Supplementary Information

The preparation of Al_2O_3/g-C_3N_4 composites in aluminum-water self-assembly system and its improved photocatalytic properties

Yining Zheng, Cundi Wei , Qi An, Jinsheng Yu, Shaonan Xu* and Lina Li *

Key Laboratory of Automobile Materials of Ministry of Education, Solid Waste Recycling Engineering Research Center of Jilin, School of Materials Science and Engineering, State Key laboratory of Inorganic Synthesis & Preparative Chemistry, Jilin University, Changchun, 130022, Jilin Prov., China;

S1. Preparation of photocatalyst

Certain amount of Al-Ga-In ternary aluminum alloys (0.01 g, 0.05 g, 0.1 g, 0.2 g, 0.3 g orther 0.4 g) was added into 150 mL beakers with deionized water to 90 ℃, together with 1.5 g melamine and 1.5 g cyanuric acid. (each for M and CA) to each beaker. Then, the reaction system kept stirring for 3 hours at 90 ℃ until the reaction is complete. The mixture was cooled to room temperature, and then filtered, dried, and ground. The drying temperature was 80 ℃. The obtained powder samples were heated to 600 ℃ at a heating rate of 5 ℃/min in an argon atmosphere of a tube furnace, kept for 4.5 h, cooled to room temperature, and then taken out to obtain a composite photocatalytic material Al_2O_3/g-C_3N_4. According to the quality of the Al-Ga-In ternary alloy added during the synthesis process, the composite photocatalytic materials were named AlOOH/CM-1 ~ AlOOH/CM-6 before calcination, and the samples after calcination were named Al_2O_3/g-C_3N_4-1 ~ Al_2O_3/g-C_3N_4-6.

S2. Degradation reaction of RhB

In a typical photocatalytic experiment, 5 mg photocatalyst are accurately weighted and added in to a 10 mL of 10 mgL^{-1} RhB solution in a sealed glass bottle. A 50 W LED lamp with white light irradiation (380-840 nm) was used at a distance of 20 cm. Before the light irradiation, the suspensions were magnetically stirred for 30 min to reach the adsorption-desorption equilibrium. After the light irradiation, 3 mL solution was taken and centrifugated for UV−vis absorption spectra measurement. During the experiments, all the steps are similar, only with the changes of catalysts.

S3. Characterization

PXRD patterns were recorded with a Rigacu Dmax 2500 instrument with Cu Kα radiation at 35 kV and 40 mA. Fourier transform infrared spectroscopy (FTIR) was was collected on a Bruker IFS 66 v/s spectrometer which was registered between 4000 and 500 cm-1 with 128 scans per spectrum. Scanning electron microscope (XL-30 ESEM, FEI COMPANYTM) and electronic differential system (X-MAX, OXFORD INSTRUMENTS) were employed to reveal morphology of the synthesized samples. Ultroviolet photoelectron spectrometer (UPS,

ESCALAB 250 Xi) analyzed was carry out analysis with a excitation source of He I 21.22 eV radiation and UVS 10/35. And The calibration was performed by fermi level of silver reference sample. The specific surface area and N_2 adsorption-desorption isotherms were obtained with Micromeritics Tristar II 3020M and all samples were degassed at 150 °C for 4 h prior to measurements. UV−vis absorption spectra were recorded with a spectrophotometer (HITACHI, U-3900H). The steady-state PL spectrum was recorded using Edinburgh FLS980, and the excitation wavelength was 420 nm.

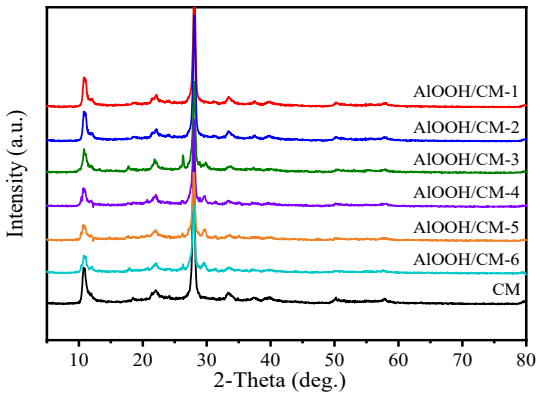
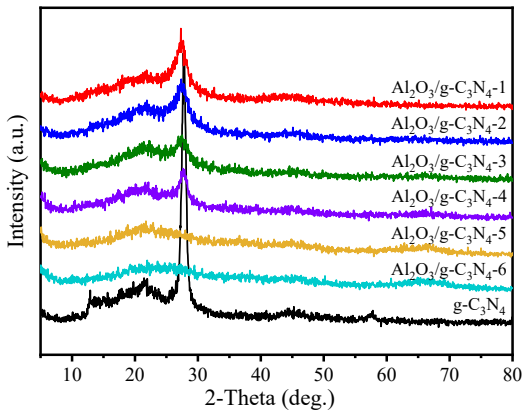


