Journal for Research in Applied Sciences and Biotechnology

www.jrasb.com

ISSN: 2583-4053

Volume-1 Issue-1 || April 2022 || PP. 65-67

https://doi.org/10.55544/jrasb.1.1.9

Study of Magnetic Susceptibility of Ge^{4+} Doped Cu-Zn Ferrite

Ashok S. Padampalle

X-ray Diffraction Laboratory, Department of Physics, Shri Chhatrapati Shivaji College, Omerga-413606. Dist. Dharashiv, Maharashtra, INDIA.

Corresponding Author: aspadampalle@yahoo.com

www.jrasb.com || Vol. 1 No. 1 (2022): April Issue

Received: 07-04-2022	**Revised:** 21-04-2022	**Accepted:** 27-04-2022

ABSTRACT

Polycrystalline spinel ferrite $Cu_{0.7+x}Zn_{0.3}Ge_xFe_{2-2x}O_4$ where x= 0.0, 0.1 to 0.6 prepared by standard double sintered ceramic method. The a. c. susceptibility measurements on powdered samples were made using double coil set up. A specimen is kept in the center of a balanced double coil which itself is at the center of a Helmholtz coil system producing an alternating magnetic field behaves like an alternating dipole and induces a differential emf in the double coil. χ_T/χ_{RT} does not vary with temperature. As composition of Ge^{4+} is increased the Curie temperature (T_c) decreases. Near the Curie temperature there is sharp decrease of χ_T/χ_{RT} suggesting the single-phase formation of material.

Keywords- Spinel Ferrite; Magnetic Susceptibility; Curie Temperature;

I. INTRODUCTION

Semiconductor natured polycrystalline spinel ferrites are most important materials due to their interesting structural, electrical and magnetic properties. In these, physical properties depend upon the nature of ions involved, their charges and their site distribution amongst tetrahedral (A) and octahedral [B] sites. For these, in spinels two extreme distributions of cations are possible i.e. normal and inverse distribution [1]. Such distribution is a result of an individual site preference of each substitutional ion. The ferrites by virtue of their structure can accommodate a verity of cations at different sites, enabling a wide variation in properties. These properties mainly depend upon chemical composition, method of preparation, sintering time and temperature [2]. By introducing small amount of foreign ion can change the electrical and magnetic properties of ferrite [3-4]. Extensive works have been carried out by various workers to upgrade the properties of ferrites by substituting different types of amount of impurities.

Copper ferrites have attracted attention of investigators for its uniqueness condition. It shows remarkable effect in structural sensitivity. In addition, the electrical and magnetic characteristics can be controlled and innovated by many factors such as preparation condition, cation distribution and ion substitution [5-6]. The copper ferrite has a structure of distortion of spinel [7]. When it is heated to a temperature above 760°c and rapidly quenched to room temperature the structure was cubic while when it is heated at a temperature below 760°c crystal structure was tetragonal. The influence of Jahn-Teller ions Cu^{2+} at octahedral [B] sites can be modified by substitution of trivalent and tetravalent ions. Many workers have reported the influence of tetravalent ions like Ge^{4+}, Ti^{4+}, Si^{4+}, Sn^{4+} and Mn^{4+} on the properties of copper ferrite [8-12].

In this paper we report the study of effect of Ge^{4+} on magnetic susceptibility of copper zinc ferrite.

II. EXPERIMENTAL DETAILS

Polycrystalline spinel ferrite $Cu_{0.7+x}Zn_{0.3}Ge_xFe_{2-2x}O_4$ where x = 0.0, 0.1 to 0.6. were prepared by standard ceramic method. The analytical reagent oxides CuO (Copper oxide), ZnO (Zinc oxide), GeO_2 (Germanium dioxide) and Fe_2O_3 (Ferric oxide)

Journal for Research in Applied Sciences and Biotechnology

www.jrasb.com

ISSN: 2583-4053

Volume-1 Issue-1 || April 2022 || PP. 65-67

https://doi.org/10.55544/jrasb.1.1.9

were used for preparation. These oxides were weighed in required mole proportions on a single pan balance having accuracy 0.1mg and mixed thoroughly. This mixture was then ground in agate mortar for about two hours. Mixture was then transferred into a silicon crucible for presintering heated at 500°C for 24 hours and cooled in the furnace to room temperature. The temperature of furnace was measured with the help of Platinum-Rhodium thermocouple. The presintering powder of samples were again ground for minimum two hours. The powder was then palletized without any binder in a die of 10mm diameter by applying a hydraulic pressure of 5 tons per square inch for about 10 minutes. After removing the load pellet was taken out from the die. The pellets were finally sintered at 950°C for 24 hours at which solid state reaction is completed and naturally cooled up to room temperature.

