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Effect of sintering on photocatalytic degradation of methyl orange using zinc ferrite

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ABSTRACT

UV-light responsive $ZnFe_2O_4$ photocatalyst was synthesized by using co-precipitation method under stoichiometric conditions. Photocatalytic activity of zinc ferrite powder was studied for the degradation of methyl orange under UV-light irradiation.

1. Introduction

Zinc ferrite semiconductor photocatalyst has been applied widely to degrade the organic pollutants for the remediation of hazardous wastes, contaminated groundwater and the control of toxic air contaminants [1]. Zinc ferrite has potential applications in the conversion of sunlight and sensitive towards visible light [2]. Spinel zinc ferrite has been reported as a semiconducting material with tetrahedral sites occupied by Zn^{2+} ions and octahedral sites by Fe^{3+} ions [3–5]. The conduction mechanism in zinc ferrite is due to the Fe^{2+} and Fe^{3+} ions present in octahedral sites as suggested by Feteira et al. [6]. Its chemical and thermal stability has made zinc ferrite important materials, such as magnetic materials [7], catalysts [8,9] and absorbent materials [10,11], in the past decade. Particularly, nanosized zinc ferrite has been extensively studied by worldwide researchers because of its unique size dependent physical and chemical properties as compared to bulk counterpart material [7]. Advanced oxidation processes are of ample interest currently for the effective oxidation of a wide variety of organics and dyes [12]. Among them, top priority goes to semiconductor assisted photocatalytic degradation. Most of the photocatalytic studies use either synthetic or commercial TiO_2 as the photocatalyst [13]. However, recently some studies have been carried out to evaluate the priority of other metal oxides [14]. Among the other semiconductors, ZnO appears to be a highly promising photocatalyst [15]. Due to the high concentration of organics in the effluents and the higher stability of modern synthetic dyes, the conventional biological treatment methods are ineffective for the complete color removal and degradation of organics and dyes [16]. Other conventional methods of color removal from an aqueous medium include techniques like coagulation, filtration, and adsorption by activated carbon and treatment with ozone [17].

In this article, we report the microstructure and UV-light induced photodegradation performance of $ZnFe_2O_4$ nanoparticles. The photocatalytic degradation of methyl orange has been investigated for different sintering temperature and irradiation time of this sample and the observed photocatalytic activity is correlated with the physicochemical properties of this catalyst.

2. Experimental

The zinc ferrite has been synthesized by using co-precipitation technique. A. R. grade zinc sulphate and ferrous sulphate were dissolved in appropriate proportion. The metal salts were then precipitated as hydroxides using 10% NaOH solution maintaining the pH at 10. Hydroxides were then oxidized using 30% H_2O_2 (100 Vml) solution. The precipitate was washed and filtered till it is free from sulphate and excess alkali. The precipitate was dried in vacuum cryostat at 110 °C and sintered at different temperatures from 500 to 900 °C for 4 h. X-ray powder diffraction patterns were recorded on a diffractometer (Philips PW 1730) with microprocessor controller, using CrKα radiation ($\lambda = 2.289$ Å).The morphological features were observed by a scanning electron microscope (SEM: model JEOL-JSM 6360).

2.1. Photodegradation of methyl orange (MO)

Ultra-violet light photocatalytic activities of the obtained photocatalyst were measured by the decomposition of methyl orange in an aqueous solution at ambient temperature. A cut-off filter was placed under the UV lamp (230 V) to remove all wavelengths less than 400 nm.

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