Structure and Magnetic Properties of Hydrothermally Synthesized $CuFe_2O_4$/Reduced Graphene Oxide Nanocomposites

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Spinel ferrites are a class of materials with a general formula of MFe_2O_4, where M is a divalent cation such as Zn^{2+}, Ni^{2+}, Mn^{2+}, or Cu^{2+}. These materials have gained increasing attention in recent years due to their beneficial combination of magnetic, electrical, and optical properties, suitable for a variety of applications - from data storage (high anisotropy and coercivity magnetic nanoparticles), biomedical (drug delivery, magnetic resonance imaging, hyperthermia), energy storage (chemically stable redox electrode for batteries and supercapacitors). Spinel nanoparticles have shown great potential for environmental applications such as water treatment agents (heavy metals removal or the catalytic destruction of organic pollutants). Copper ferrites $CuFe_2O_4$ is an attractive catalyst for both organic synthesis (oxidation of alcohols, the Knoevenagel condensation reaction, synthesis of heterocyclic compounds) and environmental applications (photodegradation of organic pollutants such as dyes and pesticides in contaminated water while the magnetic properties allow its easy separation). The catalytic activity of $CuFe_2O_4$ nanoparticles can be improved by finding the conditions of thermal treatment that lead to the optimal balance between surface area and crystallinity. The use of $CuFe_2O_4$ / rGO (reduced graphene oxide) composites allows for enhancing catalytic properties due to the synergistic effect, resulting from the interfacial interaction between ferrite and rGO in the composite. This work aims to establish the effect of various calcination temperatures on the magnetic and structural properties of $CuFe_2O_4$ / rGO composites.

All samples were calcinated at 300, 400, and 500^0C in argon flow. The average particle size values were 19 nm for initial $CuFe_2O_4$ and 17, 16, and 13 nm after calcination at 300, 400, and 500^0C. Mossbauer spectra measured for these materials consist of a central doublet and broadened two sextets that correspond to the presence of both ferromagnetic and superparamagnetic ferrite particles. The increase in the annealing temperature causes the crystallization of both tetrahedral and cubic phases of $CuFe_2O_4$ as a part of composite materials. The Mossbauer spectra of the $CuFe_2O_4$ / rGO sample annealed at 400^0C indicate its transition state between superparamagnetic and ferromagnetic state. The suggested approach allows obtaining the thermally stable $CuFe_2O_4$/rGO composite with controllable structural and magnetic properties.

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