Electronic Supplementary Material (ESI) for Sustainable Energy & Fuels.

Electronic Supplementary Information

Phase junction crystalline carbon nitride nanosheets modified with CdS nanoparticles for photocatalytic CO_2 reduction

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Experimental details

Materials characterization. Powder X-ray diffraction (XRD) tests were carried out on a Rigaku Minflex 600 Advance X-ray instrument (Cu Kα radiation, λ = 1.5406 Å) at a voltage of 40 kV and a current of 40 mA. A Nicolet IS50 FTIR spectrometer (Thermo Scientific) was employed to collect the Fourier transform infrared (FTIR) spectra. Field-emission scanning electron microscope (FESEM; Hitachi SU 8010) and transmission electron microscope (TEM; Philips, Tecnai 20 FEI) were used to examine the morphology and structure of the samples. The compositions of the samples were determined by energy-dispersive X-ray spectroscopy (EDS) attached to transmission electron microscope (TEM; Philips, Tecnai 20 FEI) and inductively coupled plasma emission spectrometer (iCAP7400). X-ray photoelectron spectroscopy (XPS) analysis and Ultraviolet photoelectron spectra were carried out on a PHI Quantum 2000 XPS system with C 1s binding energy (284.8 eV) as the reference and He I excitation (21.22 eV) as the monochromatic light source. N_2 and CO_2 adsorption-desorption isotherms characterizations were conducted on a Micromeritics ASAP2020 under liquid nitrogen (77K) temperature and ice/water mixture temperature (273K), respectively. UV-vis diffuse reflectance spectra (DRS) were obtained using a Lambda 950 UV-vis spectrometer equipped with an integrating sphere, and $BaSO_4$ was used as a reference. The room temperature photoluminescence (PL) characterizations were carried out on Hitachi F-7000 spectrophotometer. The fluorescence lifetime is determined by recording the time-resolved fluorescence emission spectra on a Deltapro Fluorescence Lifetime System. The electrochemical analysis carried out on Metrohm Autolab Electrochemical System, using a conventional three electrodes cell with Pt electrode and Ag/AgCl electrode as the counter electrode and reference electrode, respectively. The transient photocurrent response spectra were collected in 0.2 M Na_2SO_4 aqueous solution with a 300 W xenon lamp as a light source. The EIS were collected in 0.2 M Na_2SO_4 aqueous solution without light, and testing frequency range from 10 mHz to 1000 KHz.

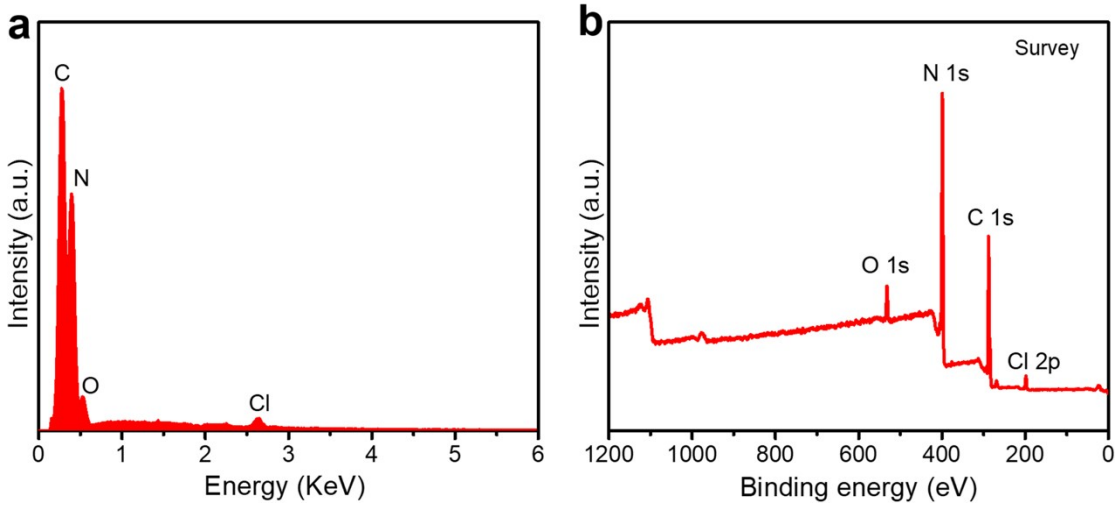

Fig. S1 (a) EDX and (b) XPS survey spectra of CCN NSs.

