Electronic Supplementary Information for

Decomposition of Hydrogen Sulfide in Non-Thermal Plasma Aided by Supported CdS and ZnS Semiconductors

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Experimental Section

Al_2O_3-supported metal oxide precursors were prepared by impregnation from their salts and Al_2O_3. A loading level of 10 wt% oxide precursor was chosen for each catalyst. For example, CdO/Al_2O_3 was prepared as follows: γ-Al_2O_3 extrudes (surface area: 270 m^2/g) were crushed and sieved to 40-60 mesh. 4.0 g $Cd(NO_3)_2 \cdot 4H_2O$ was dissolved in 15.0 mL de-ionized water. The resulting solution was mixed with 15.0 g γ-Al_2O_3 pellets, which were kept at room temperature for 8 h. Then the mixture was dried at 120 ^{o}C for 12 h, followed by calcination at 450 ^{o}C for 5 h. CdS/Al_2O_3 (surface area: 205 m^2/g) and ZnS/Al_2O_3 (surface area: 213 m^2/g) were obtained by sulfidation of the oxide precursors at 400 °C for 180 min in a 10% H_2S/Ar flow (80 mL/min). H_2S decomposition was carried out in a DBD reactor, which mainly consisted of a quartz tube and two electrodes (Fig. S1, ESI†). The high-voltage electrode was a stainless-steel rod with a diameter of 2.5 mm, which was installed in the axis of the quartz tube and connected to an alternating current supply. The grounding electrode was an aluminum foil, which was wrapped around the quartz tube and was connected to ground by a wire. 15.0 mL of Al_2O_3 or the supported catalyst were charged into the gap between the quartz tube and the high-voltage electrode. The reactor was immersed in an oil bath, which was kept at 120 °C. A flow of 20% H_2S in Ar (30 mL/min) was passed through the catalyst bed while a head-to-head voltage (10 kHz) was applied to generate a non-thermal plasma by DBD. The effluent was passed through a saturated NaOH solution trap to remove unreacted H_2S, and the hydrogen content was analyzed by an on-line gas chromatograph equipped with a thermal conductivity detector. At full conversion, the effluent was rechecked with lead acetate test paper. Specific input energy (SIE) was determined by the discharge power divided by gas flow rate. The discharge power was calculated using the Q-V Lissajous diagram, which was measured by a digital oscilloscope. The energy consumption cost in terms of hydrogen production was calculated from the SIE and H_2 yield. The supported metal sulfides, fresh and spent, were characterized by XRD (Rigaku D/Max 2400) to determine their crystal phases.
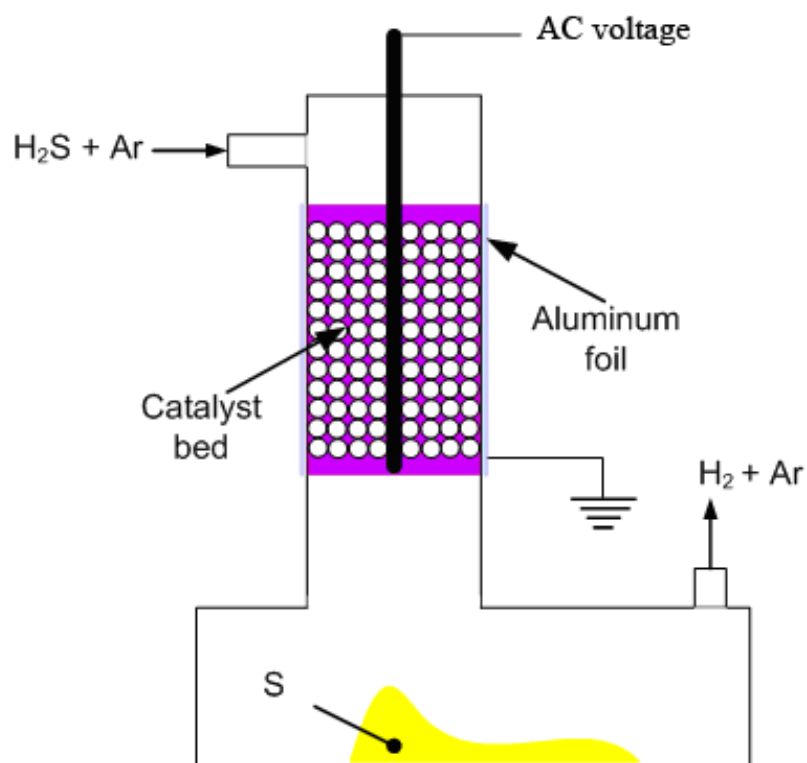
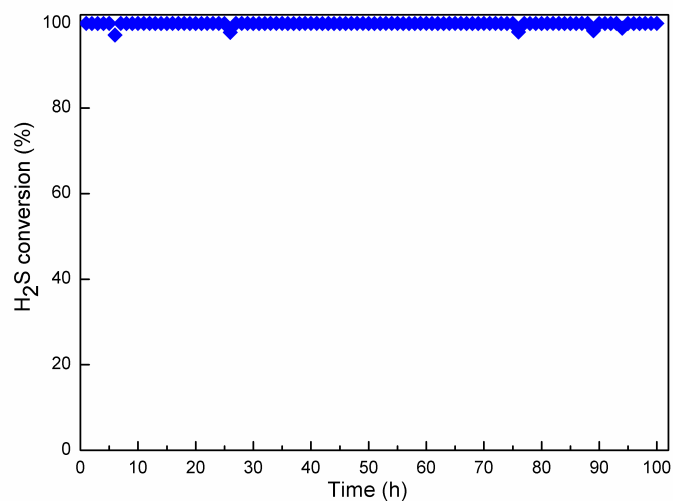**Fig. S1** Schematic diagram of the DBD reactor for plasma-induced H$_2$S decomposition.

