Supporting Information

Reduced graphene oxide modified Z-scheme g-C_3N_4/CdS photocatalyst with staggered structure for enhanced photoreduction of CO_2

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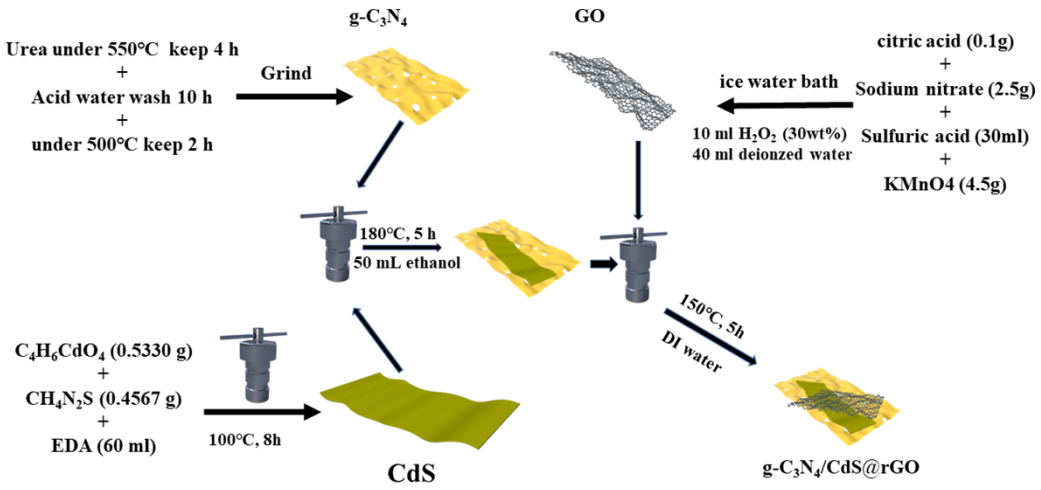
Experimental Section

Synthesis of 2D g-C_3N_4

Pour 10.0 g urea into a 100 mL crucible and calcine at 550 °C for 4 h in the muffle furnace. The obtained pale-yellow powder is poured into a beaker containing 200 mL of deionized water, add 0.5 mL of concentrated nitric acid, then stirring for 10 h with water bath at 80 °C. The suspension is repeatedly washed to neutrality and drying at room temperature. After the sample calcine at 500 °C for 2 h in the muffle furnace, the ultrathin g-C_3N_4 (named as CN) can be obtained.

Synthesis of 2D CdS

Weigh 1.0 mmol of cadmium acetate dihydrate and 0.6 mmol of thiourea, and pour them into a beaker containing 50 mL of ethylenediamine solution. Then it was stirred vigorously at room temperature for 40 min, and then transferred to an 80 mL reactor and kept at 100°C for 8 h. The resultant product was collected by keeping it at 10,000 rotation speed for 5 minutes, and washed repeatedly with water and ethanol. Finally, 2D CdS was obtained after drying at 60°C for 12 h.



Scheme. 1 The schematic diagram of the synthetic route of CN/CdS@rGO.

Characterizations

The Photoluminescence spectra collected by Quanta Master™ 40 (Photon Technology International, USA). XRD patterns were determined by a diffractometer XRD-6100 (Shimazu instruments, Japan). X-ray photo-electron spectroscopy (XPS) was identify by Escalab 250 Xi

(Thermo Fisher Scientific, USA). Transmission electron microscope (TEM) images were monitored by JEM-2100 (JEOL, Japan). The Fourier transform infrared spectroscopy (FT-IR) spectra was undertaken on Nicolet iS50 FT-IR (Thermo Fisher Scientific, USA). Photocurrent responses (PR) and Electrochemical impedance (EIS) were investigated using Versa STAT 3 (Princeton Applied Research, USA). Electron spin-resonance (ESR) spectroscopy was carried out by Electron Paramagnetic Resonance Spectrometer A300-10/12 (BRUKER, Germany). N_2 adsorption-desorption characteristics gained from BEL SORP mini (Microtrac BEL, Japan). UV–Visible diffuse-reflectance spectrum (UV–Vis DRS) were obtained by UV-3600Plus (Shimadzu, Japan). The composition of the product for photocatalytic CO_2 reduction was analyzed by GC 5890P (KeJie Instrument, China).

Table. S1 The specific surface area, pore volume and average pore diameter of CN, CdS, CS-65 and CSR-3.

