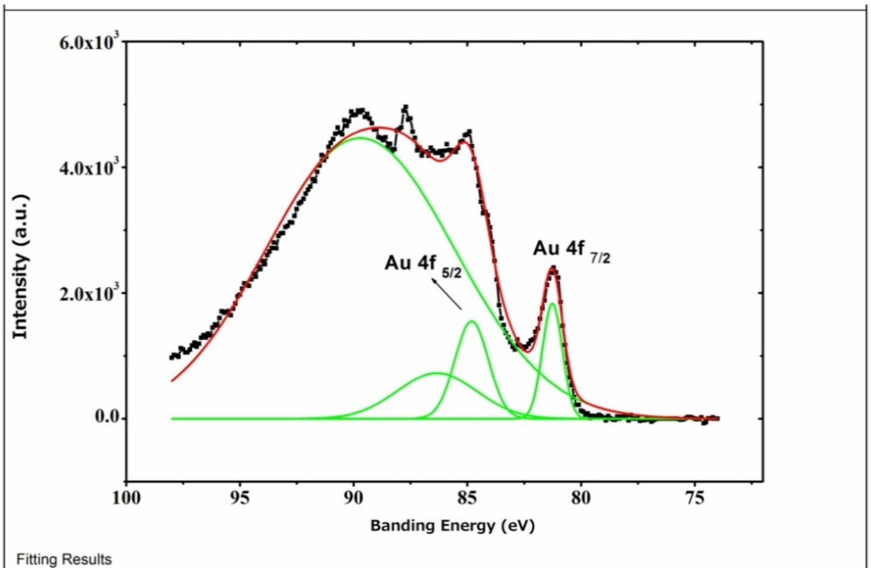


Fig. S9 Real-time responses of the H_2S sensors based on the Au NPs/ZnO NPs, ZnO nanoparticles and ZnO mesocrystals, respectively, at different gas concentrations and low working temperature of 100°C.



Fitting Results

Peak Index	Peak Type	Area Intg	FWHM	Max Height	Center Grvty	Area IntgP
1.	Gaussian	2009.75261	1.03012	1832.83641	81.26146	3.7689
2.	Gaussian	2863.91009	1.73514	1550.57295	84.81199	5.37071
3.	Gaussian	3194.32928	4.13676	725.41545	86.34064	5.99035
4.	Gaussian	45256.59561	9.74293	4464.80849	89.71017	84.87003

Fig. S10 XPS analysis of Au element for the Au NS/ZnO MC heterostructures.

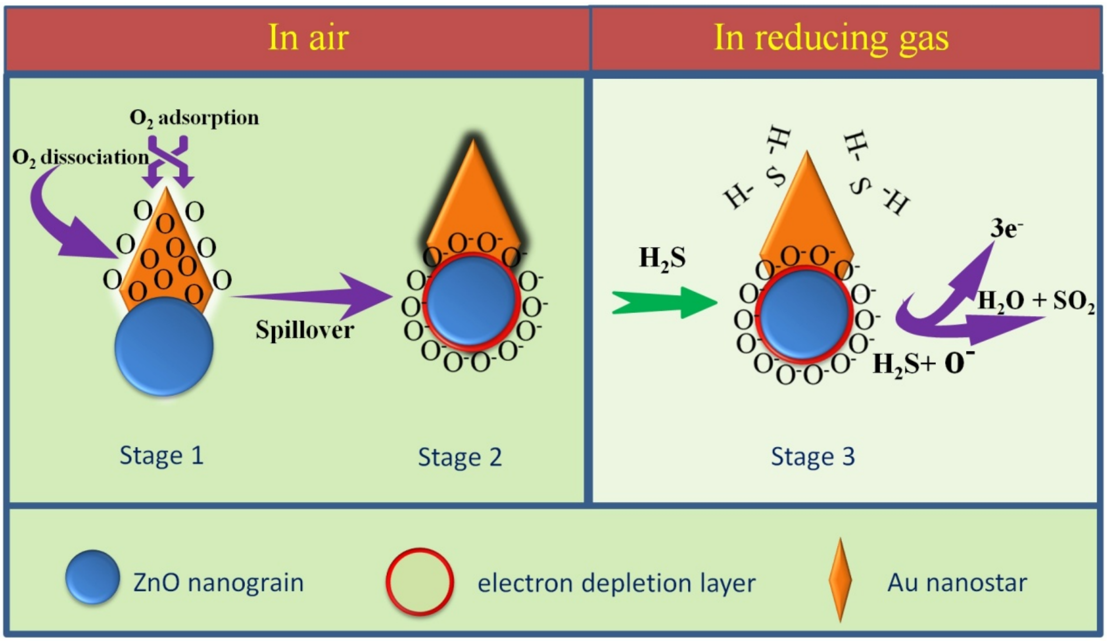


Fig. S11 Schematic illustration of the catalytic sensing mechanism over the Au NS/ZnO MC heterostructures for enhanced H_2S sensing performance.

S1. Calculation for detection limit:

According to the formula (1) below, and R_E and R_F obtained by the polynomial fit method in **Fig. S7**, V_χ^2 can be calculated,

$$V_\chi^2 = \Sigma (R_F - R_E)^2 \qquad (1)$$

$$V_\chi^2 = 0.000736903$$

In terms of the Root mean square (rms), i.e., formula (2), rms can be calculated as follows

$$rms_{noise} = \sqrt{(V\chi2/N)} \quad (N=100) \qquad (2)$$

therefore, rms_{noise}=0.0027;

Finally, according to the formula (3) and the value of slope (*0.618*) obtained from **Fig. S8**, the theoretic detection limit (DL) can be calculated:

$$DL(ppb) = 3*(rms_{noise}/slope) \qquad (3)$$

$$= 3*(0.0027/0.618) = 0.131$$

That is, DL(ppb)=0.131

Tab. S1 Results of control experiments conducted under different compositions in reaction systems. (For all reaction systems, the concentrations of reactants are the same as the one in typical synthetic protocol)

Compositions of reaction system		Products
a	DMF + $Zn(Ac)_2$	monodispersed ZnO nanoparticles
b	DMF + $Zn(Ac)_2$ + HMTA	ZnO mesocrystals comprised of oriented nanograins
c	DMF + $Zn(Ac)_2$ + HMTA + $HAuCl_4$	loose aggregates of ZnO nanograins + Au nanoparticles
d	DMF + $Zn(Ac)_2$ + HMTA + Formamide	no product
e	DMF + $Zn(Ac)_2$ + HMTA + $HAuCl_4$ + Formamide	The typical Au NS/ZnO MC heterostructures

Tab. S2 Responses of various ZnO-based products towards H_2S at different concentrations

H_2S concentration (ppb)		5	50	500	1250
Response	Au NSs/ZnO MCs	1.65	2.5	26	78
	Au NPs/ZnO NPs	1.2	2.5	9	10.5
H_2S concentration (ppb)		50	500	5000	12500
Response	ZnO mesocrystals	×	1.5	5.9	9.5
	ZnO NPs	×	1.3	2.8	5.2

Tab. S3 Response times of various ZnO-based products towards H_2S at different concentrations

H_2S concentration (ppb)		5	50	500	1250
Response time (s)	Au NSs/ZnO MCs	300	522	450	460
	Au NPs/ZnO NPs	375	688	458	354
H_2S concentration (ppb)		50	500	5000	12500
Response time (s)	ZnO mesocrystals	×	710	360	520
	ZnO NPs	×	730	937	730