

## Photocatalytic Activity of Sol-gel Synthesized Fe<sub>3</sub>O<sub>4</sub>/MgO Nanocomposites for Methylene Blue Dye Degradation

V. Gurunathanan<sup>1\*</sup>, K.B. Wijyaratne<sup>1,2</sup>, B.S. Dassanayake<sup>1,2</sup>, and H.C.S. Perera<sup>1,2</sup>

<sup>1</sup>*Postgraduate Institute of Science, University of Peradeniya, Peradeniya, Sri Lanka*

<sup>2</sup>*Department of Physics, University of Peradeniya, Peradeniya, Sri Lanka*

*\*guru201666@gmail.com*

Water pollution from industrial effluents with organic dyes is an urgent environmental concern. Methylene blue (MB) is particularly problematic due to its wide industrial use and known persistence and toxicity. Photocatalysis offers promise for organic dye degradation, and incorporating magnetic materials allows easy separation and recyclability. We focused on synthesizing Fe<sub>3</sub>O<sub>4</sub>/MgO nanocomposites and evaluating their photocatalytic activity for MB dye degradation. Fe<sub>3</sub>O<sub>4</sub>/MgO nanocomposites (particle size = 82.9 nm) were successfully synthesized via a controlled sol-gel method, featuring unique aloe vera stem-like structures with granular particle morphology, indicating a high surface area for enhanced photocatalytic activity. Powder X-ray diffraction confirmed cubic Fe<sub>3</sub>O<sub>4</sub> and MgO structures. For photocatalytic degradation, the Fe<sub>3</sub>O<sub>4</sub>/MgO photocatalyst was dispersed in a 50 ml MB solution and exposed to direct sunlight. Over time, MB concentration progressively decreased, with the characteristic absorption peak vanishing after 2.5 hours. Kinetic analysis yielded an optimum rate constant of  $1.55 \times 10^{-4} \text{ s}^{-1}$ , resulting in 99% degradation after 2.5 hours. Dark adsorption studies established equilibrium with minimal dye concentration variation. In the presence of the catalyst and light, significant degradation occurred, highlighting the catalyst's importance. Control experiments without the catalyst showed no self-degradation of dyes under sunlight (optimum rate constant of  $0.95 \times 10^{-4} \text{ s}^{-1}$ ). The sol-gel-synthesized Fe<sub>3</sub>O<sub>4</sub>/MgO nanocomposites exhibited excellent photocatalytic efficiency under sunlight, making them promising for organic pollutant treatment in wastewater. Magnetic properties coupled with photocatalytic performance offer an effective and sustainable solution for water pollution from organic dyes. Utilizing these nanocomposites can safeguard the environment and public health from harmful industrial pollution.

**Keywords:** Degradation, Organic dyes, Photocatalysis, Sol-gel synthesis, Water pollution

*Acknowledgement: This work was supported by the science batch of 1976-1980 of the University of Peradeniya, Sri Lanka*