Supplementary Information

Fabrication of a CuS-cocatalyst-supported g-C_3N_4 nanosheet composite photocatalyst with improved performance in the photocatalytic reduction of CO_2

Fangjun Wang[1], Shiyi Chen[1], Jiang Wu[2,3*], Wenguo Xiang[1], Lunbo Duan[1*]

1. Key Laboratory of Energy Thermal Conversion and Control of Ministry of Education, School of Energy and Environment, Southeast University, Nanjing 210096, China

2. College of Energy and Mechanical Engineering, Shanghai University of Electric Power, Shanghai 200090, China

3. Shanghai Institute of Pollution Control and Ecological Security, Shanghai, China

Corresponding authors

Jiang Wu
Tel.: +86-21-35303902.
Mobile: +86-13371896217.
E-mail Address: wjcfd2002@163.com
Postal Address: No. 2103 Pingliang Road, Shanghai 200090, China.

Lunbo Duan
Mobile: +86-13951912858
E-mail Address: duanlunbo@seu.edu.cn
Postal Address: No. 2 Sipailou, Xuanwu District, Nanjing 210096, China.

1. Characterization

The crystal characteristics of the prepared catalysts were studied by XRD (D8-FOCUS, Bruker) using Cu Kα as the radiation source and its scanning scope 2=15-65° (scan rate 5°/min). Fourier transform Infrared spectrum (FTIR) spectra were determined by infrared spectroscopy (Vector-22, Bruker). The surface morphology and the microstructure of the as-prepared samples were detected by SEM (ZEISS GEMINI 300) and TEM (FEI Tecnai F20). At the same time, high-resolution TEM (HRTEM) was used to deeply study the lattice fringes and internal structure of the crystal. EDS was applied to detect the content and type of all elements in catalyst. The Brunauer-Emmett-Teller (BET) and Barrett-Joyner-Halenda (BJH) method (Micromeritics ASAP 2460) were employed to determine the specific surface area, pore volume and pore size of the samples, and nitrogen adsorption/desorption isotherm was used to calculate the specific surface and porosity. XPS (PHI 5000C) was utilized to analyze the chemical state, chemical bond and other surface properties of the samples. Ultraviolet visible diffuse reflection spectra (UV-vis DRS) and photoluminescence (PL) spectra recorded on SHIMADZU UV-3600 and Hitachi F-4600, respectively, were used to analyze the optical properties.

2. Photoelectrochemical measurements

Photoelectrochemical measurements were measured on an electrochemical system (CHI 660E, Shanghai Chenhua Instrument Co., Ltd. China). A typical three-electrode was immersed in a 0.5 mol/L Na_2SO_4 electrolyte solution. Fluorine-doped tin oxide (FTO) conductive glass was employed as the working electrode, Pt and saturated calomel electrode (SCE) were used as the counter-electrode and the reference electrode, respectively. The working electrode was obtained by the following steps: the prepared sample (10 mg) was dispersed into a mixed solution of ethanol (1 mL) and nafion (20 μL, 5%), then the mixture was ultrasonically dispersed for 2 hours. After that, 0.1 mL slurry was dropped on the surface of FTO glass (1×1 cm). After evaporation of ethanol, the photocatalyst was uniformly attached to the FTO glass. EIS and photocurrent measurements were taken with a 300 W Xenon-arc lamp. The Mott-Schottky measurement was performed at a frequency of 1000 Hz.

3. Photocatalytic activity evaluation

The CO_2 photocatalytic reduction activity experiments of g-C_3N_4, CuS monomers and CuS/g-C_3N_4 composites were performed in a gas-closed circulation system with a 500 mL reactor (Perfect Light Company, Beijing, China). The reaction was performed with a 300 W Xenon-arc lamp as a light source. In general, the solution contained 50 mg photocatalyst and 100 mL deionized water were stirred continuously, and then the suspension was vacuum-treated and filled with 100 kPa CO_2 (99.999%) for 30 min to reach the adsorption-desorption equilibrium before illumination. The experiment was started when the light was on. The reactor temperature were maintained at 25°C via a cooling sink. During the reaction, the reduction products were detected by gas chromatograph (GC9790II, Zhejiang Fuli Technology Co., Ltd)