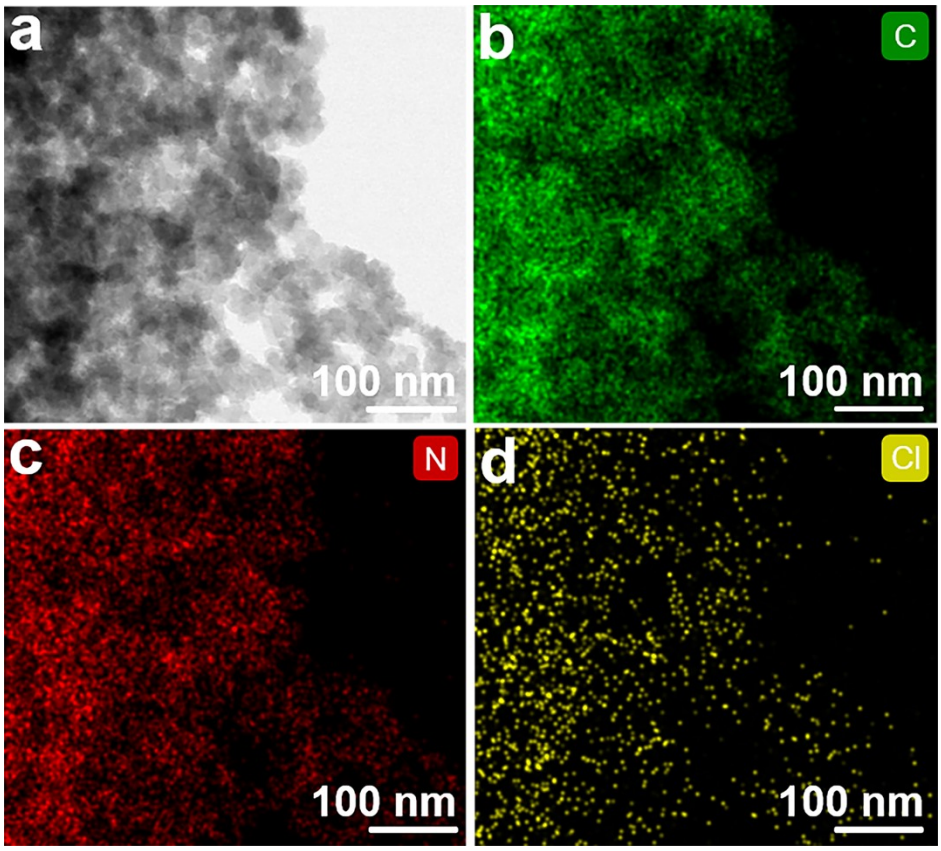

Fig. S2 (a) TEM image, (b-d) elemental mapping images of CCN NSs.

