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# Studies on the catalytic activity of $CuO/TiO_2/ZnO$ ternary nanocomposites prepared via one step hydrothermal green approach

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## Abstract

In the present investigation, $CuO/TiO_2/ZnO$ ternary nanocomposites (CTZ TNCs) were developed via one-step hydrothermal green approach using *Delonix regia* flower extract. The monoclinic, tetragonal and hexagonal wurtzite phase structures were observed from the CTZ TNCs, which was primarily identified by the PXRD pattern. The structural defects and crystal nature was demonstrated by the Raman analysis. The individual prominent Raman modes of CuO, $TiO_2$ and ZnO were observed from the CTZ TNCs. The morphological study was investigated by using Field Emission Scanning Electron Microscope (FESEM) analysis. From the FESEM analysis, needle like structure was observed from the prepared material of CTZ TNCs and size was achieved around to be 50–200 nm. At room temperature, ternary CTZ NCs acts as an excellent catalyst for reduction of 4-nitrophenol (4-NP), Methylene Blue (MB) and Crystal violet (CV) dyes and degradation efficiency achieved to be 95.48%, 94.84% and 82.18%, respectively.

## 1. Introduction

In the recent decade, water pollution is a vital environmental issue owing to the fast growth of chemical industries and the discharge of industrial pollutants into the water system [1]. In generally, textiles, paper mills and bio-medical industries are utilized different types of organic pollutants such as crystal violet, methylene blue and 4-nitrophenol used as a fabrication process [2]. In these dyes are causing mutagenic and carcinogenic substantial injury to human life. Hence, these dyes are necessary to remove from our water resources. The conventional wastewater treatments like UV-irradiation, membrane separation, coagulation, adsorption techniques and hydrogen peroxide oxidation are used in the current trend. Among them, the catalytic technique is one of the effective approaches for decolourization of dyes [3].

Especially, transition metal oxides like copper oxide (CuO), Zinc oxide (ZnO) and Titanium oxide ($TiO_2$) are the significant class of semiconductor for effective dye degradation process from waste water effluents due to absorb photons, creating charge carriers which give rise to potential oxidizers of organic dyes [4]. The CuO have more attracted towards its outstanding optical, electrical and thermal properties due to its unique p-type semiconductor (1.2 ev), which has been used as magnetic storage media, photovoltaics, photocatalysis, gas sensing and battery applications. [5]. As well as, ZnO is a n-type wide band gap (3.37 eV) semiconductor and used as various applications like photovoltaics, photocatalysis, UV protection, gas sensing, pharmaceuticals etc because of its favorable optical and electrical properties [6, 7]. In addition, $TiO_2$ is n-type wide band gap (3.0–3.2 eV) semiconductor and has been widely used as various applications such as catalytic activity, gas sensor, photovoltaic and other variety of applications [8, 9].

In a recent trend, various researchers are developing new composite material for innovative direction for research and applications [10]. In this co[illegible] current research is focused to develop copper oxide-based



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