	CN	CdS	CS-65	CSR-3
$a_{s,BET}$ (m^2 g^{-1})	49.492	107.81	78.236	88.481
V_m (cm^3(STP) g^{-1})	11.371	24.77	17.975	20.329
Average pore diameter (nm)	29.89	19.80	16.89	18.29
Current density ($\mu A \cdot cm^{-2}$)	1.05	5.08	6.56	14.10
Band gap (eV)	2.68	2.36	2.32	2.11

Results

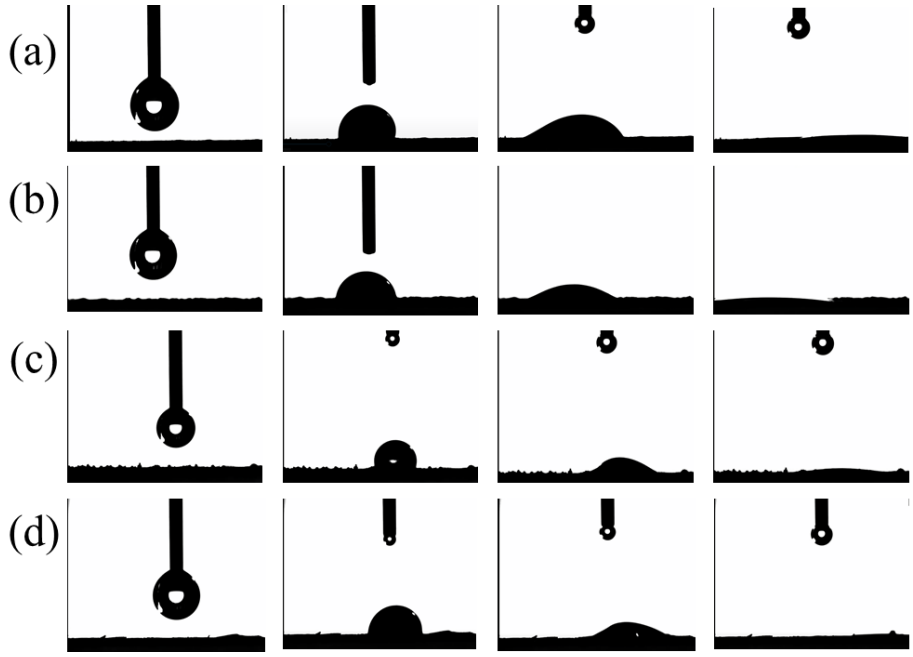


Figure. S1 The Hydrophilicity of (a)CN, (b) CdS, (c) CS-65 and (d) CSR-3.

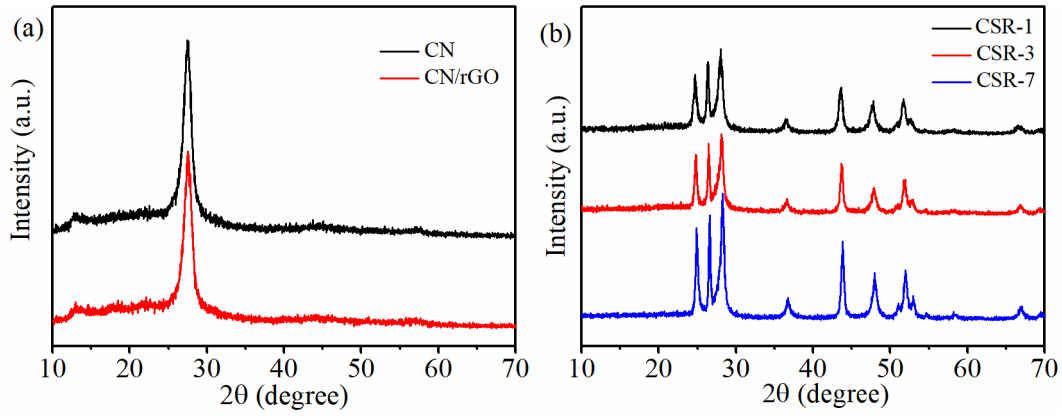


Figure. S2 The XRD of (a) CN and CN/rGO, (b) CSR-1, CSR-3 and CSR-7.

