Impact of Co^{2+} substitution on microstructural evolution and magnetic properties of zinc ferrite nanoparticles synthesized by precipitation and hydrothermal-joint method

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The microstructural characterization of spinel-ferrites has been long discussed in the literature [1]. Such interests are justified by the spinel-ferrites potential applications that involve spintronic and magnetic resonance imaging (MRI), gas sensors, magnetic recording, medical diagnostics, antibacterial agents and self-controlled magnetic hyperthermia [2]. In the present work, we have synthesized $Co_xZn_{1-x}Fe_2O_4$ spinel ferrite nanoparticles (x= 0, 0.1, 0.2, 0.3 and 0.4) via the precipitation and hydrothermal-joint method. Structural parameters were cross-verified using X-ray diffraction (XRD) and electron microscopy based-techniques. The magnetic parameters were determined by means of vibrating sample magnetometry. The as-synthesized $Co_xZn_{1-x}Fe_2O_4$ nanoparticles exhibit high phase purity with a single-phase cubic spinel-type structure of Zn-ferrite. The microstructural parameters of the samples were estimated by XRD line profile analysis using Williamson-Hall method. The calculated crystallite sizes from XRD analysis for the synthesized samples ranged from 8.3 to 11.4 nm. The electron microscopy analysis revealed that all powder samples are composed of regular spherical nanoparticles with highly homogeneous elemental composition. The $Co_xZn_{1-x}Fe_2O_4$ spinel ferrite system exhibits paramagnetic, superparamagnetic and weak ferromagnetic behavior at room temperature depending on the Co^{2+} doping ratio, while ferromagnetic ordering with a clear hysteresis loop is observed at low temperature (5K). We concluded that the substitution of Zn with Co^{2+} ions impact both structural and magnetic properties of $ZnFe_2O_4$ nanoparticles.[3]

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