The a. c. susceptibility measurements on powdered samples were made using double coil set up. The measurements were taken from room temperature to 800°K, operating at frequency of 263 Hz and rms field of 39.8Am^{-1}.

III. RESULT AND DISCUSSION

The variation of a. c. susceptibility χ_T/χ_{RT} against temperature T $Cu_{0.7+x}Zn_{0.3}Ge_xFe_{2-2x}O_4$ where x = 0.0, 0.2, 0.4 and 0.6. is as shown in Fig 1. (a and b) which exhibit normal ferrimagnetic behaviour.

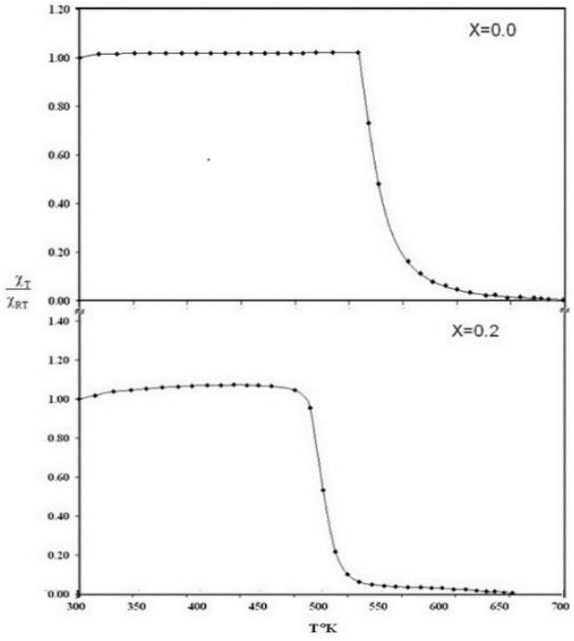

Figure 1 (a) Thermal variation of a. c. susceptibility with temperature of $Cu_{0.7+x}Zn_{0.3}Ge_xFe_{2-2x}O_4$ system for x=0.0 and x=0.2

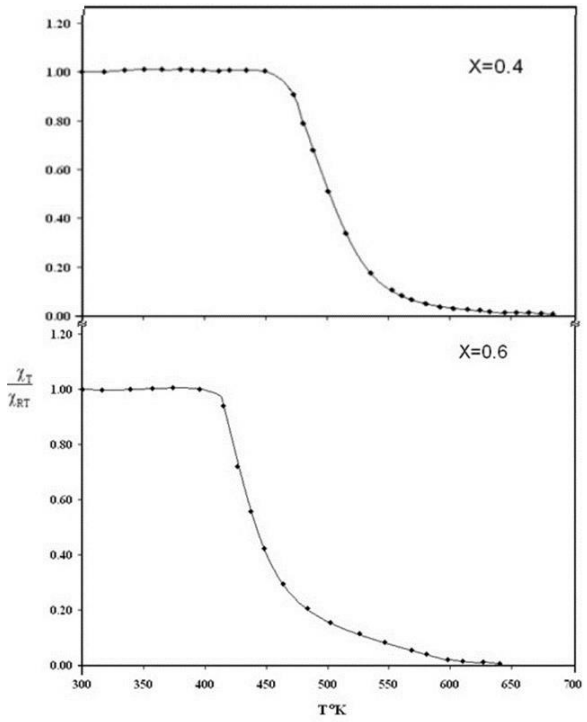

Figure 2 (b) Thermal variation of a. c. susceptibility with temperature of $Cu_{0.7+x}Zn_{0.3}Ge_xFe_{2-2x}O_4$ system for x=0.4 and x=0.6

From figure 1 following observations were made,

[1] χ_T/χ_{RT} does not vary with temperature.

[2] As the content of Ge^{4+} is increased the Curie temperature (T_c) decreases.