Fig. S1 The XRD patterns of the composite photocatalytic materials before



calcination

Fig. S2 The XRD patterns of the composite photocatalytic material Al_2O_3/ g-C_3N_4

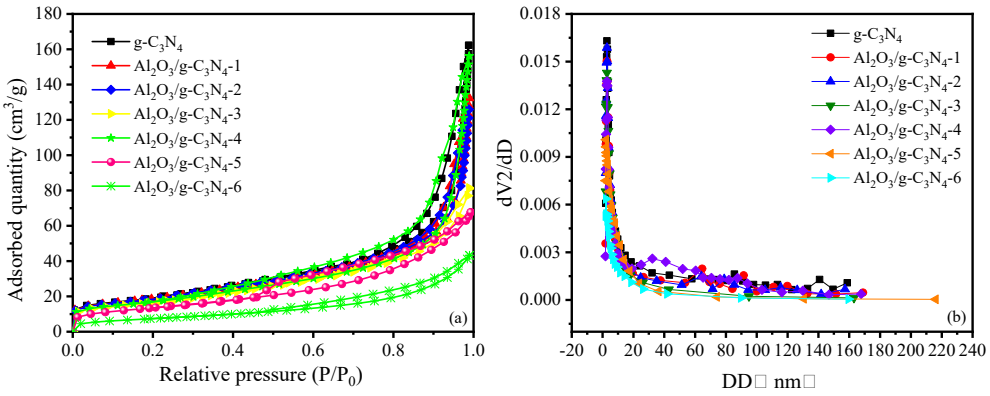


Fig. S3 The composite photocatalytic materials $Al_2O_3/g\text{-}C_3N_4$: (a) N_2 adsorption-desorption isotherm, and (b) aperture distribution diagram

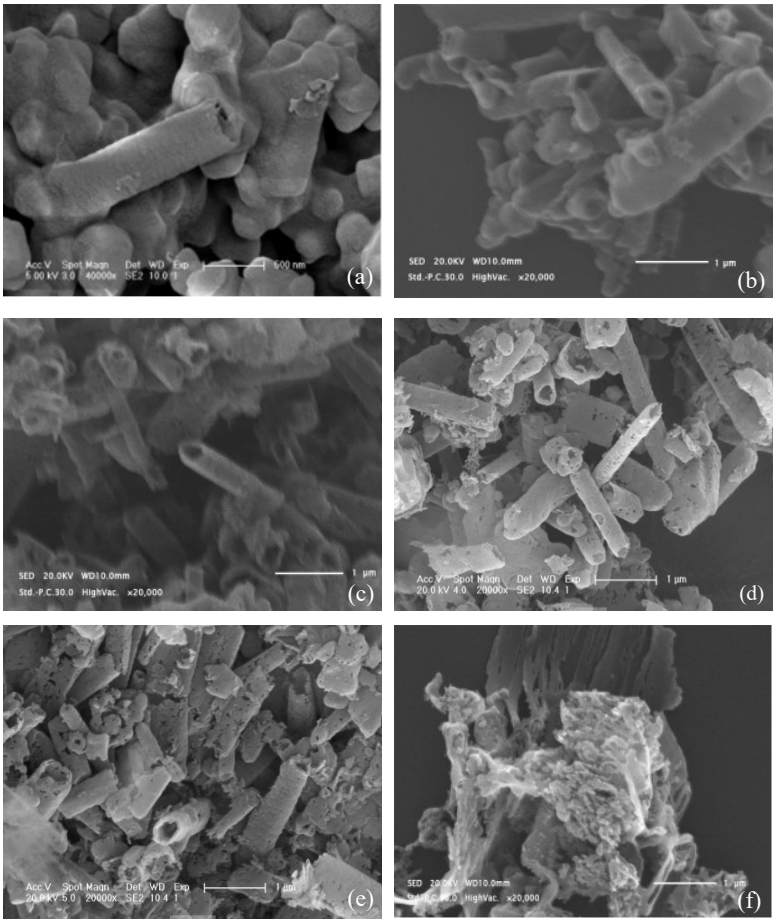


Fig. S4-1 The SEM images of pure $g\text{-}C_3N_4$ and the composite photocatalytic materials $Al_2O_3/g\text{-}C_3N_4$:(a)$g\text{-}C_3N_4$, (b)$Al_2O_3/g\text{-}C_3N_4$-1, and (c-f)$Al_2O_3/g\text{-}C_3N_4$-3 ~ $Al_2O_3/g\text{-}C_3N_4$-6

