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Sunlight assisted photocatalytic degradation of different organic pollutants and simultaneous degradation of cationic and anionic dyes using titanium and zinc based nanocomposites

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ABSTRACT

ZnO-TiO_2 nanocomposites have been successfully synthesized by using simple hydrothermal method with various ZnO-TiO_2 concentrations (such as 2:1, 1:1 and 1:2 ZnO-TiO_2, pure ZnO and TiO_2). The XRD, FT-IR, HR-TEM, FE-SEM with EDAX, XPS and UV–Visible spectroscopy were utilized for characterization of the as-prepared products. XRD revealed that samples are in nanocrystalline nature with formation of anatase TiO_2, hexagonal ZnO, cubic Zn_2TiO_4 and other zinc titanates. The average crystallite size of the samples was between 8 and 36 nm. The photocatalytic activity has been demonstrated for the degradation of methylene blue (MB), tetracycline (TC) and mixture of dyes (includes methylene blue, rhodamine B and methyl orange) under sun light irradiation at room temperature. The degradation rate of methylene blue has been significantly enhanced with increase in percentage of ZnO. Nanocomposites with 2:1 concentration of Zn and Ti, has been more efficient than that of other composites. Also, effect of different parameters such as pH of dye solution, concentration of dye and amount of catalyst etc. has been evaluated.

1. Introduction

Currently whole world suffering from environment issue such as lack of substantial and clean natural energy, pollution, contamination of the environment. The fast growing industrializations have increased the generation of highly toxic and carcinogenic wastewater. The wastewater includes high concentration of various organic dyes, surfactants, heavy metals and other harmful compounds which also hazardous to the quality of soil and introduce ill-effect on aquatic ecosystems as well as human beings [1]. From them dyes and pigments are substances with high application potential in the various industries and extensively used in textile, food, cosmetic, precious stones, leather, paper, plastics, processing, printing, rubber, pharmaceutical, tannery primarily to color the final products [2]. During the process of colouring, 10–50% dyes are losses and discharged in to the wastewater that generate coloured effluents. For example, it is estimated that there are more than 100,000 synthetic dyes, with an annual manufacture of more than 700,000 tons world-wide, producing a significant amount of wastewater [3]. In the textile effluent the concentration of dyes are differs from 10 mg/L to 250 mg/, the highest concentration 800 mg/L of reactive dye referred by Yaseen and Scholz [4,5]. Furthermore, tetracycline (TC) is frequently used as antibiotics, which on discharge to water system develops considerable adverse effects on human health and ecological systems. Due to the poor decomposition in animals and human bodies, the majority of TC is discharged into the wastewater [6]. Furthermore, antibiotic existence in the environment can affect various species of bacteria, and increase their resistance [7], thus it needs appropriate approaches for its removal.

Numerous technologies have been widely investigated to remove the concentration of dye and tetracycline from wastewater. In which photocatalytic technology is an emerging and severally demonstrated with prominent superiority for the decomposition of organic dyes, pollutants and pharmaceutically emerging contaminants from different industries, health care sector as well as agriculture field. Semiconductor composite photocatalysts have been extensively exploited in recent years owing to their promising properties due to individual components and newly introduced properties due to formation of composite. Several composites has been used for addressing the pressing task to curb the current rapid deterioration of the living environment [8]. Primarily, in photocatalysis decomposition of organic and inorganic compounds has been initiated through the generation of electron-hole pairs. Photocatalyst illuminated with light of energy

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