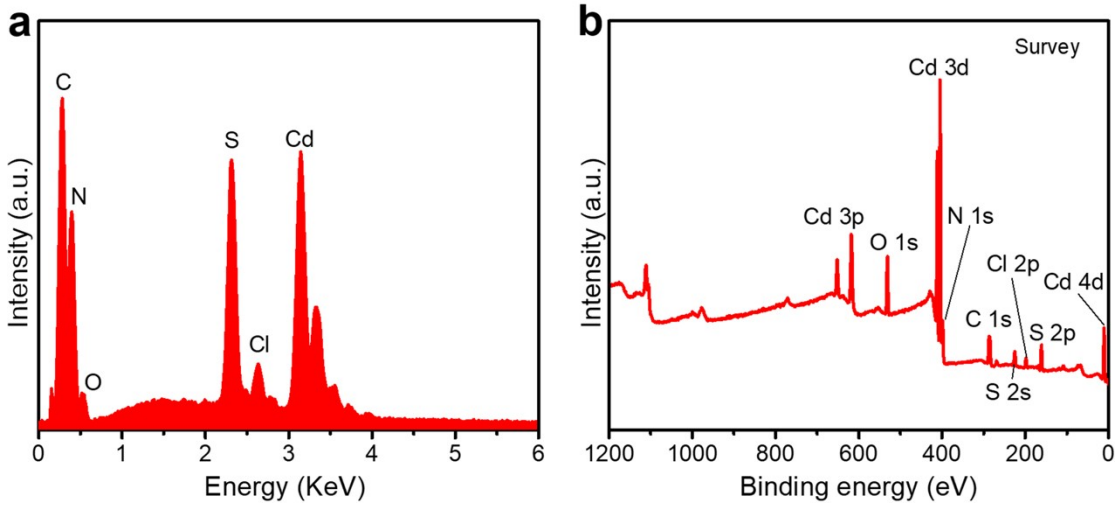

Fig. S3 (a) EDX and (b) XPS survey spectra of CCN/CdS.

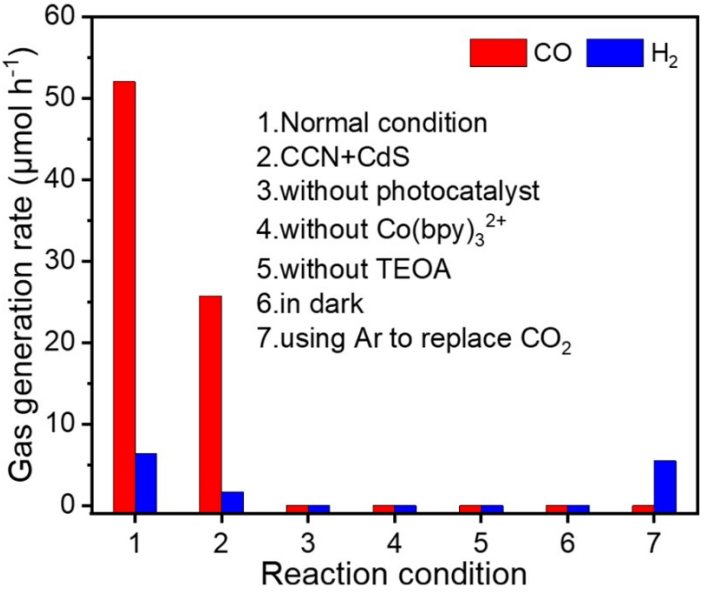

Fig. S4 CO_2 photoreduction performance under varied conditions

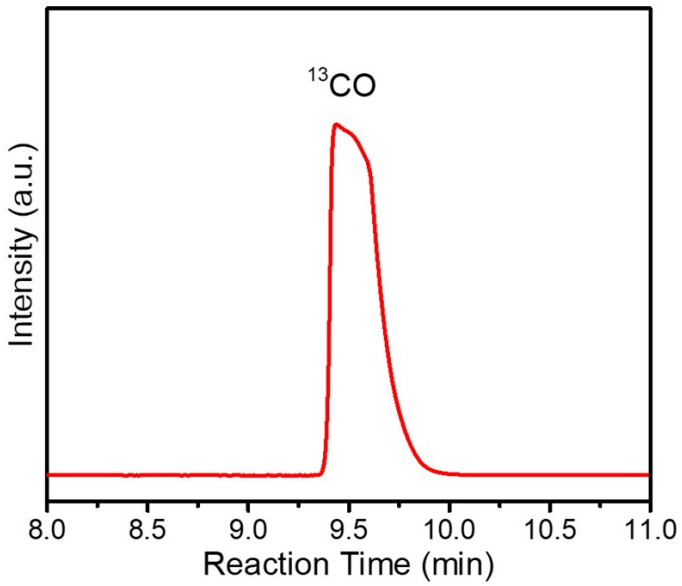

Fig. S5 GC spectrum of CO produced form $^{13}CO_2$ isotope experiment.