Fig. S2 Variation of H$_2$S conversion with time in the plasma-induced splitting over CdS/Al$_2$O$_3$. Reaction conditions: SIE of 6 kJ/L; feed: 20% H$_2$S in Ar; GHSV 120 h^{-1}; catalyst bed volume: 15.0 mL.
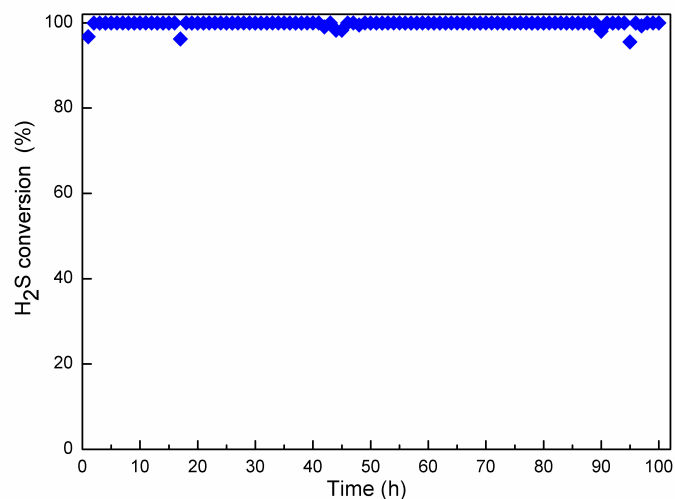
Fig. S3 Variation of H_2S conversion with time in the plasma-induced splitting over ZnS/Al_2O_3. Reaction conditions: SIE of 8 kJ/L; feed: 20% H_2S in Ar; GHSV 120 h^{-1}; catalyst bed volume: 15.0 mL.
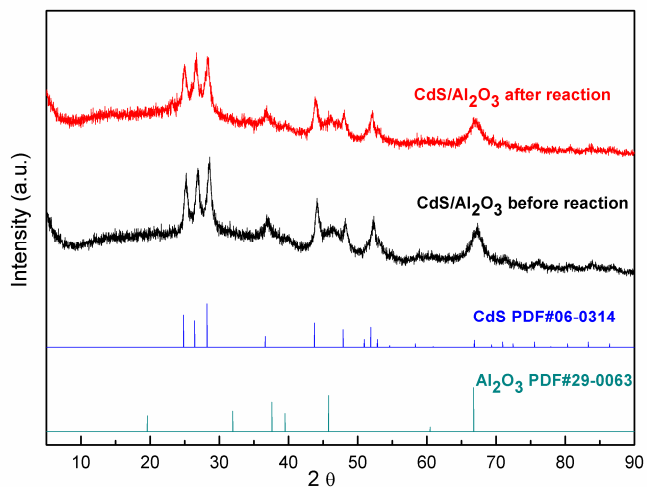

