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An intriguing Z-scheme titania loaded on fibrous silica ceria for accelerated visible-light-driven photocatalytic degradation of ciprofloxacin

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ABSTRACT

A novel Z-scheme titania loaded on fibrous silica ceria (Ti-FSC) was triumphantly fabricated via hydrothermal followed by electrolysis method and evaluated for the visible-light degradation of ciprofloxacin (CIP). Noticeably, Ti-FSC exhibits as an efficient photocatalyst for CIP photodegradation with 95% as followed by titania loaded on fibrous silica (Ti-FS) (68%), Ti–CeO_2 (35%), FSC (47%), FS (22%), and CeO_2 (17%). The combination of the inherent merits of Ti loaded on FSC is able to realize the crucial role of Ce in harnessing the high dispersion of Ti, which could beneficial for improving the performance proven by XRD, FESEM, TEM and FTIR. Consequently, high dispersion of Ti on FSC has worthwhile towards the interaction of the Si–O–Ti, Ce–O–Ti, and Si–O–Ti, which could enhance the CIP photodegradation by providing more surface defects, narrowing the band gap, improving electron-hole separation and suppressing electron-hole recombination that revealed by XPS, UV–vis/DRS, Nyquist plots and PL studies, respectively. The scavenger study revealed that the controlling species in the system was hydroxyl radical and holes. A potential Z-scheme heterojunction mechanism for Ti-FSC was deduced from the band structure analysis. The possible photodegradation pathway was proposed based on GCMS analysis. Besides, the acceptable reusability, which exceeded 90% of degradation indicated the great application potential of Z-scheme Ti-FSC in wastewater treatment and others application.

1. Introduction

Grappling with the emerging adversity of environmental pollution, which cause to energy depletion, is critical for the green chemistry community's long-term growth. Several antibiotics have a high level of contamination in the aquatic environment owing to its ability to promote resistance in the ecological system, poses serious threats to human and animal health (Lin et al., 2021; Zhu et al., 2021). Ciprofloxacin (CIP) is a fluoroquinolone antibiotic of the second generation being utilised to treat a variety of infections. However, due to it is partially metabolised in people or is discharged in sewage from pharma businesses, it is one of the commonly found antibiotics in aqueous solution (Doan et al., 2021; Yan et al., 2013). Therefore, it is critical to develop efficient alternatives for removing CIP and others targeted pollutants from wastewater.

Advanced oxidation techniques have received a lot of attention in recent years for removing residual antibiotics in wastewater (Ghasemi et al., 2020). This is attributed to superior degradation efficacy via generation of active free radicals with strong oxidizing ability in the systems, which results in the destruction of contaminants and subsequent mineralization (Moradi et al., 2021; Wang et al., 2021). Ceria (CeO_2) has sparked considerable attention among semiconductor catalysts owing to its high oxygen storage capacities, thermal stability, and ease of conversion between Ce^{3+} and Ce^{4+} oxidation states (Gnanasekaran et al., 2021; Hassandoost et al., 2019). CeO_2 can serve as an oxygen buffer by emitting and restoring oxygen, which is essential in many oxidation reactions (Shang et al., 2020). Notwithstanding, low photonic efficiency, low surface area, wide band gap and severe surface charge recombination are still the bottlenecks, which significantly lower the

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