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Investigating the governing decolorization mechanisms of nanodiamond in the treatment of an azo dye

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ABSTRACT

Heterogeneous photocatalysis is accepted as an efficient method of degrading a wide array of pollutants and inactivating bacteria. Titanium dioxide, the catalyst of choice, is very limited in its applications because of its high-energy band gap and many researchers have opted to employ doping TiO_2 to reduce the band gap between conduction and valence bands. A lot of success stories have been documented where carbon-doped TiO_2 showed improved efficiency as a result, yet no work has attempted to gauge the governing path of treatment that comes with a carbon-based material, and its photocatalytic efficiency. This study assesses the viability of photocatalytic decolorization of acid blue–stained wastewater, using nanodiamond. The findings allow for an understanding of the routes of decolorization governing this carbon-based catalyst and validation of their use as TiO_2 photocatalytic dopants. Decolorization was assessed using three catalysts namely, TiO_2, Fe–TiO_2, and nanodiamond. Feasibility was tested under two different excitation light sources and one set of tests was performed in the dark to negate any photoactivation. In addition, UV–Vis spectra, X-ray powder diffraction and scanning electron microscopy were used to characterize the materials prior to treatment and post-decolorization. Nanodiamond outperformed TiO_2 and Fe–TiO_2 in regards to removal efficiency, rate of removal and breadth of effect. Photocatalysis degradation from nanodiamond samples was confirmed, yet its effects were slight and only observable at the smallest catalyst loading. Nanodiamond exhibited decolorization in both light reactors and in the dark, equally efficiently, while TiO_2 and Fe–TiO_2 showed no life in the dark. These observations are of importance to the aquatic sector that needs to gain good fundamental understanding of the governing parameters effecting treatment efficiency and how to improve them.

Keywords: Photocatalysis; Titanium dioxide; Nanodiamond; Acid Blue 113; Wastewater treatment

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