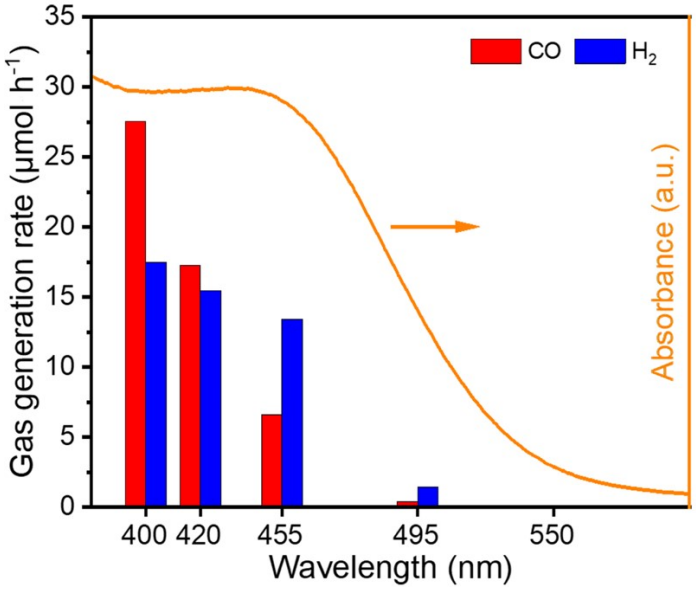

Fig. S6 Wavelength-dependent CO_2 reduction performance of CCN/CdS (the different wavelengths were obtained by applying specific long-pass cut-off filters).

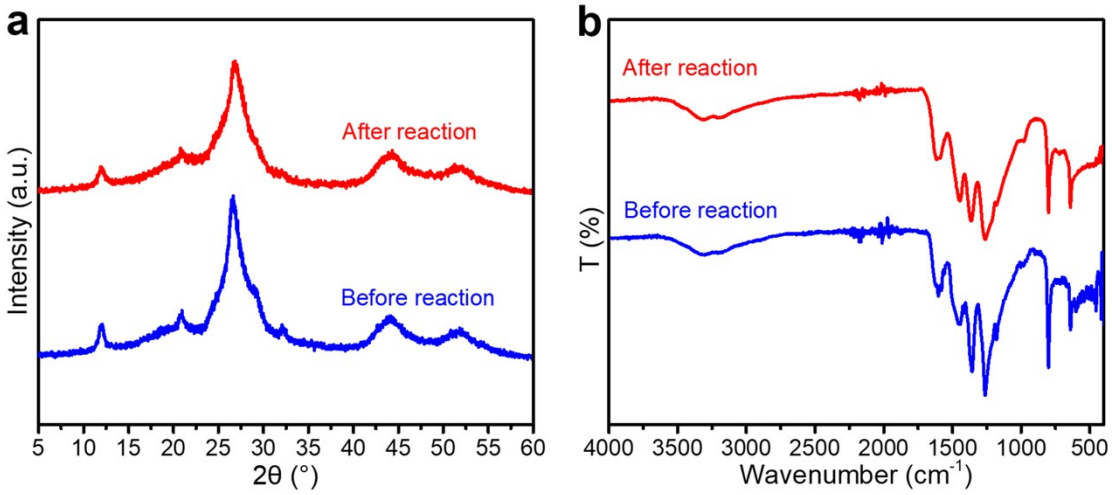

Fig. S7 (a) XRD patterns and (b) FT-IR spectra of fresh and used CCN/CdS samples.