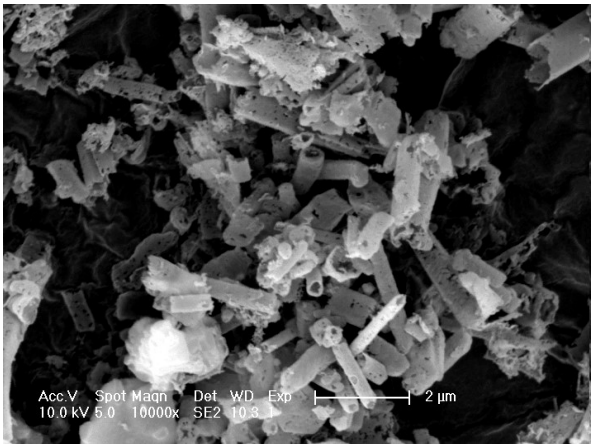


Fig. S4-2 The SEM images Al_2O_3/g-C_3N_4-4

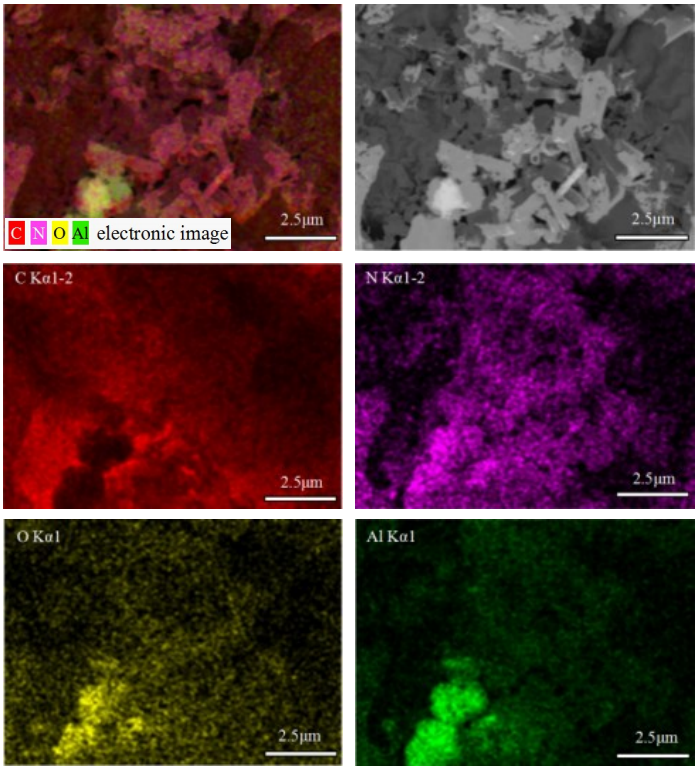


Fig. S4-3 The EDX mapping of Al_2O_3/g-C_3N_4-4

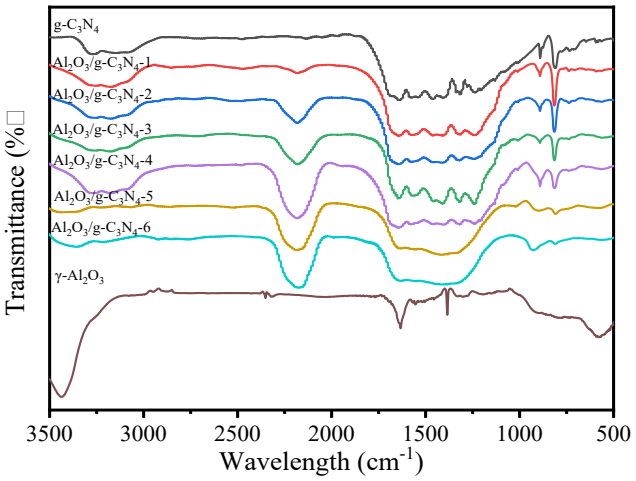


Fig. S5 The FTIR images of the composite photocatalytic materials $Al_2O_3/g\text{-}C_3N_4$

