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Construction of ternary (1D/2D/3D) Fe_2O_3-supported micro pillared Cu-based MOF on chitosan with improved photocatalytic behavior on removal of paraquat

Sivakumar Vigneshwaran[1,2] · Palliyalil Sirajudheen[2] · Valiya Peedikakkal Sajna[2] · Chang Min Park[3,4] · Sankaran Meenakshi[1]

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Abstract
A hetero-structured metal organic framework of Cu-BTC and Fe_2O_3 nano-photocatalyst were tethered over chitosan using the hydrothermal method and fabricated a hybrid porous nanocomposite (CS-Fe@Cu-BTC). X-ray diffractometer results exposed the existence of Fe_2O_3 peaks. Surface area measurements using BET showed a mesoporous structure and the formation of type IV adsorption isotherm for nanocomposite. XPS and SEM-EDAX confirmed the existence of Fe_2O_3 nanoparticles in the hybrid porous structure. The UV–vis diffuse reflectance absorption shape emphasized the role of Fe_2O_3 in enhancing the band gap of CS-Fe@Cu-BTC nanohybrid. The lower intensity photoluminescence spectra of the CS-Fe@Cu-BTC shows a competent charge partition and delayed the recombination of electron-hole pairs. The photo-mineralization efficiency of Cu-BTC and CS-Fe@Cu-BTC was evaluated in terms of electronic interactions using paraquat (PQT) as the probe molecule, which shows a mineralization of 91% at the pH range of ~ 5. The contribution of •OH in the degradation of PQT over CS-Fe@Cu-BTC nanocomposites revealed using the trapping test and the degradation mechanism follows the Langmuir-Hinshelwood model and pseudo-first-order kinetics. The durability of the CS-Fe@Cu-BTC nanocomposite was also established after four cycling processes.

Keywords Chitosan matrix · Cu-based MOF · H_2O_2 generation

Introduction

Paraquat dichloride, also referred to as Methyl Viologen which chemically known as 1′-dimethyl-4,4′-bipyridinium dichloride ($[(C_6H_7N)_2]Cl_2$). Generally, the compound is referred to as "paraquat," (PQT), which is the commonly used herbicide in agricultural fields (Marien et al. 2019). Paraquat is also generally referred to as Gramoxone (an accepted end-use product). It is a widely used important chemical for controlling weeds mainly in agriculture; it is also used in non-agricultural applications (Wongcharoen and Panomsuwan 2018). PQT is extensively used as pesticide in agricultural fields to inhibit pests in palms, peanuts, sugarcane, cotton, citrus and olives. The presence of PQT in the soil and water leads to fatal poisoning, lung cancer, and damage of the central nervous system in humans (Rashidipour et al. 2019). Hence, the removal of PQT from wastewater is regarded as a crucial initiative for environmental protection. PQT is a potential source for causing health risk to animals kingdom due to its non-biodegradable nature and even it show highly resistance to degradation by chemicals (Kojic et al. 2020). Multiple techniques like solvent extraction (Zahedi et al. 2015), ion exchange (Prabhu and Meenakshi 2013), coagulation-flocculation (Farooq Shera et al. 2020), filtration (Sarkar et al. 2007), electrochemical treatment (Tufa et al. 2020), adsorption (Etcheverry et al. 2017), and advanced oxidation processes (Jang et al. 2020; Sorolla et al. 2012), are commonly used to treat pesticide-affected wastewater. Among them, the advanced oxidation processes method is extensively used because of its easy operation, good removal effect, and the fact that it does not lead to any

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✉ Chang Min Park
cmpark@knu.ac.kr

✉ Sankaran Meenakshi
sankaranmeenakshi2014@gmail.com

Extended author information available on the last page of the article