Journal of Water Process Engineering 57 (2024) 104645

Contents lists available at ScienceDirect

Journal of Water Process Engineering

journal homepage: www.elsevier.com/locate/jwpe

CQDs embed g-C_3N_4 photocatalyst in dye removal and hydrogen evolution: An insight review

Solayman H. M.[a], Azrina Abd Aziz[a,b,*], Noor Yahida Yahya[a], Kah Hon Leong[c], Lan Ching Sim[d], Md. Kamal Hossain[e], Md. Badiuzzaman Khan[f], Kyung-Duk Zoh[g]

[a] Faculty of Civil Engineering Technology, Universiti Malaysia Pahang Al-Sultan Abdullah, 26300 Gambang, Pahang, Malaysia
[b] Advanced Intelligent Materials Centre, Universiti Malaysia Pahang Al-Sultan Abdullah, 26300 Gambang, Pahang, Malaysia
[c] Department of Environmental Engineering, Faculty of Engineering and Green Technology, Universiti Tunku Abdul Rahman, 31900 Kampar, Perak, Malaysia
[d] Department of Chemical Engineering, Lee Kong Chian Faculty of Engineering and Science, Universiti Tunku Abdul Rahman, 43200 Kajang, Selangor, Malaysia
[e] Bangladesh Council of Scientific and Industrial Research, BCSIR Laboratories, Dhaka 1205, Bangladesh
[f] Department of Environmental Science, Bangladesh Agricultural University, Mymensingh 2202, Bangladesh
[g] Department of Environmental Health Sciences, School of Public Health, Seoul National University, Seoul 151-742, Republic of Korea

ARTICLE INFO

Keywords:
CQDs
g-C_3N_4
Photocatalysis
Hydrogen evolution
Dye wastewater treatment

ABSTRACT

Recent research has highlighted heterogeneous photocatalysts as a feasible contender for addressing energy shortages and environmental cleanup. One of the best semiconducting photocatalysts used in wastewater treatment, disinfection, and energy evolution is graphitic carbon nitrate (g-C_3N_4). Researchers have used carbon quantum dots (CQDs) to maximize and enhance the photocatalytic activity of g-C_3N_4 and to get over the material's limits due to photoinduced charges, partial surface area, and insufficient light-capturing difficulties. In this context, the fundamentals of CQDs and g-C_3N_4 are described in length, along with their structural state, synthesis, and modification techniques. The classification, manufacturing procedure, and characterization of CQDs/g-C_3N_4 are then highlighted in this paper. Following that, it is shown how CQDs/g-C_3N_4 photocatalysts are used in dye removal and hydrogen evolution studies. The discussion of CQDs/g-C_3N_4's present hurdles, unmet needs, and future research prospects concludes while keeping in mind their practical applications. This study shows that by embedding CQDs, the influence of charges, morphological modification, and textural quality of g-C_3N_4 have been altered. It is anticipated that this review will offer a practical overview and comprehension of CQDs embedded with g-C_3N_4 photocatalysts in order to promote their utilization. The ultimate goal of this review may be to impart a fundamental understanding of photocatalysis while also providing an expository evaluation of the most recent advancements in g-C_3N_4/CQDs photocatalysts in the sectors of energy and environmental security.

1. Introduction

Currently, environmental remediation and energy security have emerged as serious problems that are harmful to both people and the environment. Physical, chemical, biological, advanced and hybrid technologies are successfully applied to overcome energy and environmental issues [1,2]. Numerous advanced oxidation processes (AOPs) are used in wastewater treatment, including fenton oxidation, ultrasonic oxidation, moist air oxidation, photochemical oxidation, ozonation, and electrochemical oxidation [2,3]. However, there are many underlying factors that limits the application and performance of the methods such as pH dependent, costly, slow process, secondary sludge and well catalyst requires [3–5]. Consequently, researchers introduced AOPs based photocatalysis method to combat and purify the wastewater and simultaneously convert solar energy into green hydrogen [6]. Several photocatalysts such as TiO_2, ZnO, Mn_2O_3, ZnS, SnO_2, Fe_2O_3, WO_3 are commonly used in photocatalysis system that are widely functional in hydrogen (H_2) production, pollutants photodegradation, CO_2 reduction, and other related fields [7–15]. Therefore, conventional photocatalyst has some drawbacks such as low photo quantum efficiencies, high electron recombination rate, low efficiencies and poor stabilities that need to be solved [6,16]. A well functional photocatalyst should have an appropriate bandgap that satisfies efficient light absorption as well as an excellent conduction band (CB) and valance band (VB) and high

* Corresponding author at: Faculty of Civil Engineering Technology, Universiti Malaysia Pahang Al-Sultan Abdullah, 26300 Gambang, Pahang, Malaysia.
E-mail address: azrinaaziz@umpsa.edu.my (A. Abd Aziz).

https://doi.org/10.1016/j.jwpe.2023.104645
Received 22 August 2023; Received in revised form 4 October 2023; Accepted 30 November 2023
Available online 7 December 2023
2214-7144/