Electronic Supplementary Information

Amorphous/crystalline g-C₃N₄homojunction for visible light photocatalysis reaction with superior activity

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Experimental section

1. Synthesis of photocatalysts

Sample AGCN: 2g of melamine was placed in a porcelain boat and calcined at 650 °C for 2h in a conventional tube furnace under N₂ atmosphere at a temperature elevation rate of 2°C min⁻¹. The resulting sample was washed and centrifuged in deionized water and dried at 60 °C overnight. Finally, the yellow powder was obtained as amorphous g-C₃N₄ (AGCN).

Sample CGCN: 2g of melamine was placed in a porcelain boat and calcined at 600 °C for 4h in a conventional tube furnace under N_2 atmosphere at a temperature of about 5 °C min⁻¹. The yellowish powder of A_{600} GCN was obtained as a precursor. Afterward, 2 g of A_{600} GCN was placed in a porcelain boat and calcined at 750 °C for 1h in a conventional tube furnace under Ar atmosphere at a temperature of about 2 °C min⁻¹. The resulting sample was washed and centrifuged in deionized water and dried at 60 °C overnight. Finally, the dark yellow powder was obtained as crystalline g-C₃N₄ (CGCN).

Preparation of A-CGCN: A certain amount of CGCN and 2 g of melamine were mixed and calcined in a conventional tube furnace at 650 °C for 2 h under N₂ atmosphere at a temperature elevation rate of 2 °C min⁻¹. The resulting sample was washed and centrifuged in deionized water and dried at 60 °C overnight. Finally, the yellow powder was obtained as amorphous/crystalline metal-free g-C₃N₄homojunction (A-CGCN).

Preparation of AGCN+CGCN: For comparison, samples AGCN and CGCN were physically

mixed via an agate mortar for an hour, and the resulting mixed sample was named as AGCN + CGCN.

2. Characterization

Morphology observation is carried out by scanning electron microscopy (SEM) (QUANTA 250 FEG, FEI, America) and transmission electron microscopy (TEM) (FEIG2F20). The X-ray diffraction (XRD) patterns of as-synthesis samples were taken by an X-ray diffract meter (Bruker D8, Germany) with a Cu Kα radiation source and recorded in the 2θ range 10-80°. AUV/visible spectrophotometer (U-4100, Hitachi) was used to make the UV-visible diffuse reflectance spectra and absorption spectra. The photoluminescence (PL) spectra was obtained on Hitachi F-4600 Fluorescence spectrometer at room temperature using 400 nm as the excitation wavelength .X-ray photoelectron spectroscopy (XPS) and XPS valence band spectroscopy (VB XPS) data were used on Thermo ESCALAB250xi instrument with a monochromatized AlKα line source (200 W).

3. Photocatalytic performance test

3.1 Photocatalytic H₂ production

Photocatalytic H₂production was carried out in a Pyrex top-irradiation reaction vessel connected to a glass-closed gas circulation system.10mg prepared samples were dispersed in 100ml of an aqueous solution, the solution is composed of 10% triethanolamine and 90% deionized water, the mixed solution was added an appropriate amount of Pt provided by H₂PtCl₆·6H₂O. The mixed solution should be sonicated for at least 10 min before light exposure and the solution was evacuated before testing. During the test, the solution was irradiated under a 300 W Xe lamp with a cutoff filter ($\lambda > 420$ nm) while being stirred. The amount of evolved H₂ was detected by an online gas chromatography (Shimadzu GC-7920) with Argon as the carrier gas.

3.2 Photocatalytic degradation of organic pollutants

The AGCN, CGCN and A-CGCN were used to degradation rhodamine (RhB) under visible light. The samples (0.03g) were added into RhB solution (50ml, 10mgL-1). In order to get the equilibrium absorption state, the mixed solution was stirred in the dark for 60 minutes. The 300W Xe arc lamp was used to as the optical source and with a UV-cut off filter ($\lambda \ge 420$ nm). Using a UV/visible spectrophotometer, the absorbance of RhB was obtained.

3.3 Capture experiments

To prove the active substances that play a major role in the photocatalytic process,AgNO₃ (10 mM, 0.0849 g), Triethanolamine (TEOA, 0.0746 g), Para-benzoquinone (BQ, 0.05405 g) and isopropanol (IPA, 5 mL) were added to a 50 mL RhB solution dispersed with the photocatalyst to capture electron (e⁻),holes (h⁺), the superoxide radicals (O_2^{-}) and hydroxyl radicals(\cdot OH), respectively.

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Sample	Calcination temperature (°C)	Mass ratio of crystal phase $g-C_3N_4(X\%)$	
CGCN	750	100	
AGCN	650	0	
A ₆₀₀ GCN	600	0	
A-C _{0.5%} GCN	650	0.5	
A-C _{4%} GCN	650	4	
A-C _{6%} GCN	650	6	
A-C _{10%} GCN	650	10	
A ₍₅₅₀₎ -CGCN	550	0.5	

 Table S1 Preparation conditions of samples



Fig. S1 N₂ adsorption-desorption isotherms and the corresponding Barrett- Joyner-Halenda pore-size distribution of AGCN, A-CGCN and CGCN.

Table S2 Specific surface area and pore size of samples AGCN, CGCN and A-CGCN. S, Specificsurface area and D, diameter of pore.SampleS (m²/g)D (nm)

Sample	$S(m^2/g)$	D (nm)
AGCN	57.7	6.2
CGCN	119.1	7
A-CGCN	87.6	4.8



Fig. S2 XPS spectra of sample A-CGCN.



Fig. S3 XPS spectra of sample AGCN.



Fig. S4 XPS spectra of sample CGCN.



Fig. S5 Photoluminescence spectra of samples AGCN, CGCN and A-CGCN.



Fig. S6 (a) RhB degradation curves and (b) degradation fitting histogram of samples under visible light ($\lambda > 420$ nm). Sample AGCN*is just heated in the dark without giving illumination for comparison.



Fig. S7 (a) H₂ production curves and (b) apparent rate constants for H₂ evolution of samples A-CGCN Pt X% (X = 1, 2, 3) under visible light ($\lambda > 420$ nm).



Fig. S8 (a) H₂ production curves and (b) apparent rate constants for H₂ evolution of samples A-C_{X%}GCN X% (X = 0.5, 4, 6, 10) and AGCN+CGCN under visible light ($\lambda > 420$ nm).



Fig. S9 TEM images of Pt-loaded sample (a) before and (b) after testing.