



Synthesis of TiO₂/SBA-15 photocatalyst for the azo dye decolorization through the polyol method

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HIGHLIGHTS

- ▶ The TiO₂ was synthesized via polyol method to increase the quantitative effect.
- ▶ By immobilizing the nano-sized TiO₂ on hydrophilic SBA-15, the aggregation was avoided.
- ▶ The crystalline size and surface charge of TiO₂ have influences on AR1 degradation.
- ▶ The 2,3-butanedione was adsorbed on the surface of TiO₂ during the polyol process.
- ▶ The electrophilic at carbon of ketone may attributed to the adsorption of AR1.

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ABSTRACT

The nano-sized TiO₂ powder and immobilized TiO₂/SBA-15 photocatalysts were synthesized via a polyol method with an attempt to increase the quantitative effect by reducing the particle size and avoid the aggregation by immobilizing on hydrophilic SBA-15 support. The effect of reduction temperature on the TiO₂ crystalline size was investigated. The X-ray diffraction (XRD) and Field-emission scanning electron microscopy (FE-SEM) results showed that the crystallite size of the TiO₂ particles is in the nano-regime and indicated that depended on the nucleation and growth process, different sizes and shapes of monodisperse or polydisperse TiO₂ powders are formed. The photocatalytic activities of the samples were evaluated for the decolorization of an azo dye, acid red 1 (AR1) were studied in aqueous solution under UV light irradiation. The effect of different parameters such as catalyst dosage, solution pH, TiO₂ loading weight, and different support materials Al₂O₃ and glass bead on the decolorization efficiency of AR1 were studied. The results indicated that the self-synthesized TiO₂ showed comparable decolorization efficiency than commercial P25, and the efficiency can be significantly improved by using SBA-15 as support material due to its hydrophilicity.

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1. Introduction

Acid red (AR) dyes are a type of azo dyes characterized by a nitrogen-to-nitrogen double bond (—N=N—). AR dyes are the largest and most important class of synthetic organic dyes widely used in industries today because they are cheap to synthesize, firm, and have a great variety of colors compared with natural dyes [1,2]. Yearly, 800,000 tons of dye is produced worldwide, and about 50% of these are azo dyes [3]. Azo dyes, however, are not biodegradable

by aerobic treatment processes [4]. In addition, they are reducible to potentially carcinogenic aromatic amines under anaerobic condition, thereby causing long-term health concerns [5,6].

In recent years, there has been extensive interest in the use of semiconductors, such as TiO₂, as photocatalysts for azo dye decolorization [7–9]. In this photocatalytic process, UV light was usually used to stimulate the semiconductor surface to generate photo-induced holes or reactive oxygen species, such as ·OH and ·O₂[−] radicals, which further interact with organic pollutants and lead to oxidation and overall mineralization [10–13]. The destruction and/or mineralization efficiency of this process depends on the TiO₂ surface properties and, more importantly, on the quantum yield and its recombination rate [13–15].

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