

## **ABSTRACT**

The present study focuses on the facile and non-toxic synthesis of hybrid or trimetallic nano-composite of Zinc Oxide by co-precipitation for photo-catalytic and detection applications. The objective of this comparative study is to introduce an efficient photo-catalyst and sensor. The resulting composites Cu/Ni-doped ZnO, Cr/Ni-doped ZnO, Gd/Ni-doped ZnO, and Gd/Cr-doped ZnO characterized and optical properties were studied using UV-Visible absorption spectroscopy and photoluminescence spectroscopy. The UV-Vis spectroscopy showed a decrease in band-gap of Cu/Ni-doped ZnO, Cr/Ni-doped ZnO, and Gd/Cr-doped ZnO except for Gd/Ni-doped ZnO as compared to pure zinc oxide nanoparticles. Gd/Ni-doped ZnO showed a blue shift. The PL-spectroscopy analysis showed orange-red emission defects. The photocatalytic activity was tested by the degradation of methyl blue and 2-nitrophenol under UV-light, Sunlight, and without irradiation. The results showed that composites effectively bleached out methyl blue and reduces 2-nitrophenol to 2-aminophenol. The enhanced photoactivity of nano-composite photo-catalyst was attributed to greater absorptivity, extended light absorption, and large surface area due to surface defects. The sensing efficiency of composites was tested by indirect fluorescence method (quenching based sensing). 2-nitrophenol (explosive) was used as a quencher or analyte. Among all composites, Cu/Ni-doped ZnO and Gd/Cr-doped ZnO were found efficient with 80-95% degradation and fluorescence efficiency. The observed results govern that these hybrid nano-composites can be the potential candidate for a photo-catalyst and a sensing probe.