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Photocatalytic Activity of $ZnFe_2O_4$ for the Degradation of Fast Green FCF and Orange II

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INTRODUCTION & AIM

Synthetic dyes, are extensively used in various industries. However, their persistence, toxicity, and resistance to biodegradation make them significant environmental pollutants, particularly in wastewater. Traditional treatment methods often fall short in completely removing such contaminants. In recent years, photocatalysis using semiconductor materials has emerged as a promising approach for dye degradation under mild conditions. Among various metal oxide photocatalysts, zinc ferrite ($ZnFe_2O_4$) has gained attention due to its narrow band gap, good stability, low cost, and activation under visible light.

MATERIALS AND METHOD

All of the chemicals employed in this work were of analytical grade, no additional purification was required before use. Zinc nitrate hexahydrate ($Zn(NO_3)_2 \cdot 6H_2O$), ferric nitrate nonahydrate ($Fe(NO_3)_3 \cdot 9H_2O$) were procured from Sisco Research Laboratories Pvt. Ltd.) sodium hydroxide (NaOH), ethanol and Fast Green FCF dye were procured from SRL. NEUATION iFUGE D08 centrifuge machine was used for centrifuging the reaction mixtures and recovering the precipitates. UV–Visible absorption spectra were recorded between 200–800 nm using Agilent Cary UV-Vis Compact Peltier R3.15AL250V spectrophotometer. The crystallinity and phase identification purity of the synthesised precursors were detected by using a diffractometer (Model No.: D8 Advance Eco, Make: Bruker, Germany). FT-IR spectra were obtained using a spectrophotometer (Model No.: Nicole 6700, Make: Thermo-Scientific, USA). The morphology was studied by a Scanning Electron microscope (Model: JSM 6490 LV, Make: JEOL, Japan).