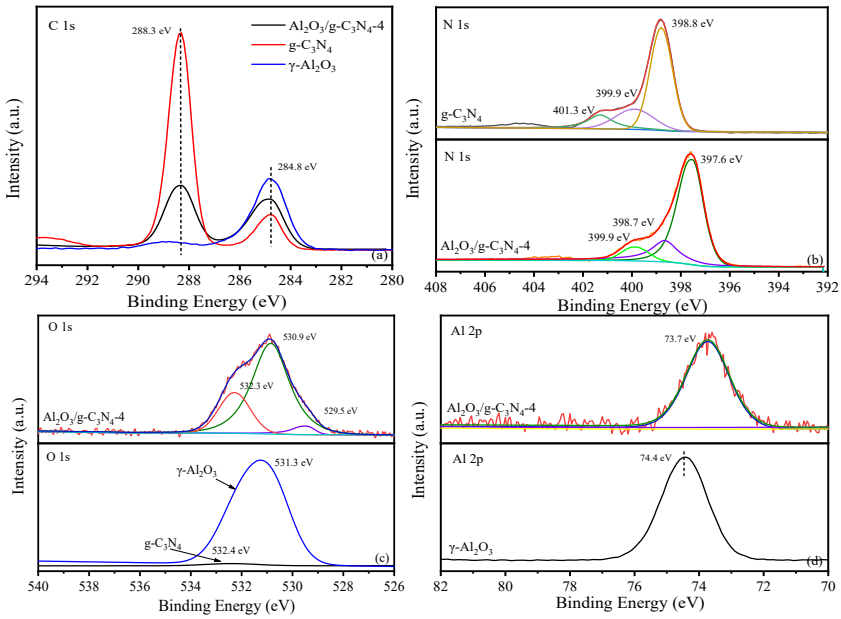


Fig. S6 XPS high-resolution spectrogram of composite photocatalytic material $Al_2O_3/g\text{-}C_3N_4$-4: (a) C 1s, (b) N 1s, (c) O 1s, and (d) Al 2p

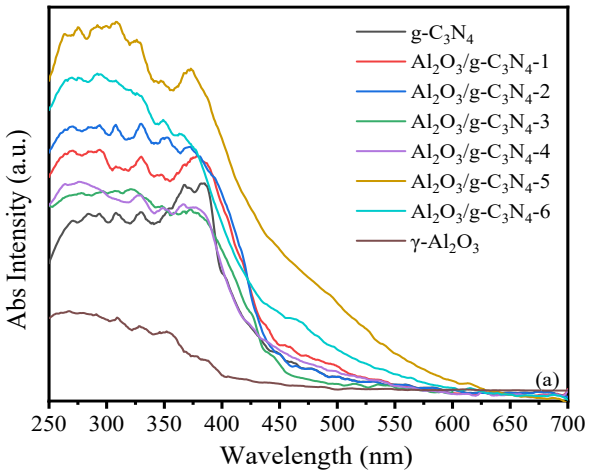


Fig. S7 UV–vis absorption spectra of single g-C_3N_4, and Al_2O_3/g-C_3N_4

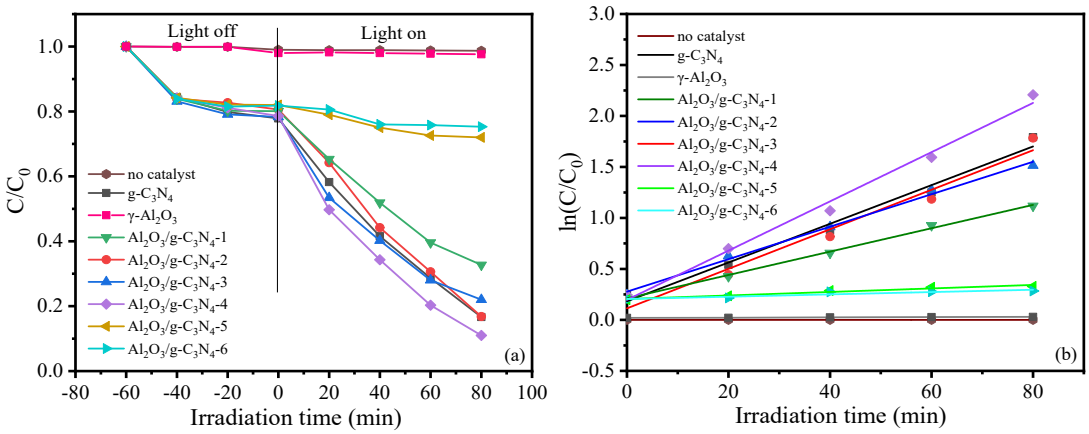


Fig. S8 (a)The photodegradation RhB photocatalytic activity of Al_2O_3/g-C_3N_4 under visible light irradiation, and (b) the first-order curve of photodegraded RhB of the samples