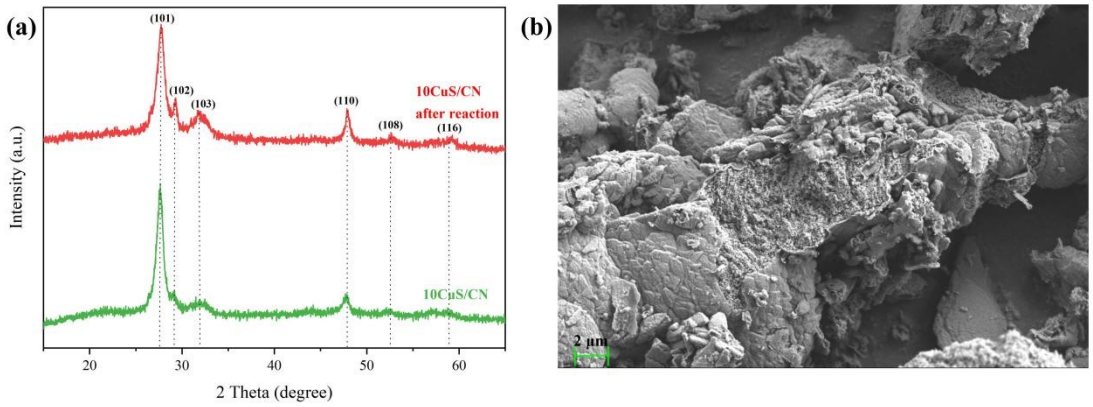

Fig. S1. (a) XRD and (b) SEM of 10CuS/CN before and after photocatalytic reduction of CO_2.

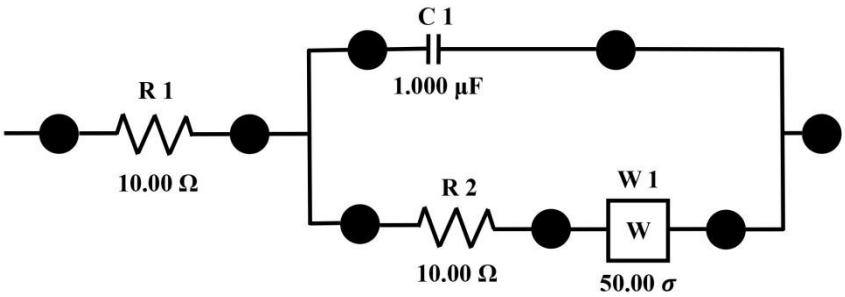

Fig. S2. Equivalent circuit diagram of EIS.

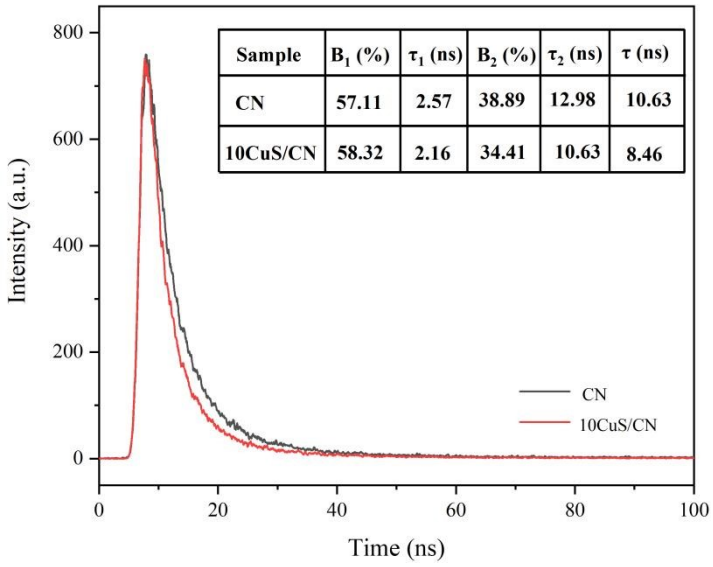

Fig. S3. Time-resolved fluorescence decay spectra and the fitted data (inset) of CN and 10CuS/CN.

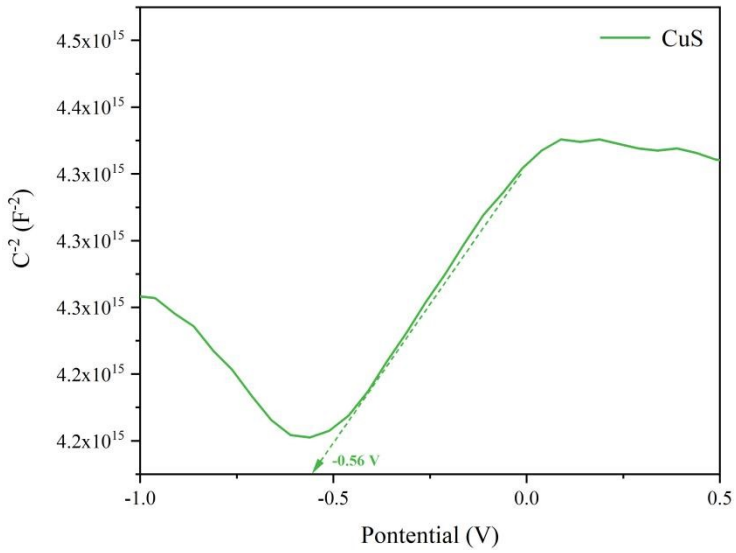

Fig. S4. Mott-Schottky plots for CuS.