Journal of Advances in Applied Sciences and Technology
ISSN : 2393-8188 (print)
2393-8196 (online)
www.milliyasrcollege.org.journal.php

THERMOELECTRIC POWER MEASUREMENT OF $CU_{0.6}ZN_{0.4}AL_{X}FE_{2-X}O_4$ OXIDE SPINEL FERRITE PREPARED BY CERAMIC METHOD

V. B. Kawade[1] , N. G. Nisal[2], S. T. Alone[3], G. K Bichile[4]*

[1]Department of Physics, L. L. D. Mahila Mahavidyalaya, Parali(V), Beed(MS) India
[2]Department of Physics, Devgiri College, Aurangabad (MS) India
[3]Department of Physics, Rajarshi Shahu A. S. C. College, Pathri, Aurangabad (MS) India
[4] Department of Physics, Dr. B. A. M. University, Aurangabad (MS) India
*Corresponding Author: drsureshtalone@gmail.com

ABSTRACT:

The samples of $Cu_{0.6}Zn_{0.4}Al_xFe_{2-x}O_4$ ferrite system with (x = 0.0, 0.2, 0.4, 0.6, 0.8 and 1.0) were prepared by the usual doubled sintering conventional ceramic technique. The powder samples were annealed at 900^0C for 24 hours and the samples were pressed into pellets of 10mm diameter are sintered at 1100^0C for 36 hours. Thermoelectric measurement suggests that the charge transport in the ferrite is disordered by localized model of conduction. The Variation of the Seebeck coefficient (α) carrier concentration (n), the resistivity (ρ) and the charge mobility (μ_d) are studied.

KEYWORDS: Ferrite, Ceramic method, TEP measurement.

1. INTRODUCTION

The study of structural, electrical and magnetic properties of solids is of fundamental significance in understanding of matter as well as of great technological importance. Murthy and Sobhandri[1] have investigated the D. C. conductivity and the Seebeck coefficient of some Ni-Zn ferrite as a function of temperature from room temperature to 600K. The ferrites with iron in excess shows n-type conduction and those with iron deficiency shows p-type conduction. The temperature dependance of thermo emf was carried out by Secrist and Turk [2] on high density iron deficient Ni-Zn ferrites. Strygin and Makienko[3] have been investigated the temperature dependances of thermoelectric power and electrical resistivity of Ni-Zn-Co ferrites. Mechanism of conduction or charge transport in ferrites was explained by Verway et.al. [4]. Elwel et.al.[5] have calculated intrinsic activation energy applying Uietret consideration to materials Jonkar[6] has studied the ferrite $Co_xFe_{3-x}O_4$ and predicted qualitatively the hopping mechanism. In the present paper we report our results on the d. c. resistivity and TEP measurement study of $Cu_{0.6}Zn_{0.4}Al_xFe_{2-x}O_4$ system (x = 0.0, 0.2, 0.4, 0.6, 0.8 and 1.0) prepared by Ceramic method.

2. EXPERIMENT:

The polycrystalline samples of Al^{3+} substituted $Cu_{0.6}Zn_{0.4}Al_xFe_{2-x}O_4$ system (x = 0.0, 0.2, 0.4, 0.6, 0.8 and 1.0) were prepared by conventional ceramic technique. The starting materials were Fe_20_3, CuO, ZnO, Al_2O_3 supplied by E-Merck .The oxides were mixed thoroughly in stoichiometric proportions to get the desired composition and wet ground using acetone as the medium. The mixture was dried and pressed it to form pallets. The pellets were fired at 900^0C for 24 hours and cooled slowly to room temperature. The samples were again finely powdered and pressed into pellets of 10mm diameter by applying a pressure of 5 tones per sq. inch. The pellets were finally sintered at 1100^0C, for 36 hours and were cooled to room temperature in air using the temperature controlled carbolyte furnace. The pallets were found to be crack free, flat and hard.

Thermoelectric power measurement is carried out over the temperature range of 300K to 750K. The temperature difference of 20 K is maintained across the pellet.

3. RESULTS AND DISCUSSION

Thermoelectric properties are widely used used in interpretation of the conduction mechanism in semiconductor. The sign of the thermo-emf gives vital information about the type of conduction in semiconductor whether it is p-type or n-type. The seebeck coefficient (α) is given by the relation

$$\alpha = \frac{\Delta V}{\Delta T}$$

where ΔV is the voltage measured across the sample and ΔT is the temperature difference across the sample. The temperature variation of the thermoelectric power coefficient α for the system $Cu_{0.6}Zn_{0.4}Al_xFe_{2-x}O_4$ is as shown in Fig.1 The common feature for all the composition is that the α is negative over the whole range of temperature indicating that the samples shows n- type conduction throughout the measurement. The absolute values of thermoelectric power (α) increases with temperature.

The drift mobility (μ_d) was calculated by using the data of (ρ) and (α) and applying the method of Eatah et. al. [7] and Ghani [8] The relation for drift mobility is given by

