



Original research article

Photocatalytic degradation of Alizarin Red dye under visible light using ZnO & CdO nanomaterial

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ABSTRACT

ZnO, CdO nanomaterial were utilized for the degradation of Alizarin Red dye photocatalytically under visible light illumination. ZnO photocatalyst was prepared by the hydrothermal method at a temperature of 160 °C and CdO synthesized by the microwave-assisted hydrothermal method at a temperature of 140 °C. Synthesized nanomaterial was characterized by XRD, SEM, TEM, UV–vis spectroscopy and PL. The photocatalytic degradation of Alizarin Red (AR) dye was carried out utilizing prepared photocatalyst irradiated with 60 W Tungsten light source with the fixed dose of catalyst on standard AR dye and studied its Kinetic analysis of photodegradation on Alizarin Red dye and conclude the efficiency of ZnO and CdO nano photocatalyst at the same condition.

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1. Introduction

Over so many decades dyes has been prepared and used. In ancient time dyes are prepared from the natural source and degraded naturally but after industrialization, so many organic dyes synthesized artificially because of much more demand in textile, leather, paper, paint and other industries. All over world approximately 7×10^5 tons of dye and pigments are produced and have thousands of varieties. During the process of dyeing 20–25% dye of worldwide production is readily released in the form of industrial effluent and today's most threatening part due to which environmental pollution occurred in wastewater which was most probably released from textile and other industries. [1,2]. Without dye textile industries existence in doubt i.e. dye vs. textile industry. Most worried part of the organic dye is modern dyes are more stable for the quality reason of dyeing i.e. resistant chemically and biological and to light-induced fading. Now this one causes big trouble in the form wastewater which causes environmental pollution. Therefore, the new method for treatment of dyes, which should be easier and cheaper with higher efficiency, is necessary. Recently AOP and photocatalysts which employs suitable semiconductor with visible light as a promising destructive technology leading to complete removal of pollutants basically dye, pigments etc. [3–5]. Photocatalytic nanomaterial with narrow band gap energy is suitable for photodegradation of dye.

As wide band gap is decreases called as semiconductors and it will absorb energy of certain wavelength due to which electrons from valence band promotes to the conduction band, leaves the hole in valence band and electron in conduction band called as the photogenerated electron-hole pair. This electron and hole promotes reduction and oxidation of dye whenever adsorbed at the surface of photocatalyst showing semiconducting behavior and shows oxidative degradation

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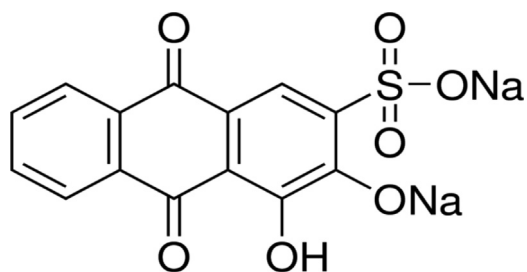


Fig. 1. Structure of Alizarin Red S ($C_{14}H_6Na_2O_7S$).

of dye via radical mechanism. The absorption of energy of certain wavelengths by a semiconductor [6,7] & Photocatalytic degradation of Alizarin Red dye using semiconductor such as ZnO and CdO is simple and effective and clean technology and applied for industrial post production wastewater treatment with minimum dose has attract more attention [8,9]. This technique is popularized because it shows an ability completely degradation of organic dye into the water and carbon dioxide and minimal and or no any harmful by-products i.e. water purifier [10–12]. ZnO and CdO nanomaterials semiconductor is most favored material in this technique and as particle size decreases surface area increased also shows some interesting results. This photodegradation technique for removal of Alizarin Red dye and its mechanism shown in many kinds of literature [13–18]. Alizarin Red dye selected as the standard dye for this study for coming to conclusion because it is water soluble and widely used as a coloring agent in the industry such as leather, fiber, textiles etc. [19–21]. The chemical structure of selected alizarin red dye Fig. 1.

This study was conducted with the aim and objective of synthesis of ZnO and CdO photocatalysts nanomaterial by hydrothermal and microwave assisted method and estimated the photocatalytic degradation of Alizarin Red dye under visible light with fixed dose catalysts on same dye concentration to compare.

2. Materials and experiment

2.1. Material for synthesis of ZnO and CdO

a) For ZnO nonmaterial synthesis

Zinc acetate [$Zn(CH_3COO)_2$], Urea [$(NH_2)_2CO$], Cyclohexane (C_6H_{12}), Tertiary Butyl Alcohol (C_4H_9OH), cetyl trimethylammonium bromide (CTAB), ethanol and deionised water.

b) For CdO nanomaterial synthesis

Cadmium oxalate [$Cd(C_2O_4)$], Urea [$(NH_2)_2CO$], Cyclohexane (C_6H_{12}), Tertiary Butyl Alcohol (C_4H_9OH), cetyl trimethylammonium bromide (CTAB), ethanol and deionised water. All reagents used without further purification.

2.2. Synthesis of ZnO naomaterial

Hydrothermal synthesis of ZnO already discuss but it will further analyzed and compaired [22]. Firstly, take 3 g cetyltrimethylammonium bromide (CTAB) and 1.8 g of urea and dissolved in 150 ml of deionized water and stirred for 15 min to this add 50 ml cyclohexane and 6 ml t-butyl alcohol again stirred for 5 min. After 5 min, 0.5 mmol $Zn(OAc)_2$ was added dropwise prepared in 25 ml distilled water. This mixture was transferred to a hydrothermal reactor and heated at $180^\circ C$ for 16 h, then cooled to room temperature and washed several times with distilled water and ethanol and calcinated at $200^\circ C$ for 2 h and collected air dried.

2.3. Synthesis of CdO nanomaterial

The nanosize CdO particles were grown using microwave-assisted reactor. Aqueous solutions of cadmium oxalate [CdC_2O_4] and urea [$CO(NH_2)_2$] were used as sources of Cd^{2+} and O^{2-} ions, respectively. Firstly, prepare 5 ml of 0.5 mmol cadmium sulfate in the beakers. An appropriate amount of 0.104 g CTAB was then added with continuous stirring to the 500 ml round bottom flask containing 100 ml millipore water. After stirring for 15 min, 5 ml of 5 mmol urea was added dropwise to the round bottom flask to this adds 25 ml cyclohexane and 4 ml t-butyl alcohol and again stir for 5 min. After, 5 ml of 0.5 mmol cadmium sulfate was added dropwise to round bottom flask and stir for 30 min. After half an hour transfer inside a microwave oven. The deposition was performed at $150^\circ C$ for 10 min under microwave irradiation. The samples were washed with deionized water & ethanol to collect cadmium hydroxide [$Cd(OH)_2$] on calcination at $300^\circ C$ for 2 h, finally, collect Cadmium oxide (CdO) nanoparticles.

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