STUDY ON STRUCTURAL AND MAGNETIC PROPERTIES OF HIGH-ENERGY BALL-MILLED NANOPARTICLES $CoFe_2O_4$ BY NEUTRON DIFFRACTION

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Among spinel-structured materials, cobalt ferrite ($CoFe_2O_4$) has been extensively studied due to its numerous potential technological applications, including outstanding hard magnets, ultra-dense information storage, catalysts, sensors, ferromagnetic fluids, cancer therapy, drug delivery, and biomedical imaging. Furthermore, this material is also a subject of great interest from a fundamental science perspective due to the magnetic attraction phenomena arising from the interaction between geometrically frustrated lattice arrangements and complex cation distribution at crystal sites [1]. Meanwhile, neutron diffraction is a powerful experimental technique for the simultaneous investigation of crystal structures and magnetic ordering in solid-state materials. Due to their electrical neutrality, neutrons are only scattered by atomic nuclei. This characteristic enables the precise localization of atomic positions within the unit cell and grants neutrons a significantly greater penetration depth compared to X-rays [2]. In this study, nanoparticles were synthesized from the initial bulk $CoFe_2O_4$ using high-energy ball milling. Neutron diffraction analysis confirmed that the resulting nanoparticles maintain a stable, single-phase spinel structure with space group $Fd\bar{3}m$ throughout the milling process. Furthermore, neutron diffraction analysis revealed ferrimagnetic behavior as milling time increased, significantly influencing the magnetic ordering of the system.

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