Supplementary Material for

Designed ZnS/CdS/rGO composite nanosheet photocatalyst with multi-interface electron transfer for high conversion of CO_2

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1. Materials

Zinc nitrate hexahydrate ($Zn(NO_3)_2·6H_2O$), ethylenediamine ($C_2H_8N_2$), thiourea (CH_4N_2S), cadmium nitrate tetrahydrate ($Cd(NO_3)_2·4H_2O$), Sodium sulfide nonahydrate ($Na_2S·9H_2O$), ethanol (C_2H_5OH), potassium permanganate ($KMnO_4$), graphite powder, sodium nitrate ($NaNO_3$), hydrogen peroxide (H_2O_2) (30%), sulfuric acid (H_2SO_4), triethanolamine (TEOA). All the chemicals are of analytical grade that procured from Sinopharm Chemical Reagent Co., Ltd. (Shanghai, China) and used without further processing.

2. Photoelectrochemical Test

Electrochemical impedance spectroscopy (EIS), linear sweep voltammograms (LSV) and transient photocurrent responses of the catalysts were tested on an electrochemical workstation (CHI760E). The electrochemical system uses a standard three-electrode quartz battery, with 0.5 M Na_2SO_4 as the electrolyte solution, a Pt wire as the counter electrode, and a saturated calomel electrode (SCE) as the reference electrode. The preparation process of the working electrode is: 0.1 g of as-synthesized samples, 0.01 g of PVP (k = 5800) and 30 μL of oleic acid were put into 3 mL of ethanol to mixture uniform. Then, the suspension was spin-coated on FTO conducting glass (1 cm×1 cm). Electrochemical impedance spectroscopy (EIS) was performed in a 0.5 M Na_2SO_4 solution with a frequency range from 0.1 Hz to 100 kHz at 0.5 V with an ac amplitude of 5 mV. The transient photocurrent uses a 300W Xe-lamp as light source.

Fig. S1. The XRD images of rGO.
Fig. S2. The SEM images of ZnS (a) and ZnS/CdS (b).
Fig. S3. The DRS spectra and band gap energy of all ZnS@CdS/rGO samples
Fig. S4. CO_2 adsorption ability of ZnS, ZnS/CdS and ZnS/CdS/rGO, respectively.
Fig. S5. Contact angle test of ZnS, CdS, ZnS@CdS and ZnS@CdS/rGO photocatalyst.
Fig. S6. Brunauer-Emmett-Teller patterns of ZnS@CdS/1%rGO, ZnS@CdS/3%rGO, ZnS@CdS/5%rGO and ZnS@CdS/10%rGO sample (a) and corresponding pore-size distribution curves (b).
Fig. S7. The Mott-Schottky plot of ZnS (a) and the Mott-Schottky plot of CdS (b).
Table 1 Band gap energy of ZnS/CdS/1%rGO, ZnS/CdS/3%rGO, ZnS/CdS/5%rGO and ZnS/CdS/10%rGO photocatalysts.

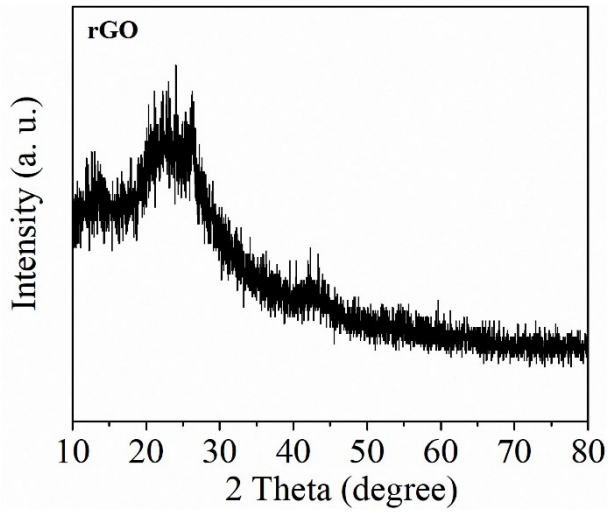

Fig. S1. The XRD images of rGO.