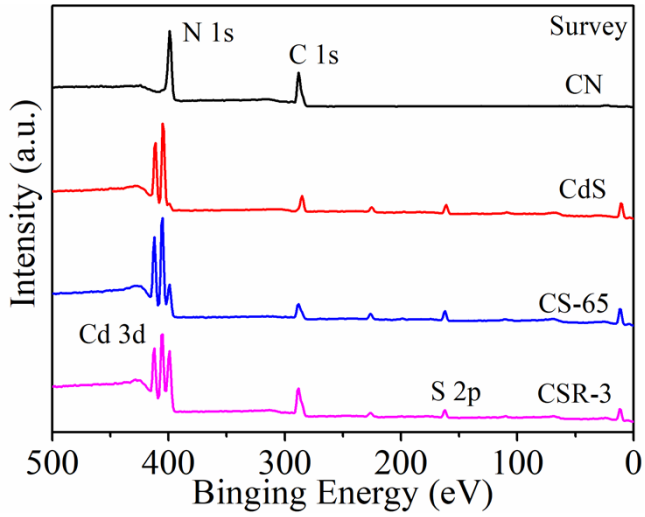


Figure. S3 The XPS Survey spectra of CN, CdS, CS-65 and CSR-3.

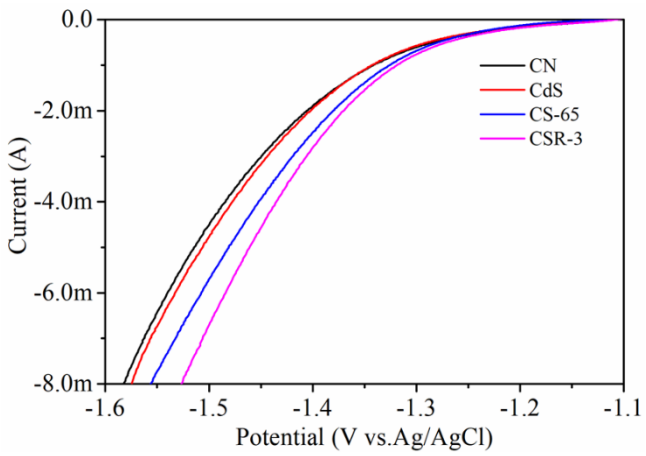


Figure. S4 The LSV spectra of CN, CdS, CS-65 and CSR-3.

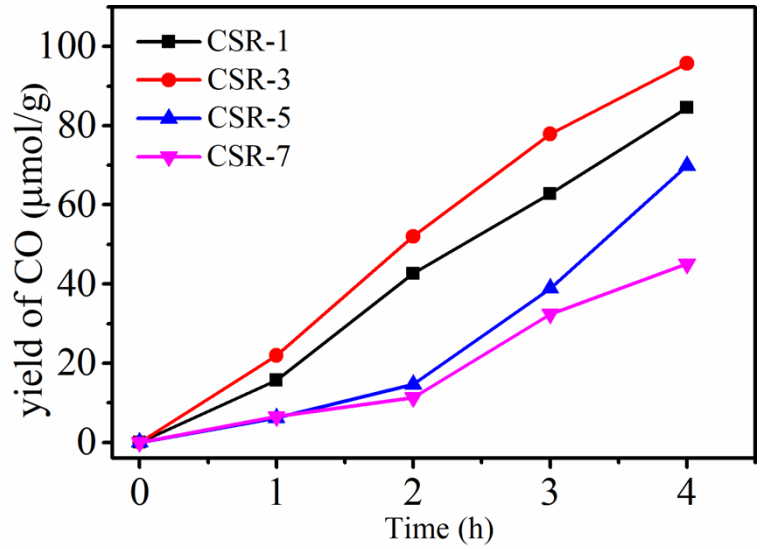


Figure.S5 The CO yield of CSR-1, CSR-3, CSR-5 and CSR-7.

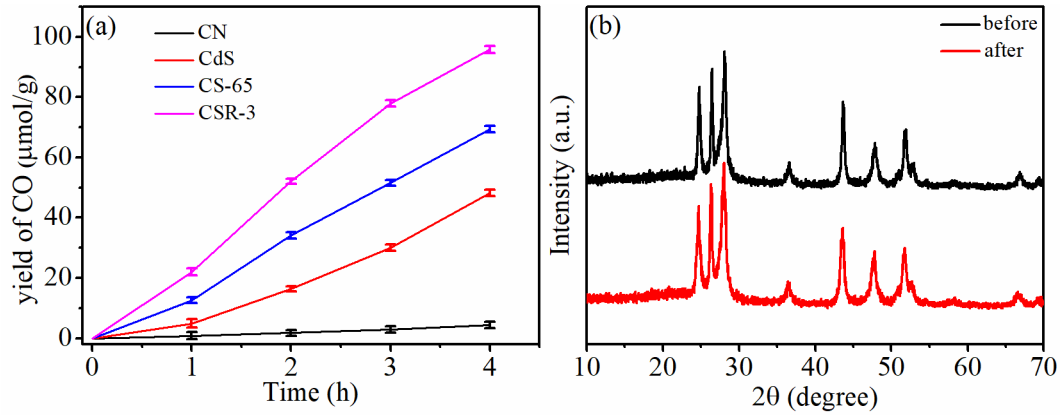


Figure. S6 (a) Deviation analysis of CO yield. (b)The XRD of CSR-3 before and after CO_2 reduction experiment.

