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Study of Tunable Exchnage Bias Behavior on $Ni(Cr_{1-x}Mn_x)_2O_4$

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Abstract—*Spinel chromites ACr_2O_4 (A = Ni, Mn, Co, Fe, etc.) have attracted considerable research interest due to their potential applications and their interesting magnetoelastic, magnetoelectric and multiferroic properties. $NiCr_2O_4$ is a normal cubic spinel chromite, where Ni^{2+} ($3d^8$) ions occupy the tetrahedral A site and the Cr^{3+} ($3d^3$) ions occupy the octahedral B site. $NiCr_2O_4$ is known to crystallize in cubic structure above 320 K. While below 320 K, a cooperative Jahn-Teller distortion reduces its crystal symmetry to tetragonal [1]. In the present work we have studied the exchange bias behaviour on $Ni(Cr_{1-x}Mn_x)_2O_4$ compounds.*

$Ni(Cr_{1-x}Mn_x)_2O_4$ (x = 0.0 – 0.50) samples were prepared by using sol-gel method. Rietveld refinement of the X-ray diffraction patterns show that the parent compound crystallizes in tetragonal structure with $I4_1/amd$ space group while the Mn doped samples crystallize in cubic structure with $Fd\bar{3}m$ space group. All the samples show ferrimagnetic nature with the transition temperature (T_C) increasing form 73 K for x = 0 to 145 K for x = 0.50 sample. A negative magnetization is observed in the field cooled magnetization curve of x = 0.30 sample below the magnetic compensation temperature (T_{comp} = 35 K). This magnetization reversal is due to the different temperature dependences of the two sublattices present in the sample. Shifting of the hysteresis loop towards negative field axis i.e., negative exchange bias field is observed for x = 0.10 sample which decays exponentially with increase in temperature. On the other hand, x = 0.30 sample shows tunable positive and negative EB field across the compensation temperature. Origin of the negative magnetization as well as the behavior of exchange bias field will be presented in details.

References

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