Green Synthesis of Reduced Graphene Oxide/CoFe2O4/Fe Nanocomposite for the Photocatalytic and Fenton-Like Degradation of Glyphosate in Water

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Herbicide overuse is alarmingly high today, particularly those containing substantial amounts of Glyphosate, or GLP (C3H8NO5P). GLP, commonly used for weed control, poses significant risks due to its excessive solubility in water, far exceeding safe limits. This study introduces a ternary nanocomposite of reduced graphene oxide, cobalt ferrite, and zero-valent iron (rGO/CoFe2O4/Fe0), synthesized through an eco-friendly method. This composite serves as a catalyst to activate peroxymonosulfate (HSO5, PMS) for effective glyphosate removal from water. The rGO/CoFe2O4/Fe0 nanocomposite underwent extensive characterization using techniques like FTIR, XRD, UV-Vis DRS, VSM, SEM, TEM, EDX, Raman, and BET. It was found to have densely packed CoFe2O4 (25 nm) and Fe0 (50 nm) nanoparticles on rGO sheets. Notable features of the nanocomposite include a high specific surface area (118.9 m²/g), high saturation magnetization (30.16 emu/g at 11 kOe), superparamagnetic properties, a narrow band gap energy (1.30 eV), and a remarkable GLP degradation efficiency of 99.62%. Detailed studies were conducted to explore how various environmental factors such as catalyst dosage, PMS concentration, and pH impact GLP degradation. The study identified a photocatalytic mechanism by which reactive oxygen species (ROS) degrade GLP, emphasizing the primary role of sulfate radicals (SO4?-), followed by holes (h+), superoxide radicals (O2?-), singlet oxygen (1O2), and hydroxyl radicals (HO?). The rGO/CoFe2O4/Fe0 nanocomposite demonstrated excellent properties as a magnetic visible-light photo-Fenton-like catalyst, showing great promise for practical applications in wastewater treatment.

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