



Magnetic Properties of $M\text{FeCrO}_4$ ($M = \text{Co/Ni}$) Prepared by Solution Combustion Method

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Abstract

Single phase $M\text{FeCrO}_4$ ($M = \text{Co/Ni}$) nanosized samples are prepared by solution combustion method using glycine as fuel. Lattice parameter obtained after Rietveld refinement of the powder x-ray diffraction pattern of CoCrFeO_4 and NiCrFeO_4 samples are 8.374 and 8.325 Å and corresponding crystallite sizes are 40 and 27 nm, respectively. FTIR spectra of both samples show tetrahedral and octahedral metal oxygen bond stretching peaks at 596 and 488 cm^{-1} , indicating spinel phase formation. DC magnetisation study indicates that both samples are ferrimagnetic at room temperature, with CoCrFeO_4 having a higher value of saturation magnetisation. Mössbauer spectra indicate the presence of magnetic relaxation in the samples. Also, the strength of interaction with nearest neighbour Fe^{3+} cations is higher in NiCrFeO_4 .

Keywords Spinel oxides · Combustion synthesis · Magnetic materials · Mössbauer spectroscopy

1 Introduction

Spinel ferrites have ferrimagnetic order due to the presence of strong super-exchange interaction between tetrahedral (A-site) and octahedral (B-site) cations [1]. The strength of interaction can be altered by changing the cations occupying the two sites, which in turn affects the magnetic order. A wide variety of cations can be accommodated in this structure without any major structural transformation [2]. Cobalt and nickel ferrites are two important members of the spinel family whose

structural and magnetic properties can be easily modified by the substitution of divalent ions [3, 4]. A number of researchers have reported that there is a significant variation in the value of saturation magnetisation when these ferrites are doped with zinc [4–6]. Compared to the number of reports on the substitution of divalent cations, studies reporting the substitution of trivalent cations in these ferrites are few. Kadhim et al. reported the influence of chromium substitution on the structural properties of $\text{ZnFe}_{2-x}\text{Cr}_x\text{O}_4$ ferrite, synthesised by ceramic method [7]. Köseoğlu used hydrothermal technique to prepare $\text{Ni}_{0.5}\text{Zn}_{0.5}\text{Cr}_x\text{Fe}_{2-x}\text{O}_4$ and studied the influence of structural and magnetic properties [8]. Sharma et al. reported the preparation of CoCrFeO_4 samples by solution combustion method using different fuels [9]. Lyubutin et al. has reported high saturation magnetisation for $\text{NiFe}_{0.75}\text{Cr}_{1.25}\text{O}_4$ nanoparticles prepared by combustion method which is higher than the bulk value [10]. The recent research works in the literature gives evidence to the growing interest on the spinel ferrites containing Cr^{3+} and Fe^{3+} cations [11–14]. Replacing Fe^{3+} with Cr^{3+} ions in spinel ferrites modify the magnetic interaction in the system. Since chromium has strong preferential occupancy at octahedral site, incorporation of chromium reduces the magnetic moment at B-site [15]. These systems are reported to introduce frustrations in the magnetic structure due to the strong negative $\text{Cr}^{3+}(\text{B})\text{—O—Cr}^{3+}(\text{B})$ interaction [16]. Complete replacement of iron with chromium leads to the

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