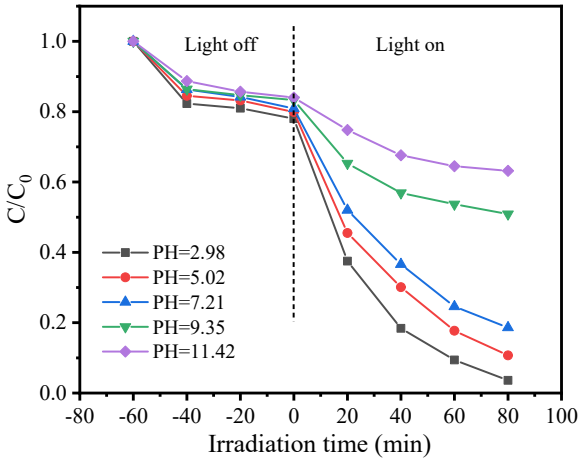


Fig. S9 Degradation rate profile of RhB catalysed by Al_2O_3/g-C_3N_4 at variable pH

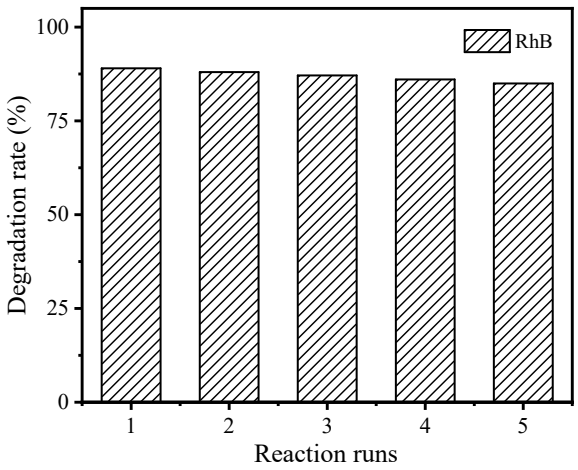


Fig. S10 Photocatalytic degradation of RhB after up to five cycles measured after visible light irradiation of 80 min

Table S1 Comparison of the advantages and disadvantages of the experimental method in this article and other methods

Preparation strategy	**Whether to prepare at the same time**	**Dosage of chemicals (Represented by ☆)**	**Performance improvement effect (Compared to a single g-C_3N_4)**	**Article source**
One step-1	Yes	☆	1.7 times	This article
One step-2	Yes	☆☆☆	2.1 times	*Catalysts* 2020, 10, 1036 (My other experimental work）
Two-step hydrothermal method	No	☆☆☆☆☆	2.5 times	*Ind. Eng. Chem. Res.* 2014, 53, 19540−19549

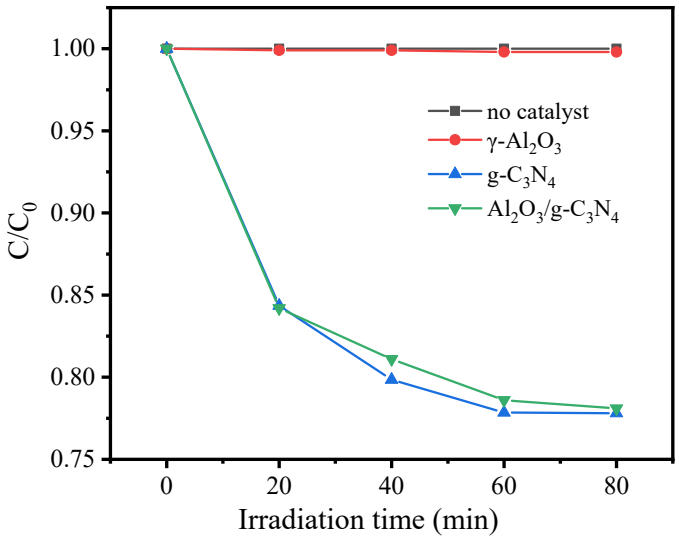


Fig. S11 Al_2O_3/g-C_3N_4 adsorption experiment for RhB