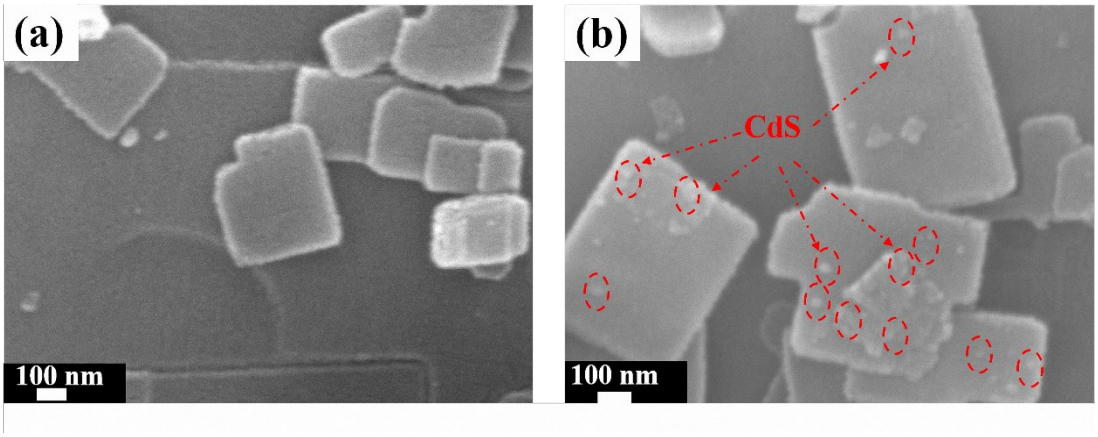

Fig. S2. The SEM images of ZnS (a) and ZnS/CdS (b).

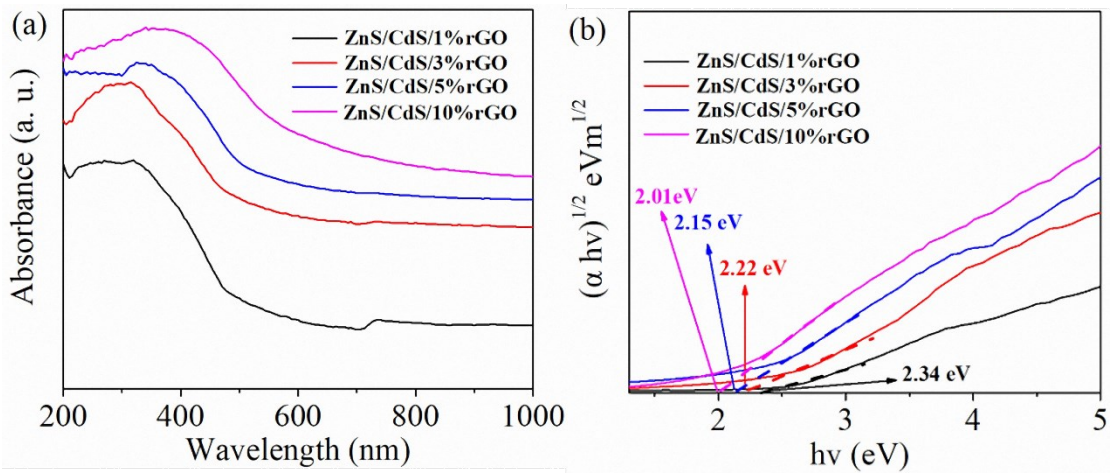

Fig. S3. The DRS spectra and band gap energy of all ZnS@CdS/rGO samples.

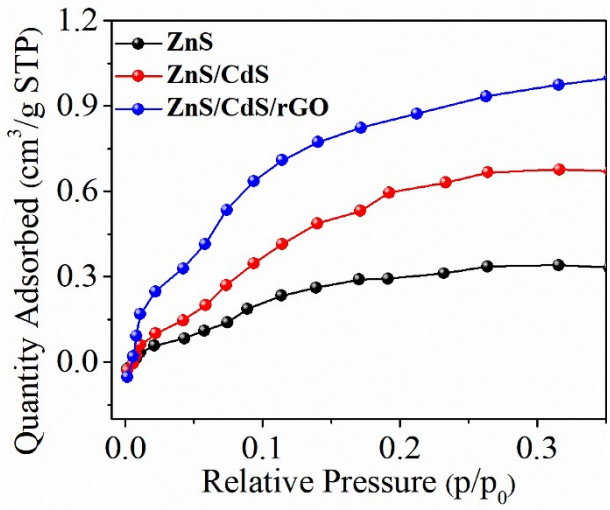

Fig. S4. CO_2 adsorption ability of ZnS, ZnS/CdS and ZnS/CdS/rGO, respectively.