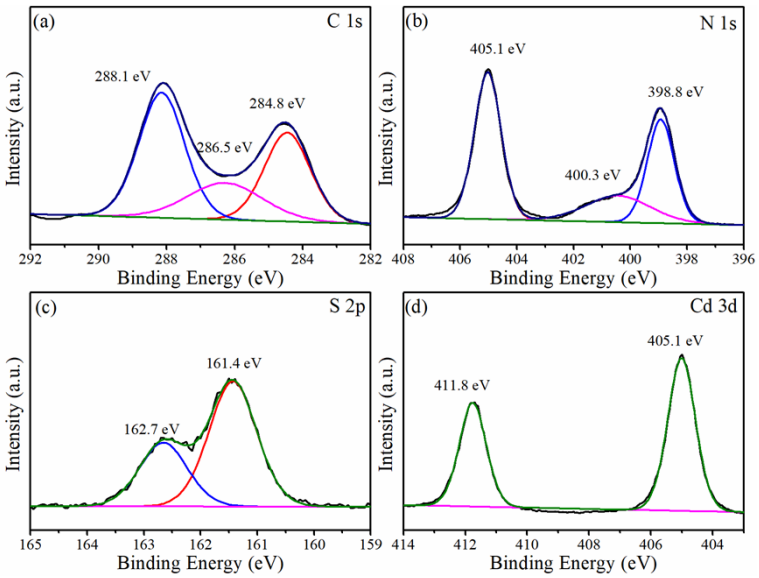


Figure. S7 XPS of CSR-3 after cycling experiment.

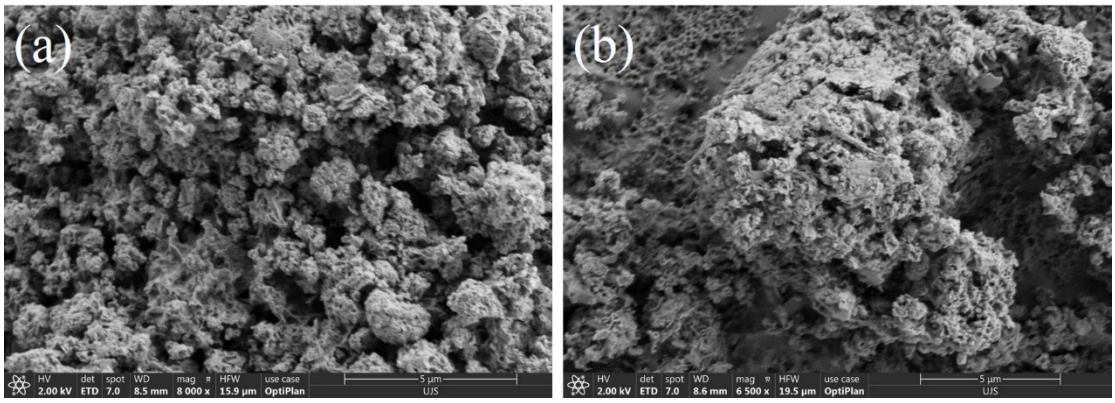


Figure. S8 The SEM of (a) CdS, (b) CSR-3 of after cycling experiment.

Photocatalytic CO_2 reduction

In the photocatalytic CO_2 reduction, 50 mg catalyst, 10 mL TEOA and 90 mL H_2O were poured into the quartz reactor and kept stirring. Pour CO_2 into the reaction kettle to remove impurities, then seal the reaction kettle and increase the pressure inside the kettle to about 0.4 MPa to maintain stability. Sampling and testing were performed every 1 h. Take the same steps and replace CO_2 with N_2 for experimentation to verify the source of carbon in the product.

Each 5 mL sample was analyzed by gas chromatography (the carrier gas was nitrogen). The injector temperature was 150°C, and the temperature of the column furnace is 550°C, and the detection temperature is 100°C.