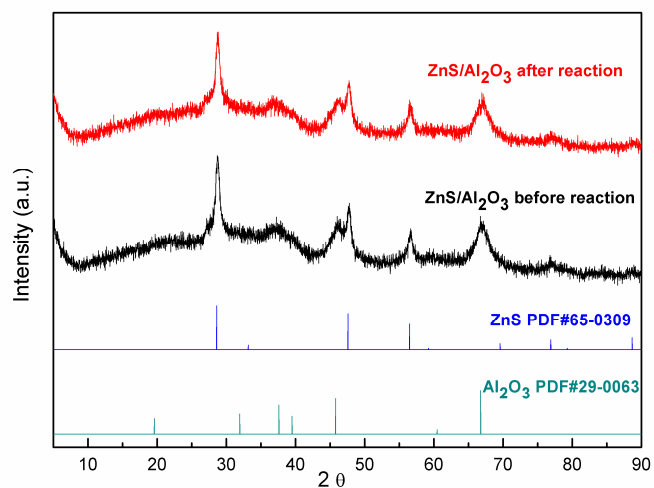**Fig. S4** XRD patterns of CdS/Al_2O_3 catalyst before and after H_2S decomposition reaction.

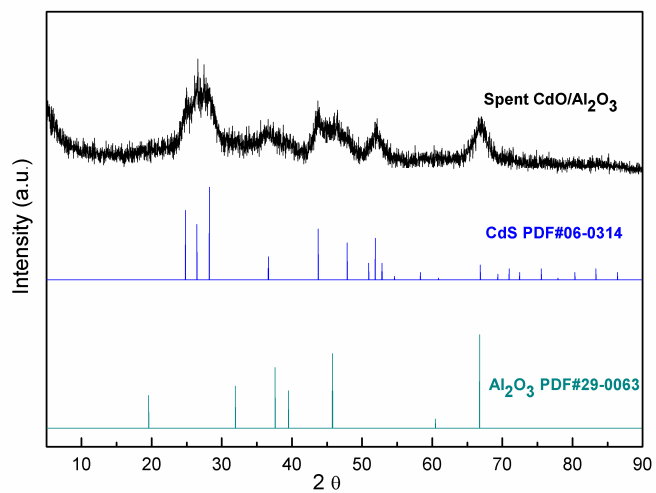**Fig. S5** XRD patterns of ZnS/Al$_2$O$_3$ catalyst before and after H$_2$S decomposition reaction.