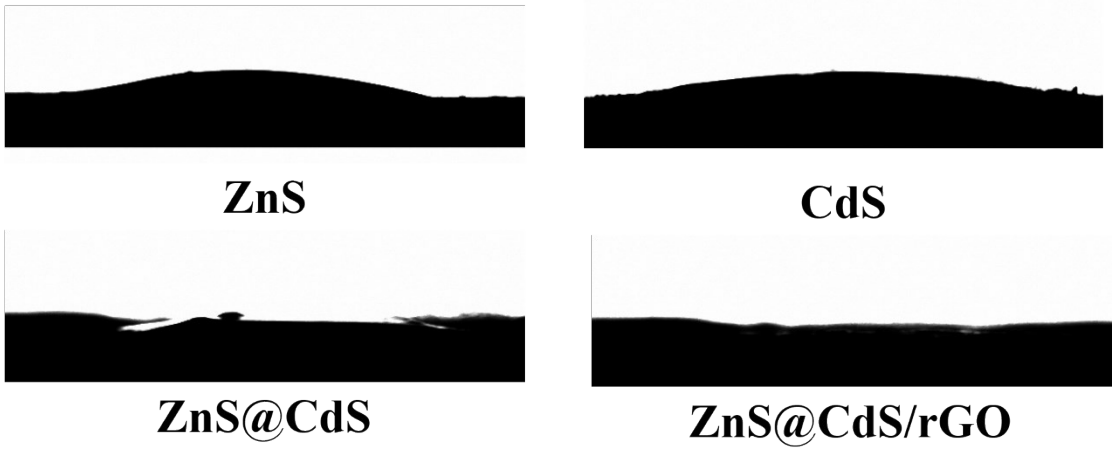

Fig. S5. Contact angle test of ZnS, CdS, ZnS@CdS and ZnS@CdS/rGO photocatalyst.

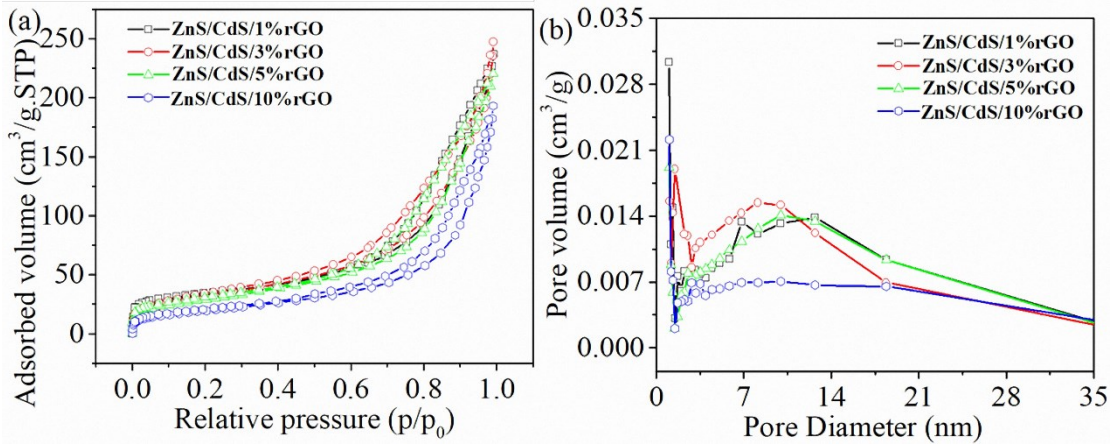

Fig. S6. Brunauer-Emmett-Teller patterns of ZnS@CdS/1%rGO, ZnS@CdS/3%rGO, ZnS@CdS/5%rGO and ZnS@CdS/10%rGO sample (a) and corresponding pore-size distribution curves (b).

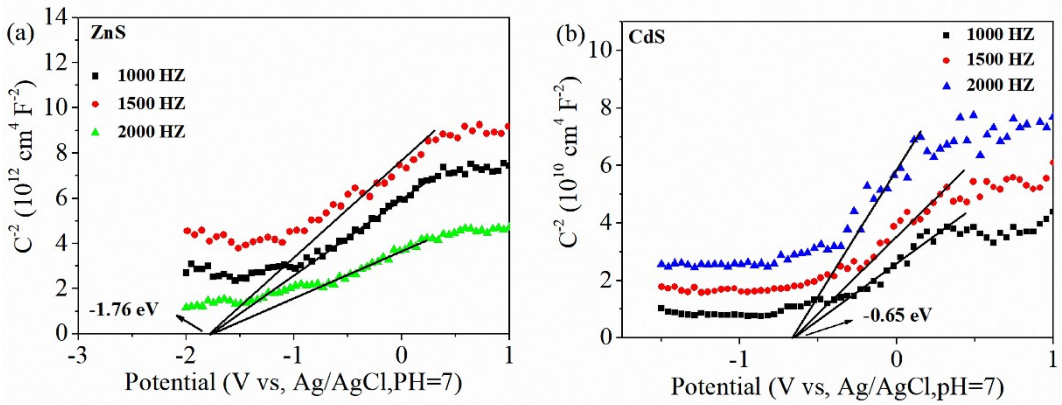

Fig. S7. The Mott-Schottky plot of ZnS (a) and the Mott-Schottky plot of CdS (b).

Table 1 Band gap energy of ZnS/CdS/1%rGO, ZnS/CdS/3%rGO, ZnS/CdS/5%rGO and ZnS/CdS/10%rGO photocatalysts.

Sample name	ZnS/CdS/1%rGO	ZnS/CdS/3%rGO	ZnS/CdS/5%rGO	ZnS/CdS/10%rGO
E_g (eV)	2.34	2.22	2.15	2.10