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Characterization

The crystal phase was determined by X-ray diffraction (Bruker D8 CEVANCE) using graphite monochromatized Cu-Ka (λ = 1.5406 Å) radiation. Optical properties were analyzed by using UV–vis diffuse reflectance spectra (DRS, Varian Cary 300) and photoluminescence spectra (F-7000, Hitachi, Japan) at room temperature. Fourier transformed infrared (FTIR) spectra of the samples were performed by a VERTEX-70 spectrometer, and KBr was used as a blank control. The morphology and structure of samples were studied using a scanning electron microscope (SEM, Hitachi S-4800), which was quipped for energy dispersive X-ray (EDS) analysis.

Electrochemical measurements

Electrochemical measurements were performed on a CHI 660D electrochemical workstation (Shanghai Chenhua, China) using a standard three-electrode cell with a working electrode, a standard Ag/AgCl electrode as reference electrode, and a Pt electrode as counter electrode. The preparation of working electrode: samples were dispersed in water to form a 5 mg/mL solution and ultrasonicated for 20 min, then 0.1 mL of solution was dropped on the FTO glass and dry at room temperature.

Photo-catalytic performance and chemical analysis

In the photo-catalytic activity test, Rhodamine (RhB) solution 200 mL (10 ppm) was in the presence of persulfate (PS) in an open quartz tube and the suspension was stirred in the dark for 30 min to ensure the establishment of adsorption-adsorption equilibrium. A 500W Xe lamp with a 420 nm cutoff filter was used as the visible-light source. During the degradation process, 5 mL sample solution was collected at a certain

time interval and was analyzed on a Varian ultraviolet-visible.

The relative contribution of h+, ·OH, $O_2^{\cdot -}$, $SO_4^{\cdot -}$ can be roughly calculated by following formulas:

$$h^+ = \frac{k_1 - k_{h^+}}{k_1} \times 100\%$$

$$^{\bullet}OH = \frac{k_1 - k_{TBA}}{k_1} \times 100\%$$

$$O_2^{\bullet -} = \frac{k_1 - k_{O_2^{\bullet -}}}{k_1} \times 100\%$$

$$SO_4^{\bullet -} = \frac{k_{TBA} - k_{EtOH}}{k_1} \times 100\%$$

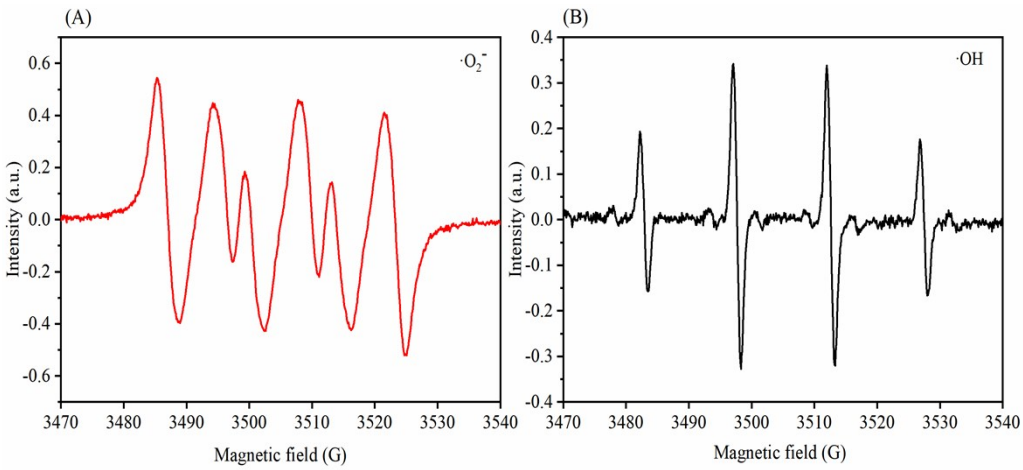

Fig. S1 (A,B) ESR spectra of 6%α-Fe_2O_3/g-C_3N_4.

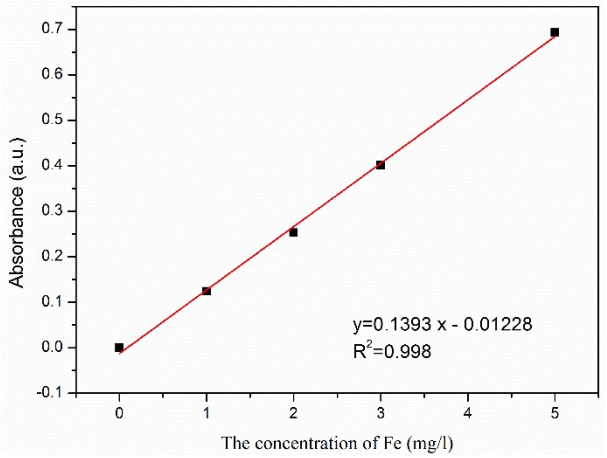

Fig. S2 The linear fitting spectra of Fe ions concentration *vs* UV-vis absorption intensity

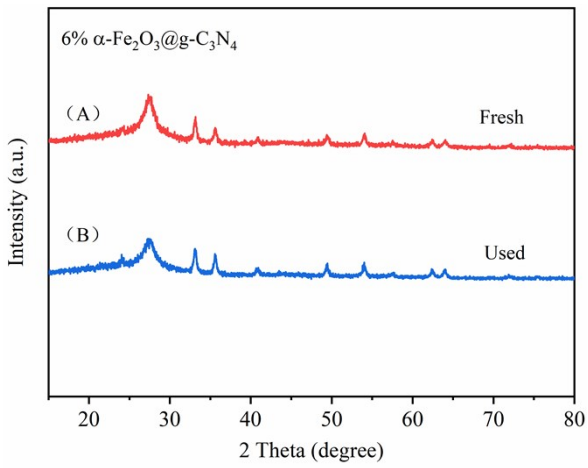

Fig. S3 XRD spectra of 6%α-Fe_2O_3/g-C_3N_4 (A) Fresh and (B) Used

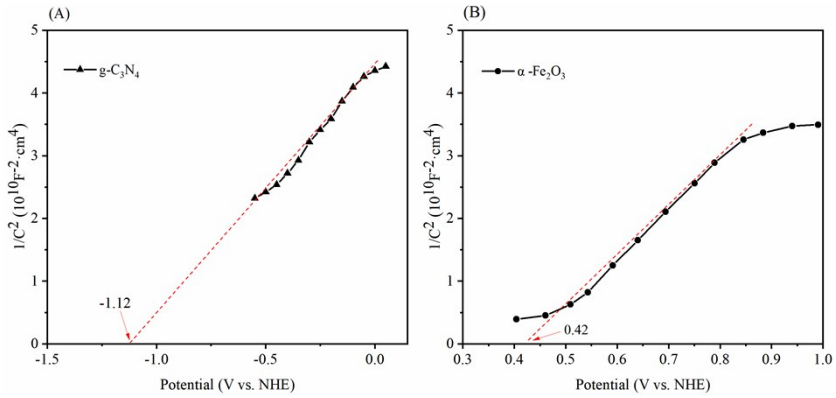

Fig. S4 Mott-Schottky plots of g-C_3N_4 (A) and α-Fe_2O_3 (B)