Contribution ID: **183** Type: **Oral Presentation**

Structural and magnetic properties of $Co_{(1-x)}$ Cu_x Cr_2O_4 nanoparticles

Thursday, 7 July 2022 11:45 (15 minutes)

$CoCr_2O_4$ is a ferrimagnetic material with a cubic Fd3m space group belonging to a normal spinel structure attributed to the large octahedral ligand field stabilization energy of Cr^{3+}[1]. These spinels belong to a class of mixed oxides in which the Co^{2+} ions occupy the tetrahedral *A* sites and the Cr^{3+} ions occupy all of the octahedral *B* sites with the general formula AB_2O_4 [2]. Previous studies on spinel compounds have indicated that the Jahn-Teller (JT) effect is responsible for a structural distortion due to the presence of the Ni^{2+} and Cu^2+ ions at tetrahedral sites. This distortion is caused by the elimination of the orbital degeneracy, resulting in an ordering of the *d* orbitals and a lowering of the crystal lattice symmetry [3, 4, 5]. In the present work Cu-substituted cobalt ($Co_{(1-x)}Cu_x$ Cr_2O_4, with x=0.10, 0.50, and 0.90) nanoparticles were synthesized by sol-gel [6] method and calcined at 500 ℃. Rietveld refinement of the powder x-ray diffraction (XRD) patterns confirm that the structure is dependent on x, changing from cubic for $Co_{0.90}Cu_{0.10}Cr_2O_4$, to a mixture of cubic and tetragonal for $Co_{0.50}Cu_{0.50}Cr_2O_4$, and pure tetragonal for $Co_{0.10}Cu_{0.90}Cr_2O_4$. This is in agreement with what is expected considering the structures observed in $CoCr_2O_4$ and $CuCr_2O_4$ [7, 8]. The crystallite size (D) was found to be 8±2 nm ($Co_{0.90}Cu_{0.10}Cr_2O_4$), 9±2nm ($Co_{0.50}Cu_{0.50}Cr_2O_4$) and 8±2 nm ($Co_{0.10}Cu_{0.90}Cr_2O_4$), respectively. The size distribution and morphology of the nanoparticles were determined using transmission electron microscopy. The particle sizes of 10±2 nm ($Co_{0.90}Cu_{0.10}Cr_2O_4$), 8±2 nm ($Co_{0.50}Cu_{0.50}Cr_2O_4$), and 26±2 nm ($Co_{0.10}Cu_{0.90}Cr_2O_4$), respectively, was obtained from the TEM. Magnetic properties of the synthesized nanoparticles were studied using a vibrating sample magnetometer. The ZFC and FC curve results show that the two different magnetic phase transitions at T_C = 94 K associated with long-range ferrimagnetic order, while at T_S = 26 K, a spiral magnetic structure is observed [9]. T_S is suppressed for the $Co_{0.50}Cu_{0.50}Cr_2O_4$ sample because of the cubic to tetragonal structural phase transition. The magnetization as a function of applied field measurements, $M(\mu_0 H)$, of Cu-doped $CoCr_2O_4$ nanoparticles indicate that the magnetic properties change from ferrimagnetic to paramagnetic behaviour [10]. The magnetic saturation (M_s), remanence (M_r), and coercivity (H_c) of the samples were obtained from the results of $M(\mu_0 H)$ and will be discussed.

References:

1. Tsurkan *et al.*, 2018, *Condensed Matter Material Science,* **5605,** 1-5.
2. Nadeem *et al.*, 2020, *Journal of Alloys and Compounds,* **832,** 155031.
3. Wang *et al.*, 2019, *Applied Physics letters,* **115,** 082903.
4. Mohanty *et al.*, 2021, *AIP advances,* **11,** 025113.
5. Ghosh *et al.*, 2021, *Material Science and Engineering B,* **263,** 114864.
6. Arshada *et al.*, 2011, *Journal of Alloys and Compounds,* **509,** 8378–8381.
7. Akyola *et al.*, 2017, *Physica B,* **525,** 144-148.
8. Paul *et al.*, 2015, *Journal of Alloys and Compounds,* **648,** 629-635.
9. Dutta *et al.*, 2009, *Journal of Applied Physics,* **106,** 043915.
10. Gingasu *et al.*, 2015, *Materials Research Bulletin,* **62,** 52–64.

Apply to be considered for a student ; award (Yes / No)?

Yes

Level for award;(Hons, MSc, PhD, N/A)?

PhD

Primary author: Ms NAGARAJ, Shobana (University of Johannesburg)

Co-authors: Prof. SHEPPARD, Charles (University of Johannesburg); Dr MOHANTY, Pankaj (University of Johannesburg); Prof. PRINSLOO, Aletta (University of Johannesburg)

Presenter: Ms NAGARAJ, Shobana (University of Johannesburg)

Session Classification: Physics of Condensed Matter and Materials

Track Classification: Track A - Physics of Condensed Matter and Materials