Fig. S6 XRD patterns of spent CdO/Al$_2$O$_3$ catalyst.
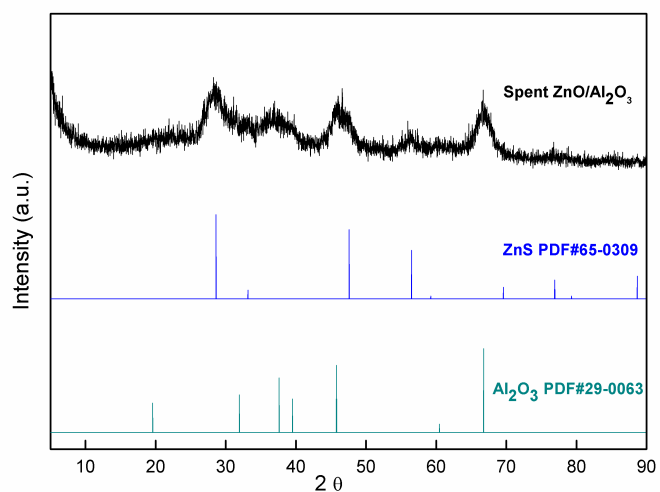
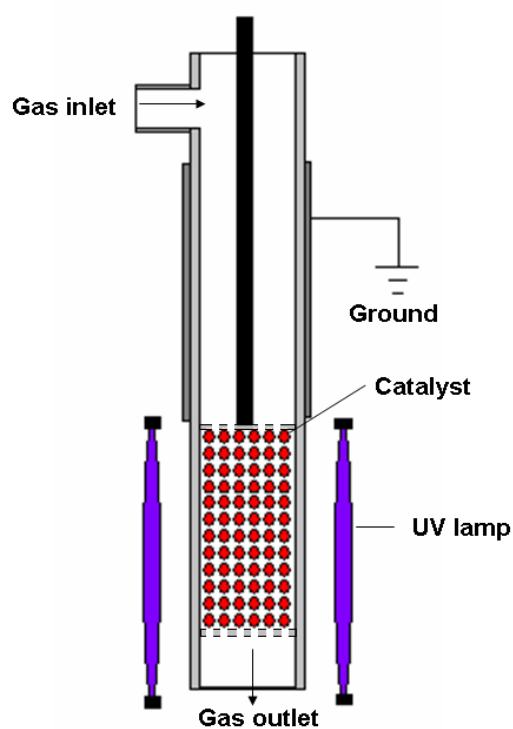**Fig. S7** XRD patterns of spent ZnO/Al$_2$O$_3$ catalyst.

Fig. S8 Schematic diagram of the DBD reactor with a downstream photocatalyst bed.
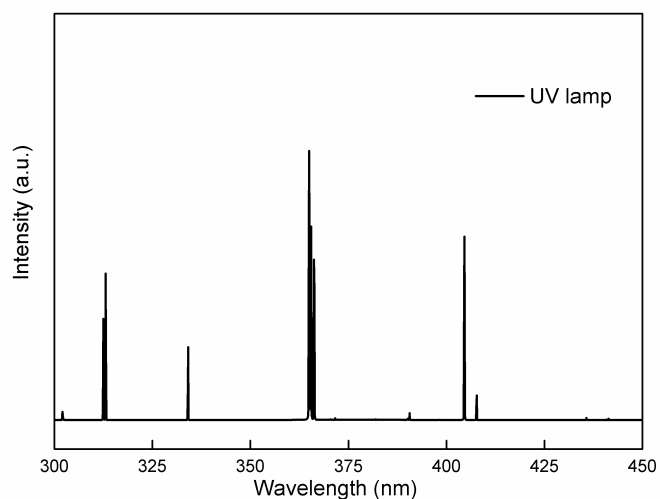
Fig. S9 Emission spectral analysis of the UV lamp.

Table S1 Conversion and dissociation energy cost as a function of SIE in the plasma-induced H_2S decomposition.

Material in gap	SIE (kJ/L)	H_2S conversion (%)	Dissociation energy cost (eV/H_2)
CdS/Al_2O_3	0.36	36.7	1.14
	0.55	42.9	1.50
	0.80	51.8	1.81
	1.05	61.0	2.01
ZnS/Al_2O_3	0.60	40.6	1.72
	0.95	45.1	2.46
	1.36	51.5	3.09
	1.70	56.5	3.52