RESEARCH ARTICLE OPEN ACCESS

Synthesis and Characterization of Cadmium Substituted Copper Nano – Ferrites

Y.C.Gangadharaiah[1] and D. Ravinder[2]
[1] *Department of Physics, Vivakananda Degree College , Malleswaram, West Post, Bangalore- 560055,Karnataka, India*
[2] *Department of Physics, Osmania University, Hyderabad- 500 007, Telangana, India*

ABSTRACT
A series of copper substituted cadmium nano ferrites with the compositional formula $Cu_{1-x}Cd_xO_4$(where x=0.1, 0.3. 0.5 and 0.7) were prepared by the Citrate gel auto combustion technique and sintered at 873 K for 4 hr. The X-ray difractrograms (XRD) clearly exhibited the existence of single phase cubic spinel structure. The crystallite size was found in the range of 10-42nm. The values of lattice parameter were calculated by using d spacing. The calculated values of lattice parameter and X-ray density were explained on the basis of composition.
Keywords: Cu-Cd Nano Ferrites; X-Ray Density; lattice parameter

I. INTRODUCTION

Spinel ferrites have been studied extensively due to easy to synthesis and abundant uses in technological and industrial applications [1-3].The useful properties of the spinel ferrites mostly depend upon the chemical composition, preparation methods, sintering temperature, nature of the additives and their distribution i.e. tendency to occupy tetrahedral (A) or octahedral (B) site [4]. Cd has a strong preference octahedral site (B-site) [5]. Cu^{2+} is the divalent ions which occupy essentially tetrahedral A-site depending on the sample preparation [6] when substituted in ferrites.

Among the spinel structures, Cu-Cd nano-ferrites ferrite has been widely used in different kinds of magnetic devices, such as inductors, magnetic heads, and magnetic devices, such as inductors, magnetic heads, magnetic refrigeration and magnetic resonance imaging. Thus, the magnetic and electric properties of nickel ferrite have been researched and improved [7]. Cu-containing ferrites form an interesting group of ferrites because of their typical electrical and magnetic properties and change in crystal structure on thermal treatment [8]. Cu-Cd nano- ferrites are low cost materials and have important magnetic and electrical properties for technological applications.

II. EXPERIMENTAL METHOD

Cu-Cd Nano Ferrite samples with the chemical formula $Cu_{1-x}Cd_xO_4$ (where x=0.1, 0.3. 0.5 and 0.7) were synthesized using citrate gel auto combustion technique. The molar quantity of AR grade of Cadmium Nitrate ($Cd(NO_3)_2 6H_2O$), Copper Nitrate ($Cu(NO_3)_2 3H_2O$),Ferric Nitrate ($Fe(NO_3)_2 9H_2O$) and Citric Acid-Citrate ($C_6H_8O_7H_2O$) Ammonia (NH_3) raw materials were taken as starting material. Metal nitrates and citric acid were dissolved in deionized water. Metal nitrate solutions were mixed with citric acid solution in 1:3 molar ratio of nitrate to citric acid. The p^H of the solution was adjusted to 7 using ammonia. The solution was first heated at 80^{o}C to transform into gel and then ignited in a self-propagating combustion manner to form a fluffy loose powder. The as-burnt ferrite powders were grained by agate motor then calcined at 600^{o}C for 4hr. the calcined ferrite powders were again grained by agate motor. As this method is a chemical route it requires no ball milling hence little scope of contamination, and better homogeneity.

The structural characterization was carried out using X-Ray Diffractomerter Bruker (Karlsruhe, Germany) D8 advanced system with a diffracted beam monochromatic Cu K_α radiation (λ = 1.5405 Å) radiation source between the Bragg Angles 20° to 80° in steps of 0.04°/Sec.

The X-ray density ρ_x of the prepared samples was calculated by the relation

$$\rho_x = \frac{8M}{Na^3}$$

III. RESULTS AND DISCUSSION

The X-ray diffraction patterns for Cu $_{1-x}$ Cd_xO_4(where x=0.1, 0.3. 0.5 and 0.7) was sintered at 600^oC are shown in **Fig.1**. The X-ray patterns show all sample are existence of the single phase of cubic spinel structure [13]. It can be seen from the **Table 1** the values of the particle size varies from 10 nm to 42 nm. Though all the samples were prepared under identical condition, the crystallite size was not the same for all Cd concentrations. This was probably due to the preparation condition followed here which gave rise to different rate of ferrite formation for different concentrations of Cu, favoring the variation of crystallite size. **Fig.2.** shows the lattice parameter versus composition. It can be seen from the figure that the values lattice parameter increases with the increase of composition. Plot of X-ray density with composition is shown in Fig 3. It can be seen from the figure the value of X-ray density is maximum for 0.7 composition.

