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Surface activated mesoporous Ag-Fe_3O_4 tethered chitosan nanomatrix heterojunction photocatalyst for organic dyes degradation: Performance, recycling, and mechanism

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ABSTRACT

Herein, Fabricated a magnetic core-shelled CS@Fe_3O_4 nanostructure with silver nanoparticle (Ag@CS-Fe_3O_4) was simply prepared through a one-pot hydrothermal method and utilized as ab photocatalyst for the degradation of dyes. Because the remediation of wastewater containing complex organic compounds is an important issue in environmental fields, Orange G (OG) and Rhodamine B (RhB) was selected as the main organic pollutants to clarify the photocatalytic activity of Ag@CS-Fe_3O_4 in this study. We confirmed the successful synthesis of nanocomposite through Fourier-transform infrared spectroscopy, X-ray diffraction, and Electron spin resonance spectroscopy analyses. The Fe_3O_4@ hierarchical Ag@CS shows a noticeable OG and RhB dyes removal of 98.6% and 95.4% within 120 min at the enhanced pH range. The catalytic reusability has been exceptional up to five repititive runs, and the practicability for the treatment of industrially contaminated water was confirmed by field trial. This study provides an ideal scheme for effectual optimization of hierarchical nanostructures for effective degradation of refractory pollutants in the environment.

1. Introduction

With the rapid development of chemical industries, huge wastewater comprising organic mixtures is discharged during industrial practices annually (Yogalakshmi et al., 2020). Most organic dyes are chemically toxic, non-biodegradable and thermally stable, which are extensively used in various industrial fields (Kim and Jo, 2019), including textiles (Mukthar Ali et al., 2019), cosmetics (Vigneshwaran et al., 2021d), paper (Khatri et al., 2018), food processing and leather tanning (Deng et al., 2019; Ibrahim et al., 2020). The discharged pollutant wastewater into the environment not only threatens aquatic life but also affects the food chain (Vigneshwaran et al., 2021e). The high toxicity affects human health, causing various health problems such as carcinogenic and impairment of kidneys (Khedkar et al., 2020). Therefore, effective measures are needed for treating these dye-containing wastewater before its discharge into the freshwater reservoir. Table 1.

Conventional treatment methods are limited in water treatment applications due to its high costs and tedious operational process, and photocatalysis is a promising route to resolve this problem (Khatri et al., 2018). Photocatalysts are the vital key to employ photocatalytic methods to remediate organic dye wastewater (Zhang et al., 2020a; Zhu et al., 2020). Therefore, the design and development of economical, eco-friendly and effective semiconductor photocatalysts have enticed severe investigation (Zhao et al., 2019). Numerous semiconductor-based photocatalyst has been developed for degrading various organic dyes (Ritika et al., 2019; Samanta et al., 2019; Wang et al., 2020a; Zhu et al., 2020). However, lower solar energy utilization of photocatalysts bounds their practical applications (Wang et al., 2020b). Various metal oxides such as ZnO, FeO, Fe_2O_3, TiO_2, Al_2O_3, WO_3, MgO, and CaO, are generally used in various forms like adsorbents (Li et al., 2020), photocatalysts (Pakzad et al., 2019), and catalyst-support in industrial applications (Tarkwa et al., 2019). Generally, nanosized metal oxides' reactivity is far better than that of their magnitude counterparts due to the increased surface area, high reactive edge and corner defects sites, and unusually stabilized lattice planes (Karthikeyan et al., 2020). Nazari and Jaafari reported the nanocrystalline Fe_3O_4 could annihilate the organic molecules owing to the enriched surface reactivity. Due to its application, magnetic nano-sized Fe_3O_4 are reflected higher efficiency than its bulk

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