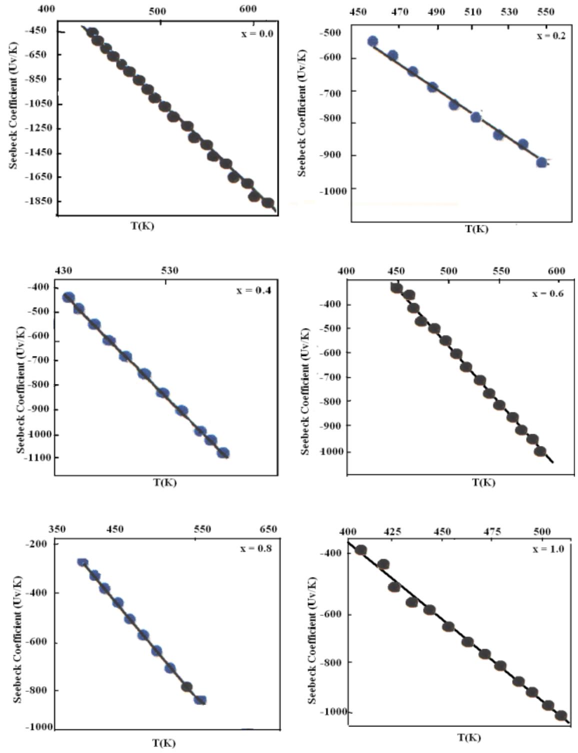

Fig. 1 The variation of Seebeck coefficient (α) *with* T(K) *for the* $Cu_{0.6}Zn_{0.4}Al_xFe_{2-x}O_4$ *system*

$$\mu_d = \frac{\exp\left(\alpha / 2.3(k/e)\right)}{2N_0 \rho e}$$

where N_0 is the concentration of Fe^{3+} ions on [B] site.

The variation of log μ_d vs $10^3/T$ is shown in the Fig.2 from the figure it is observed that the mobility increases with temperature which is attributed to the decrease of resistivity with increase in temperature.

The temperature dependence of μ_d and (α) suggest that the charge carrier in these samples, disordered by the localized model of conduction in ferrites. [9] Temperature variation of conductivity is mainly attributed to change of drift nobility with temperature rather than the variation of charge carrier concentration.

In the present study, the Seebeck coefficient for all the compositions under investigation is found to be negative indicating that the electrons are majority carriers. It increase in magnitude with temperature, which might be due to activated electron hopping between Fe^{2+} and Fe^{3+} ion in the octahedral sites. The conduction mechanism due to hopping of electrons [10] is given by

Fe^{3+} □ Fe^{2+}

The substitution of Al^{3+} ions at the B-site causes the decrease in the value of Seebeck coefficient which is attributed to the decrease in Fe^{3+} ions B-sites. Further the increase in the mobility with increase in temperature also suggest that the conduction in these ferrites is due to hopping mechanism of electrons.

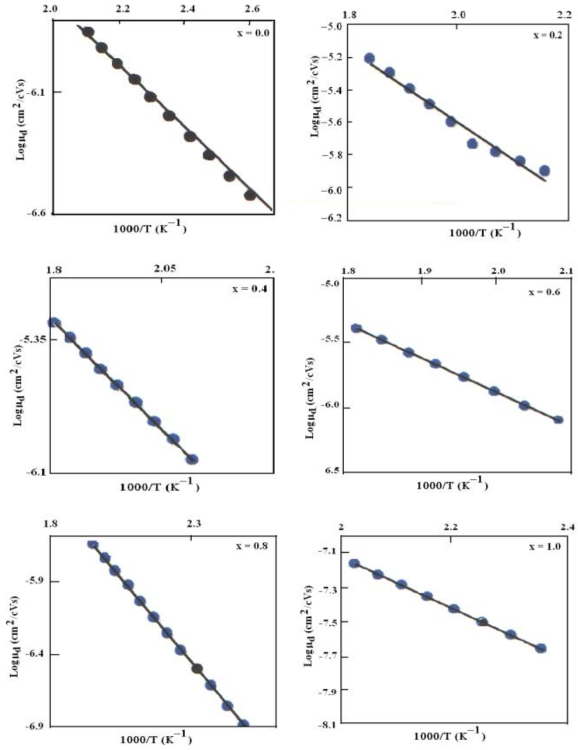

Fig. 2 The variation of log μ_d *with* 10^3/T *for the* $Cu_{0.6}Zn_{0.4}Al_xFe_{2-x}O_4$ *system*

Table 1: Variation of the Seebeck coefficient (α) carrier concentration(n) The resistivity (ρ) and the charge mobility (μ_d) at the 400 K for $Cu_{0.6}Zn_{0.4}Al_xFe_{2-x}O_4$

x	'α' (μ v/k)	'n' cm^{-3} 10^{21}	'ρ' Ω cm^{-3}	μ_d $cm^2/cVsJ^1$ 10^{-7}
0.0	-320	9.76	14.7	4.35
0.2	-302	9.71	13.1	4.94
0.4	-457	9.95	30.1	1.69
0.6	-400	9.96	79.5	0.79
0.8	-405	9.98	49.4	1.25
1.0	-300	9.7	44.7	0.14

4. CONCLUSIONS

Thermoelectric measurement suggests that the charge transport in the ferrite is disordered by localized model of conduction. The Variation of the Seebeck coefficient (α) carrier concentration (n), the resistivity (ρ) and the charge mobility (μ_d) are studied.

References

[1] V.R.K. Murthy and J. Sobhanadri, Phys.stat.sol. A38,(1976)647.
[2] D. R. Secrist and H. L. Turk, J. Am. Soc. 53,(1970)683.
[3] Y. U. Strygin and N. F. Makienko, Sov. Phys. Solid State 17,(1979)604.
[4] E. J.W. Verway, P.W. Haayaman, F. C. Romejin and G. W. Vancosterhaut, Philips Res. Rep. 5(1950)173
[5] D.Elwell, B. A. Griffiths and R. Parkar Brit. J. Appl. Phys. 17(1966)587.
[6] J. H. Jonkar, J. Phys. Chem. Sol. 9(1959)165.
[7] A.I. Eatah , A.A. Gahni M. F. Shaphat and E. Faramawy, Phys. Stat. Sol. (a) 104,(1987) 793
[8] A.A. Galmi, Nuovo Cimento, 2-D ,(1983)1923
[9] L G. Austin and N. F. Mott, Adv.Phys. 10,(1969) 41
[10] L. G. Van Uitert, J. Chem. Phys. 23, (1955)1883