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Construction novel highly active photocatalytic H_2 evolution over noble-metal-free trifunctional Cu_3P/CdS nanosphere decorated g-C_3N_4 nanosheet

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A R T I C L E I N F O

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A B S T R A C T

Hydrogen energy possesses immense potential in developing a green renewable energy system. However, a significant problem still exists in improving the photocatalytic H_2 production activity of metal-free graphitic carbon nitride (g-C_3N_4) based photocatalysts. Here is a novel Cu_3P/CdS/g-C_3N_4 ternary nanocomposite for increasing photocatalytic H_2 evolution activity. In this study, systematic characterizations have been carried out using techniques like X-ray diffraction (XRD), scanning electron microscopy (SEM), high resolution transmission electron microscopy (HR-TEM), Raman spectra, UV–Vis diffuse reflectance spectroscopy, X-ray photoelectron spectroscopy (XPS), surface area analysis (BET), electrochemical impedance (EIS), and transient photocurrent response measurements. Surprisingly, the improved 3CP/Cd-6.25CN photocatalyst displays a high H_2 evolution rate of 125721 μmol h^{-1} g^{-1}. The value obtained exceeds pristine g-C_3N_4 and Cu_3P/CdS by 339.8 and 7.6 times, respectively. This could be the maximum rate of hydrogen generation for a g–C_3N_4–based ternary nanocomposite ever seen when exposed to whole solar spectrum and visible light ($\lambda > 420$ nm). This research provides fresh perspectives on the rational manufacture of metal-free g-C_3N_4 based photocatalysts that will increase the conversion of solar energy. By reusing the used 3CP/Cd/g-C_3N_4 photocatalyst in five consecutive runs, the stability of the catalyst was investigated, and their individual activity in the H_2 production activity was assessed. To comprehend the reaction mechanisms and emphasise the value of synergy between the three components, several comparison systems are built.

1. Introduction

Researchers have attempted to develop clean and renewable energy in response to the rising energy dilemma and environmental pollution related to excessive use of petroleum-based fuels [1,2]. One way to resolve this is the utilization of hydrogen energy, because of its high energy density and cleansing qualities and is considered one of the probable alternatives for volatile fossil energy [3]. However, to achieve this hydrogen needs to be generated in a feasible manner from water, which is one of its most common sources. Since 1972, with the discovery of Honda-Fujishima phenomenon, photocatalytic water separation has acquired a lot of interest, because of its potential to create hydrogen from unlimited sunlight [4]. Many semiconductor photocatalysts have been studied in recent decades, including TiO_2 [5,6], CdS [7–9], ZnCdS

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