EXPERIMENTAL

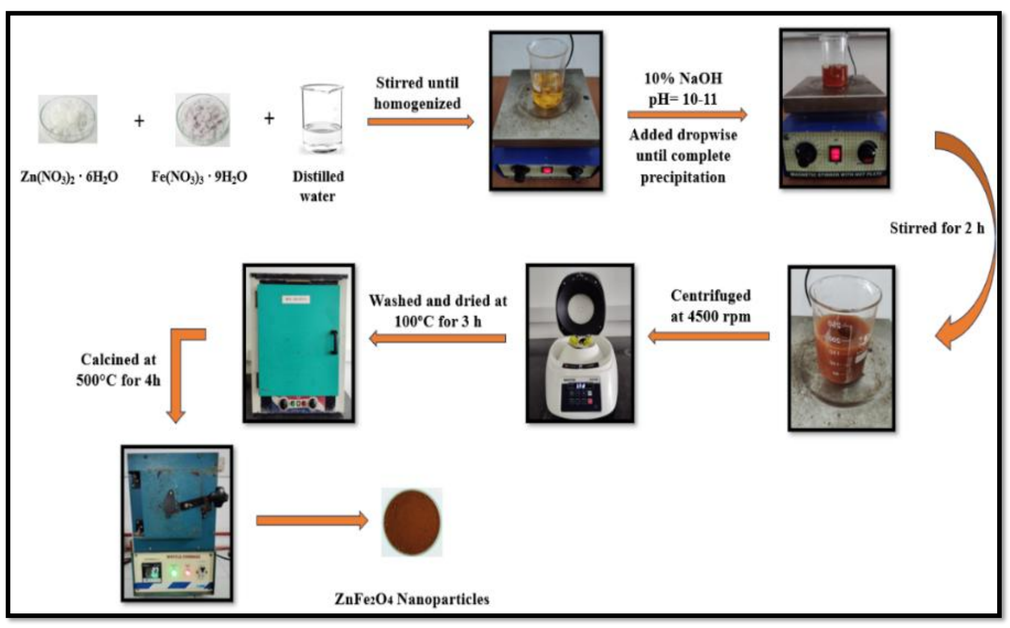


Fig. 1 Schematic representation of synthesis $ZnFe_2O_4$ NPs

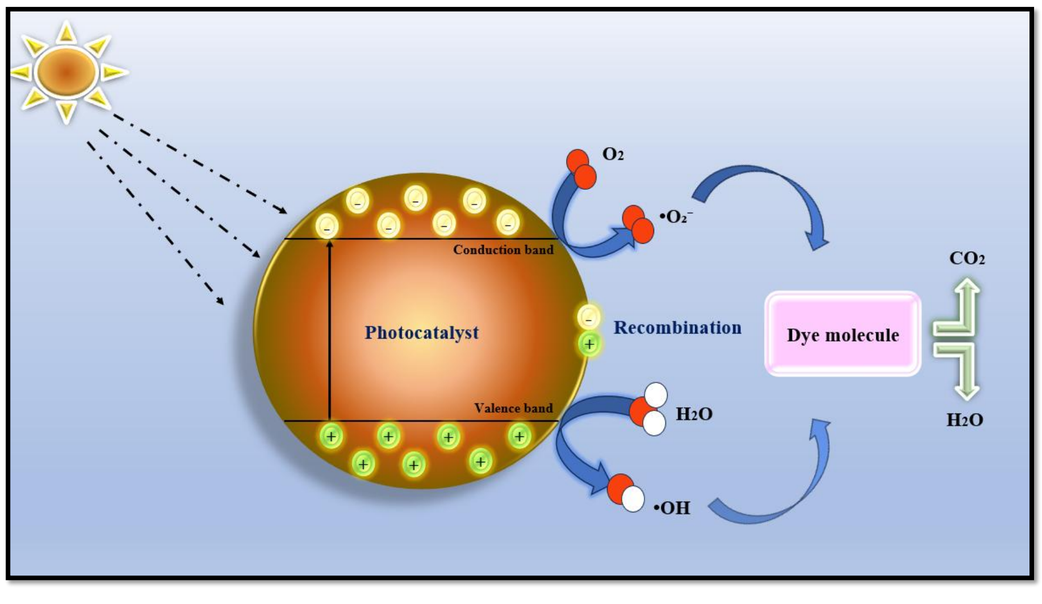
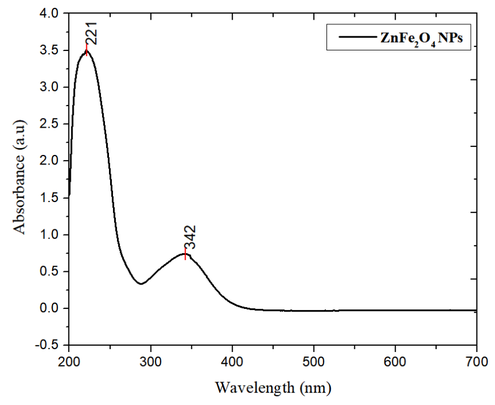
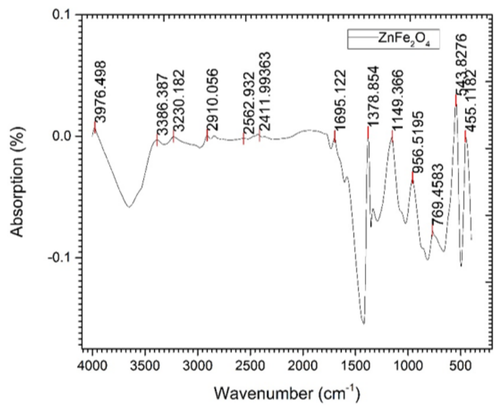


Fig. 2 Probable mechanism of Fast green FCF and Orange II degradation

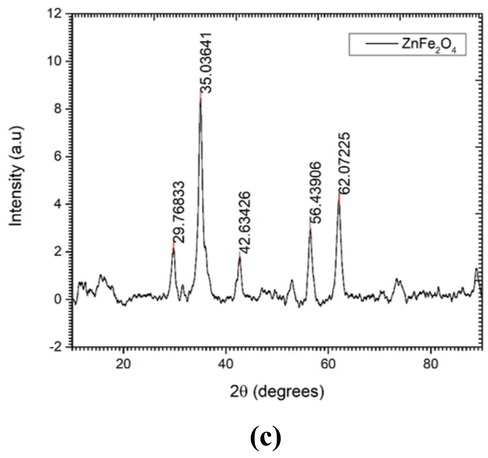
CHARACTERIZATION



(a)



