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Energy materials

Dopant-free oxygen-rich titanium dioxide: LED light-induced photocatalysis and mechanism insight

Jun Yan Tai[1], Kah Hon Leong[1], Pichiah Saravanan[2], Azrina Abd Aziz[3], and Lan Ching Sim[1,*]

[1] Department of Environmental Engineering, Faculty of Engineering and Green Technology, Universiti Tunku Abdul Rahman, Kampar, Perak, Malaysia
[2] Department of Environmental Science and Engineering, Indian Institute of Technology (ISM), Dhanbad, Dhanbad, Jharkhand 826004, India
[3] Faculty of Engineering Technology, Universiti Malaysia Pahang, 26300 Gambang, Kuantan, Pahang, Malaysia

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ABSTRACT

In this work, we successfully synthesized visible light-responsive oxygen-rich titanium dioxide (O_2–TiO_2) photocatalysts. Through hydrothermal decomposition of peroxo-titania complex, the in situ generation of oxygen significantly shifted the light absorption toward visible region. The existence and contribution of oxygen excess defect present in O_2–TiO_2 was confirmed through FTIR and XPS analysis. The annealing temperature influenced the oxygen content and textural property of O_2–TiO_2 samples and subsequently their photocatalytic activity. The O_2–TiO_2 calcined at optimum temperature of 300 °C recorded the highest photocatalytic activity toward methylene blue degradation, approximately 7.3- and 3.2-fold higher than that of commercial P25 and anatase TiO_2, respectively. The enhancement was attributed to shortening of band gap and low recombination rate of charge carriers when the oxygen content increased at higher temperature. In addition, O_2–TiO_2 displayed high reusability rate and good catalytic stability after being evaluated by four consecutive catalytic runs. The reactive radical species responsible for charge transfer mechanism and high photocatalytic activity were hydroxyl radical ($^{\cdot}OH$), holes and superoxide radical anions ($^{\cdot}O_2^-$) after performing multiple scavenging tests.

Introduction

In recent years, the contamination of natural waters is regarded as one of the major environment issues in the modern society. The most significant source of the pollutant is the untreated dye containing effluents released from the industries [1]. The breakdown products of dyes consisting of carcinogens, including benzidine, naphthalene and other aromatic compounds, are toxic and mutagenic to life forms [2]. Without adequate treatment, the dyes can persist in the environment for an extended period of time. To address these problems, advanced oxidation processes (AOPs) emerge as a promising technology for

Address correspondence to E-mail: simcl@utar.edu.my

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