[3] Near the Curie temperature, there is sharp decrease of χ_T/χ_{RT} suggesting the single-phase formation of material.

Curie temperature was measured at point on graph when χ_T/χ_{RT} =0. The details of Curie temperature are as shown in Table 1.

Table 1: Variation of Curie temperature for $Cu_{0.7+x}Zn_{0.3}Ge_xFe_{2-2x}O_4$ with composition x.

Composition 'x'	a. c. susceptibility in °K	Laoria method in °K
0.0	748	750
0.1	742	740
0.2	705	710
0.3	690	688
0.4	681	680
0.5	655	660
0.6	640	642

From table1 it is observed that, Curie temperature decreases with increase of Ge^{4+} content 'x'. This decrease in Curie temperature with Ge^{4+} for all cases is due to substitution of non-magnetic Ge^{4+} ions in the

ISSN: 2583-4053

Volume-1 Issue-1 || April 2022 || PP. 65-67

https://doi.org/10.55544/jrasb.1.1.9

present system. The non-magnetic ions reduce the active magnetic linkages per magnetic ion per formula unit as a result Curie temperature T_c decreases with increase of Ge^{4+} concentration in the system. Also decrease of Curie temperature T_c on addition of Ge^{4+} is due to reduction in A-B interaction. The thermal energy required to offset the spin alignment decreases which results in the decrease of T_c on increasing content of Ge^{4+} while the non-linear fall in T_c suggests that canted spins are favoured. From table 1, it is also observed that Curie temperature determined from susceptibility and resistivity good agreement with Curie temperature determined from Laoria method.

The influence of cation distribution on magnetic properties of copper ferrite has been studied by Stierstadt et al [13]. They concluded that the Curie temperature sensitivity depend upon the statistical distribution of Cu^{2+} ions over the octahedral and tetrahedral sites. Similar result also reported by Ghatage et al [14].

IV. CONCLUSION

A. C. susceptibility measurement suggests that the $Cu_{0.7+x}Zn_{0.3}Ge_xFe_{2-2x}O_4$ system shows normal ferrimagnetic behaviour. Also, there is decrease in Curie temperature with increasing Ge^{4+} content x. This decrease in Curie temperature with Ge^{4+} for all compositions is due to substitution of non-magnetic Ge^{4+} ions in the present system. The non-magnetic ions reduce the active magnetic linkages as a result Curie temperature (T_c) decreases with increase of Ge^{4+} concentration. Also decrease of Curie temperature on addition of Ge^{4+} is due to reduction in A-B interaction.

REFERENCES

[1] Barth T. F. and Posnjak E., Z. Krist. 82 (1923)325.
[2] Rangamohan G, Ravinder D, Raman Reddy A. V. and Bayanor B. S. Mater. Lett. 40 (1999) 39
[3] Moulson A. J. and Herbert J. M., Electroceramics, Champan and Hall, London (1990) 397.
[4] Landgonkar B. P, Vasambekar P. N. and Vaingankar A. V., J. Mater. Letter 19 (2000)1375.
[5] Mazen S. A., Mater. Chem. Phys. 62 (2000) 131.
[6] Patil B. L, Sawant S. R, Patil S. P. and Patil R. N., J. Mater. Sci. Letter 12 (1993) 399.
[7] Weil L., Bertaut E. F. and Bochirol L., J. Phys. Radium 11 (1950) 208.
[8] Upadhay R. V. and Kulkarni R. G, J. Mag. and Mag. Mater. 74 (1988) 327.
[9] Baldha G. J and Kulkarni R. G., Solid state communication 49 (2) (1984) 169.
[10] Zaki H. M. and Mansour S. F., J. of Phys and Chem. 67 (2006) 1643.
[11] Shinde S. S. and Jadhav K. M., Material Letter 37 (1998) 63.
[12] Birajdar D. S, Mane D. R, More S. S, Kawade V. B and Jadhav K. M. Material letters 59 (2005)2981.
[13] Stierstadt K., Benz H. and Rechenberg H., Proc. Int. Conf. Magnetism, Nottingham, UK, Institute of Phys (1964) 605.
[14] Ghatage A. K., Choudhari S. C., Patil S. A. and Paranjpe S.K. J. Mater. Sci. Letters 15 (1996) 1549.