ACKNOWLEDGEMENTS:

The authors are very grateful to Prof.J. Siva Kumar ,Head,Department of Physics,University College of Science, Osmania University, Hyderabad. One of the author YCG is grateful to Prof. G.K. Narayan Reddy, President of JES And former Vice-Chancellor of Karnataka University and Dr. Manchegowda, Honorary Secretary, JES.

REFERENCES

[1]. El-Sayed, H.M., 2009. Effect of induced magnetic anisotropy on the hysteresis parameters of Co ferrite prepared from nano-sized particles, Journal of Alloys and Compounds, 474(1-2): 561-564.

[2]. Sangeeta Thakur, S., C. Katyal, A. Gupta, V.R. Reddy Sangeeta Thakur, S., C. Katyal, A. Gupta, V.R. Reddy ordering in indium substituted nano-nickel-zinc ferrite, J. Appl. Phys. 105, 07A521;

[3]. Preeti Mathur, Atul Thakur and M. Singh, 2008. Effect of nanoparticles on the magnetic properties of Mn-Zn soft ferrite, JMMM 320-7: 1364-1369.

[4]. Anderson Dias, Roberto Luiz Moreira, Nelcy D.S. Mohallem and Aba Israel C. Persiano, 1997. Microstructural dependence of the magnetic properties of sintered NiZn ferrites from hydrothermal powders, JMMM, 172: L9-L14.

[5]. Kh. Roumaiah, "The Transport Properties of the Mixed Ni-Cu Ferrite," *Journal of Alloys and Compounds*, Vol. 465, 2008, pp. 291-295.

[6]. Krupicka S and Novak P 1982 Oxide spinels *Ferroelectric Materials* vol 3, ed E P Wohlforth (Amstermam: North-Holland0) vol 3

[7]. M.U. Islam, I. Ahmad, T. Abbas, M.A. Chaudhry, R. Nazmeen, in; Proceedings of the 6th International Symposium, 1999, p. 155.

[8]. S. A. Patil, S. M. Otari, V. C. Mahajan, M. G. Patil, A. B. Patil, M. K. Soudagar, B. L. Patil and S. R. Sawant, "Structural, IR and Magnetisation Studies on La3+ Sub-stituted Copper

[9]. Ferrite," *Solid State Communication*, Vol. 78, No. 1, 1991, pp. 39-42.

[10]. J.M. Song, J.G. Koh, J. Magn. Magn. Mater. 152 (1996) 383.

[11]. Iqbal M J and Siddiquah M R 2008 *J. Magn. Magn. Mater*. **320** 845

[12]. C. B. Kolekar. P. N. Kamble and S. G. Kulkarni, "Effect of Gd3+ Substitution on Dielectric Behaviour of Copper-Cadmium Ferrites." *Journal of Materials Science*, Vol.30.No. 22. 1995. pp. 5784-5788.

[13]. Kasap S O 2006 *Principles of Electronic Materials and Devices* (New York: McGraw-Hill)

[14]. S.A. Mazen, S.F. Mansour, H.M. Zaki, published on line 15 June 2003. "Some physical and magnetic properties of Mg-Zn ferrite". Cryst. Res. Technol. 38, No 6,471-478 (2003).