(b)



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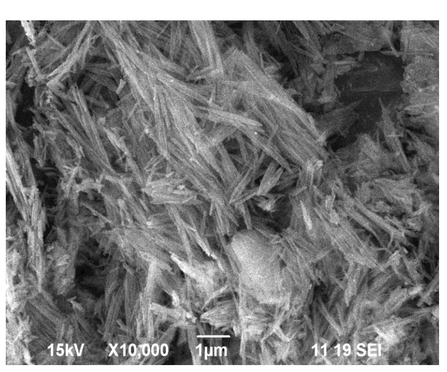
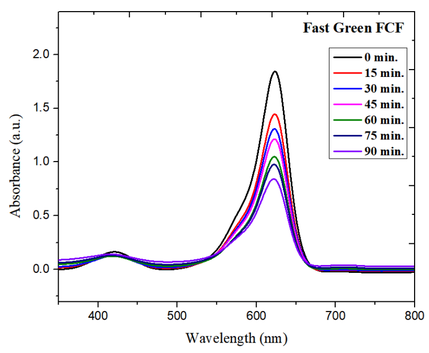


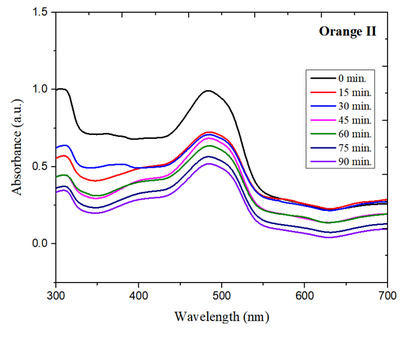
(d)

Fig. 3 (a)UV-Vis spectra (b) IR spectra (c) XRD spectra (d) SEM image of $ZnFe_2O_4$ NPs

RESULTS & DISCUSSION

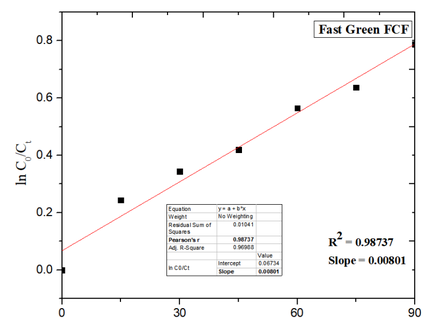


(a)

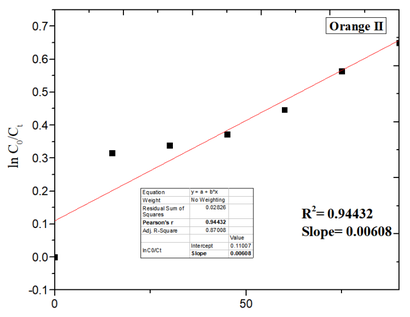


(b)

Fig. 4 Time-dependent UV-Vis spectra of (a) Fast Green FCF, (b) Orange II



(a)



(b)

Fig. 5 Pseudo-first-order kinetic plot of ln(Co/Ct) vs. time (a) Fast Green FCF , (b) Orange II

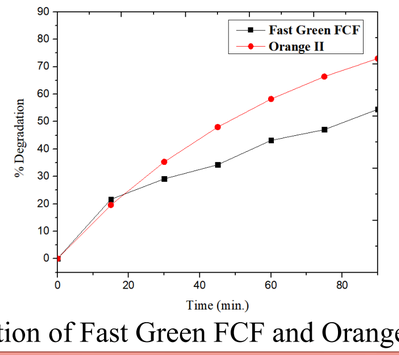


Fig. 6 % degradation of Fast Green FCF and Orange II with $ZnFe_2O_4$ NPs

CONCLUSION

The spectrophotometric monitoring of dye degradation revealed that the produced material has significant photocatalytic efficacy. Under visible light irradiation for 90 minutes, the $ZnFe_2O_4$ nanoparticles achieved 54% degradation of Fast Green FCF and 73% degradation of Orange II Sodium Salt. The study emphasizes the benefits of utilizing $ZnFe_2O_4$ as a visible-light-activated, cost-effective, and environmentally friendly photocatalyst. These findings add to the growing corpus of research aimed at establishing sustainable wastewater treatment options.