Synthesis and Characterization of $Co_xNi_{1-x}Cr_2O_4$ ($0 \leq x \leq 1$) Nano Particles.

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$CoCr_2O_4$ is a spinel ferrimagnet that crystallizes in the space group Fd3m [1]. There are two clear magnetic phases associated with the compound: a collinear ferromagnetic phase below, T_C of about 94 K and a long-range conical spiral state at the spin-spiral transition temperature, T_S at about 27 K [2]. An additional first-order transition has been reported by several authors [3,4] T_L at about 14 K. The present study aims to synthesize $Co_xNi_{1-x}Cr_2O_4$ and to probe the physical and magnetic characteristics of these nanoparticles. $NiCr_2O_4$ has a normal cubic spinel structure within the space group of Fd3m at temperatures above 320 K and exhibits two magnetic transitions at $T_C = 74$ K and $T_S = 31$ K [5]. A magneto-structural transition at 74 K where the structure changes from tetragonal to an orthorhombic phase and magnetic transition from paramagnetic to ferromagnetic. The second transition at 31 K is because of the ordering of the antiferromagnetic component. The structural and magnetic phase transitions happen simultaneously in $NiCr_2O_4$. $NiCr_2O_4$ and $CoCr_2O_4$ are both spinels but each show unique properties; thus, it is thought by considering $Co_xNi_{1-x}Cr_2O_4$with $0 \leq x \leq 1$, the modification of the magnetic as well as structural properties can be probed. The $Co_xNi_{1-x}Cr_2O_4$with $0 \leq x \leq 1$ samples were synthesized by sol-gel technique, followed by calcination at different temperatures. The structural characterizations of these samples were studied by x-ray diffraction (XRD) patterns of the samples calcined at different temperatures ranging from 400 to 900° C indicate that the powders are of single phase. The crystallite size estimated by Williamson-Hall method is 5.734 nm for sample $Co_{0.75}Ni_{0.25}Cr_2O_4$ calcined at 500° C. The transmission electron microscope (TEM) was used to study the microstructure of the calcined powders. The particles are not uniform in size. The average particle size from TEM is 5.85 ± 3nm for the sample $Co_{0.75}Ni_{0.25}Cr_2O_4$ calcined at 500° C. Most of the particles have a bi-pyramidal shape. The magnetic behavior of composition $Co_{0.75}Ni_{0.25}Cr_2O_4$ synthesized by sol-gel technique calcined at different temperatures were studied. For $Co_{0.75}Ni_{0.25}Cr_2O_4$ calcined at 700° C determined T_C =79.4 ± 0.5 K which is less than previously reported T_C = 90.6 ± 0.9 K for $Co_{0.75}Ni_{0.25}Cr_2O_4$ synthesized by co-precipitation and calcined at 900° C [6]. The study reveals the modification of magnetic properties in accordance with calcination temperatures.

References:

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