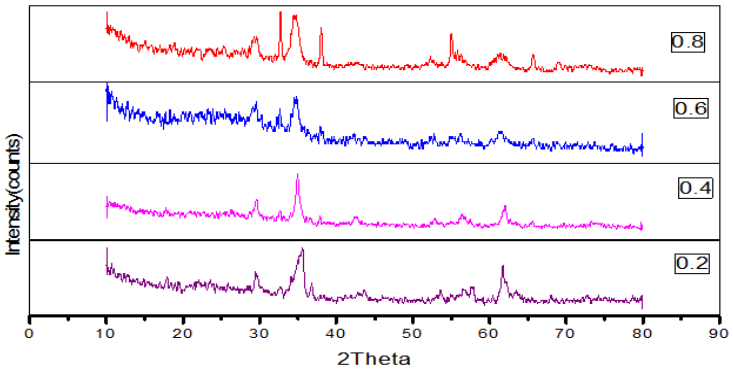

Fig. 1. XRD patterns for Cu-Cd nano-ferrites

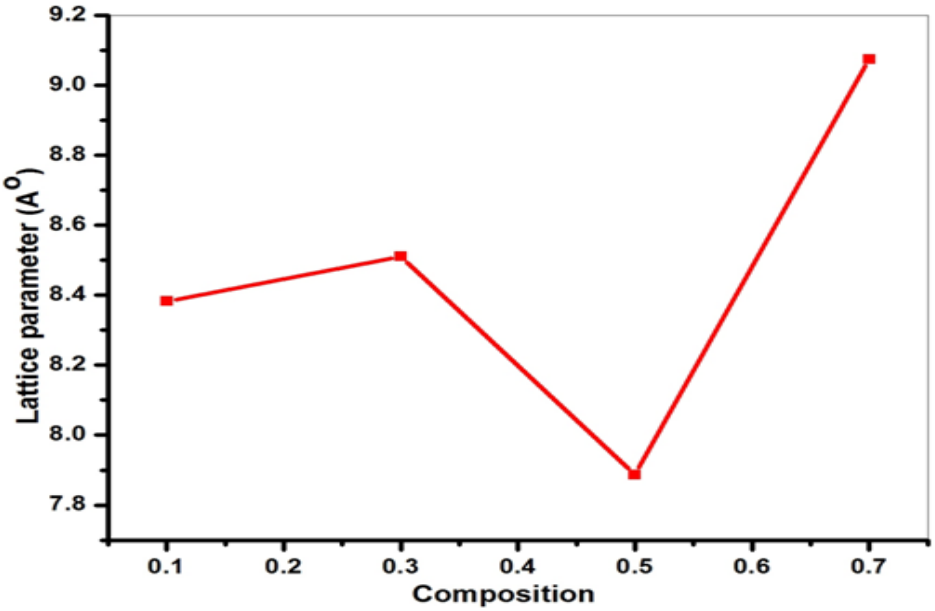

Fig.2. Plot of lattice parameter with composition.

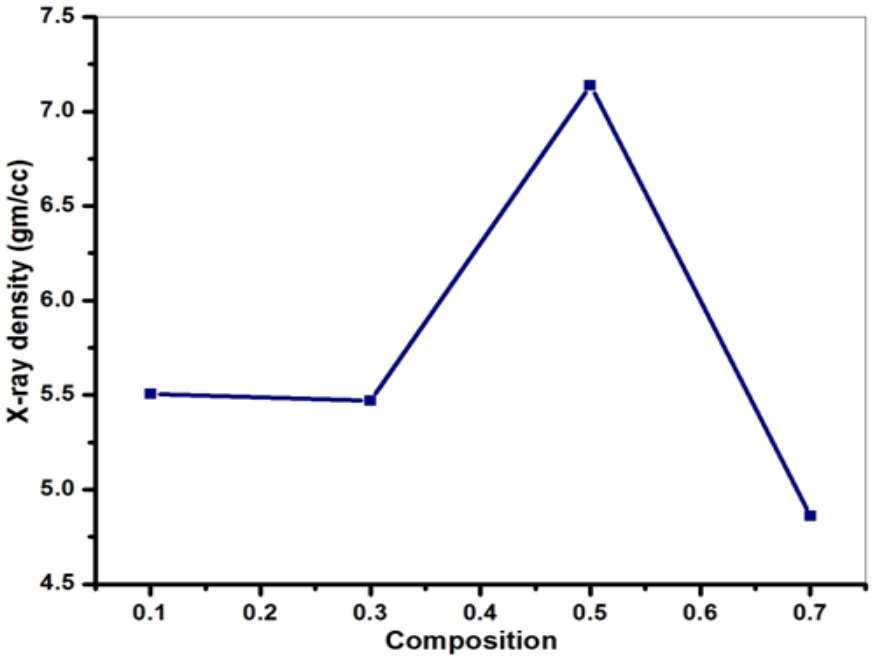

Fig.3. Plot of X-ray density with composition.

Cu-Cd	2theta	fwhm	d-space (Å)	D-crystalline size (nm)	A-lattice parameter (Å)	x-density gm/cm^3	M-weight gm
0.1	35.5183	0.9446	2.52752	22.32	8.3828	5.5049	244.103
0.3	34.9646	0.3936	2.56627	10.21	8.5113	5.4699	253.877
0.5	37.8300	0.0667	2.37822	12.06	7.8876	7.1374	263.65
0.7	32.7288	0.2362	2.73629	42.79	9.0752	4.8598	273.425

Table.1. Lattice parameter, X-ray densities and crystal Size for Cu-Cd nano-ferrites.