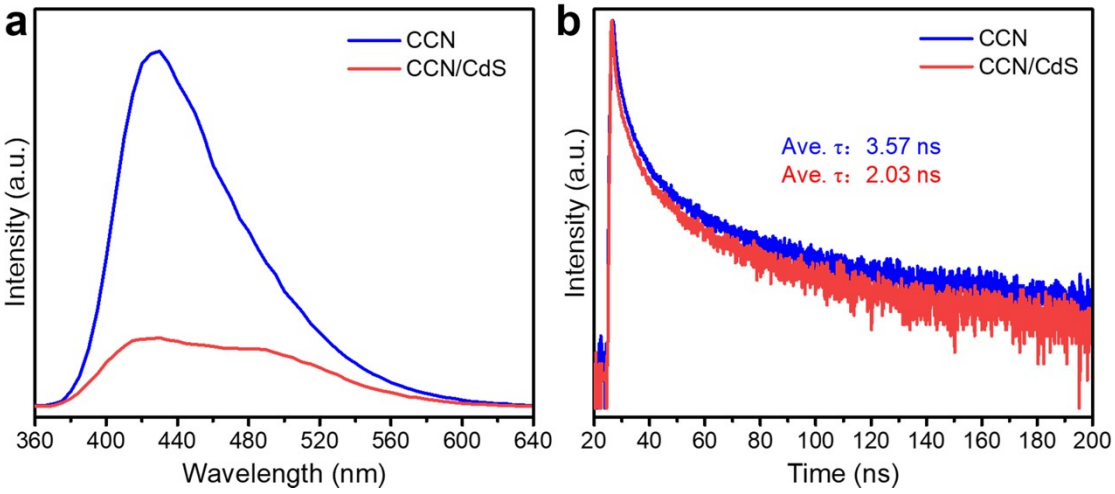

Fig. S8 (a) PL spectra of CCN and CCN/CdS using 395 nm monochromatic light as the excitation wavelength and (b) TRPL spectra of CCN and CCN/CdS.

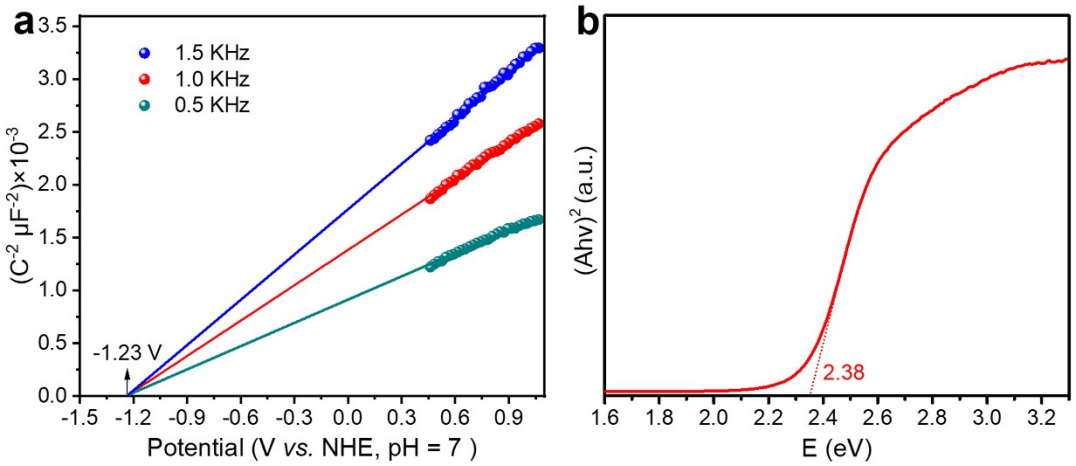

Fig. S9 (a) Mott-Schottky curves and (b) Tauc plot of CdS NPs.

Table S1. Then elemental contents of CCN NSs determined by TEM-EDX analysis.

Element	Atomic fraction (%)
C	33.82
N	65.44
Cl	0.65
O	0.07
K	0.02

Table S2. The AQE comparison of CNN/CdS with other catalysts for photocatalytic CO_2-to-CO reduction.

Catalyst	Light (nm)	AQE (%)	Ref.
CCN/CdS	λ = 420	10.8	This work
$Fe^{II}(dmp)_2(NCS)_2$	λ = 436	6.7	1
MP-TAP-CVs	λ = 420	4.80	2
mpg-C_3N_4	λ = 400	4.2	3
d_5-PCN-NSs	λ = 420	3.80	4
N-CP-D	λ = 420	3.39	5
3DOM CdSQD/NC	λ = 420	2.90	6
MPCN	λ = 420	0.86	7
Au(25)@CdS	λ = 420	0.61	8
TiO_2:Rh-LHCII	λ = 555	0.04	9

Table S3. Performance comparison of CNN/CdS with other catalysts for photocatalytic CO_2 reduction.

Catalyst	Light (nm)	CO Yield (μmol)	Ref.
CCN/CdS	λ＞300	52.0	This work
GaN nanowires	λ＞300	47.4	10
BiOI	λ＞300	42.9	11
H-Ga_2O_3	λ＞300	21.0	12
MPCN	λ＞300	7.9	7
g-C_3N_4/BiOBr	λ＞300	6.67	13
TiO_2:Rh-LHCII	λ＞300	2.8	9
TiO_2 particles	λ＞320	1.5	14
$In_2Ge_2O_7$	λ＞300	0.51	15

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