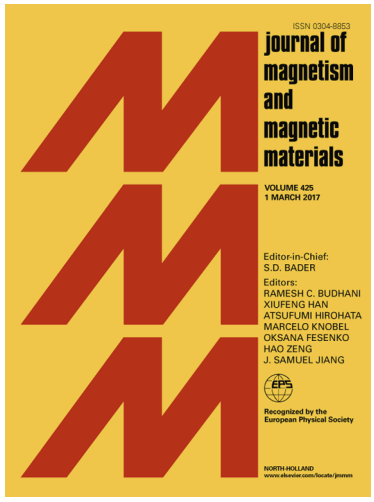

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Effect of cobalt substitution on the magnetic properties of nickel chromite

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ABSTRACT

It is of interest to study the magneto-structural coupling in geometrically frustrated antiferromagnets, where structural distortion elevates the ground state degeneracy, leading to a long-range magnetic order. In this regard a cubic spinel compound of the form AB_2O_4 is currently drawing much attention, where *A* refers to tetrahedral and *B* to octahedral sites. In the particular case of $NiCr_2O_4$ the material undergoes several structural phase transitions associated with the magnetic ordering. It is therefore necessary to study the magnetic behaviour of $NiCr_2O_4$ by substituting either *A* or *B* sites, or both systematically with suitable cations. The current work therefore aims at the modification of magnetic properties of $NiCr_2O_4$ by doping with Co^{2+} at *A* sites. In order to achieve the afore mentioned, $(Ni_{1-x}Co_x)Cr_2O_4$ ($0 \leq x \leq 1$) were prepared using chemical co-precipitation techniques. X–ray diffraction (XRD) results indicate that the samples are in the expected phase without any trace of Cr_2O_3 impurities after calcination. Transmission electron microcopy (TEM) analyses of these samples show that the particles are mostly bi-pyramidal in shape, with sizes ranging from 50 nm to 100 nm. In the present study the ferrimagnetic transition temperatures (T_C) of the various samples were determined utilizing magnetization as function of temperature measurements. T_C for $NiCr_2O_4$ and $CoCr_2O_4$ was determined to be 82.4 ± 0.8 K and 99.5 ± 0.5 K, respectively. These values are higher than those previously reported in the literature for both these compounds. Substitution of Ni by Co, results in an increase in the T_C, giving values of 89.2 ± 0.7 K and 90.6 ± 0.9 K for $(Ni_{0.5}Co_{0.5})Cr_2O_4$ and $(Ni_{0.25}Co_{0.75})Cr_2O_4$, respectively. The $(Ni_{0.5}Co_{0.5})Cr_2O_4$ sample demonstrated a high coercivity of 3.6 ± 0.1 T and a shift in the hysteresis loop observed under field cooled measurement, not previously reported in literature. X–ray photoelectron spectroscopy (XPS) of $(Ni_{0.5}Co_{0.5})Cr_2O_4$ suggests that the oxidation states of Ni and Co are 2+, while that of Cr is 3+. In order to investigate the local structure around the cations, low temperature extended x–ray absorption fine structure (EXAFS) measurements were performed. From EXAFS it is confirmed that no redistribution of *A* and *B* site cations occur at low temperatures. Present findings demonstrate that the magnetic properties of $NiCr_2O_4$ can easily and dramatically be modified by doping Co^{2+} at *A* sites.

Keywords: Chromites, Magnetic frustration, EXAFS.

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