Contribution ID: **231** Type: **Oral Presentation**

Impact of Cr substitution on magnetic properties of cobalt-doped ZnO nanoparticles

Thursday, 7 July 2022 16:00 (15 minutes)

This study focuses on the magnetic properties of $Zn_{1-x}Co_xO$, with x = 0.01, 0.03, and $Zn_{0.96}Co_{0.01}Cr_{0.03}O$, synthesized by solution combustion method. X-ray diffraction (XRD) revealed samples are in a hexagonal wurtzite structure. Rietveld refinement gives lattice parameters, a = b = 3.246 Å, and c = 5.201 Å, for $Zn_{0.99}Co_{0.01}O$; matching standard data (PDF#36-1451), and marginally increased in $Zn_{0.96}Co_{0.01}Cr_{0.03}O$, attributed to defects near dopants sites [1]. The particle size determined using transmission electron microscope images was found to be 48±2, and 39±3 nm for $Zn_{1-x}Co_xO$ (x = 0.01, 0.03), respectively, and 15±2 nm for $Zn_{0.96}Co_{0.01}Cr_{0.03}O$. Diffuse reflectance spectra show the absorption bands in all samples at 569 nm ($^4A_2(F)\rightarrow{}^4A_1(G)$), 610 nm ($^4A_2(F)\rightarrow{}^4T_1(P)$) and 660nm ($^4A_2(F)\rightarrow{}^2E(G)$) are transitions of Co^{2+} ions replacing Zn^{2+} sites [3]. In Co-Cr doped ZnO, an absorption band at 541 nm ($^4A_2(F)\rightarrow{}^4T_{2g}(F)$) reflects the transition of Cr^{3+} ions [2] in the lattice. Band-gap values found are 3.306±0.003, and 3.289±0.004 eV for $Zn_{1-x}Co_xO$ (x = 0.01, 0.03, respectively) and 3.285±0.003 eV for $Zn_{0.96}Co_{0.01}Cr_{0.03}O$. Magnetization as a function of field curves, $M(\mu_0 H)$, measured at room temperature (RT) using a vibrating sample magnetometer, of $Zn_{0.96}Co_{0.01}Cr_{0.03}O$ and $Zn_{0.97}Co_{0.03}O$ samples are hysteretic, signifying RT ferromagnetism (FM). Cobalt-doped ZnO shows diamagnetism for x = 0.01, while RTFM is seen for the x = 0.03 sample. The observed RTFM are explained based on bound magnetic polaron (BMP) mechanism. The number of BMPs created in $Zn_{0.97}Co_{0.03}O$ was found to be $2.5 \times 10^{14} cm^{-3}$. It is suggested that the exchange interaction of Co^{2+} and/or Cr^{3+} dopants mediated BMPs is ordering RTFM.

Keywords: ZnO, Combustion synthesis, Ferromagnetism, TEM.

References

1. M. Ashokkumar, S. Muthukumaran, Enhanced room temperature ferromagnetism and photoluminescence behavior of Cu-doped ZnO co-doped with Mn, Phy. E 69 (2015) 354–359. https://doi.org/10.1016/j.physe.2015.02.010.
2. J.J. Beltrán, C.A. Barrero, A. Punnoose, Combination of Defects Plus Mixed Valence of Transition Metals: A Strong Strategy for Ferromagnetic Enhancement in ZnO Nanoparticles, J. Phys. Chem. C 120 (2016) 8969–8978. https://doi.org/10.1021/acs.jpcc.6b00743.

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

No

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

N/A

Primary author: Dr HANDALAGERE SHANKARAPPA, Lokesha (University of Johannesburg)

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

Presenter: Dr HANDALAGERE SHANKARAPPA, Lokesha (University of Johannesburg)

Session Classification: Physics of Condensed Matter and Materials

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