

## Electrical Properties Of Cd-Ti Substituted Li-Mn Ferrites

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### Abstract

The electrical properties of Li ferrite can be modified by substitution of Cd, Ti & Mn to make them suitable for microwave applications. Cd-Ti substituted Li-Mn ferrites with the chemical composition  $\text{Li}_{0.5}\text{Cd}_x\text{Ti}_x\text{Mn}_{0.1}\text{Fe}_{2.4-2x}\text{O}_4$  were prepared by standard ceramic technique. The single phase cubic spinel structure of the ferrites was confirmed by X-ray diffraction analysis. The two probe method was used to measure the dc conductivity of the ferrite sample. Resistivity studies show that resistivity  $\rho_{dc}$  and  $\rho_{ac}$  of the samples in the compositions increases as  $\text{Cd}^{2+}$ ,  $\text{Ti}^{4+}$  concentration increases.

### Introduction

Lithium ferrites and substituted Li ferrites have become most attractive materials for microwave applications rather than garnets. The Li ferrite  $\text{LiFe}_5\text{O}_8$  has attractive electrical and magnetic properties for microwave and memory-core applications [1-4]. These properties can be modified by substitution of  $\text{Fe}^{3+}$  on either tetrahedral (A) or octahedral (B) sublattices, thus allowing the material to be tailored for specific applications [1,5]. It has been reported that the substitution of  $\text{Ti}^{4+}$  ion in Li ferrite has some remarkable influence on magnetic properties [6]. One can even predict the same for electric properties. In this view, a composite non-magnetic ion (Cd and Ti ions) substitution in Li-Mn ferrite can emerge out with much better electric as well as magnetic properties. Moreover, Li ferrite is popular for its application as thermistor, but sometimes as reported earlier the resistivity is low [7]. Hence non-magnetic ion substitution can lead to increase in resistivity [6]. In addition to this, numbers of researchers have discussed charge transport phenomenon in Li ferrite [8-10], Li-Ti [11] and Mn-Cd ferrite [7] but hitherto no attempt has been made to report composite non-magnetic ions substitution in Li-Mn ferrite. The present work is therefore communicated.

### Experimental

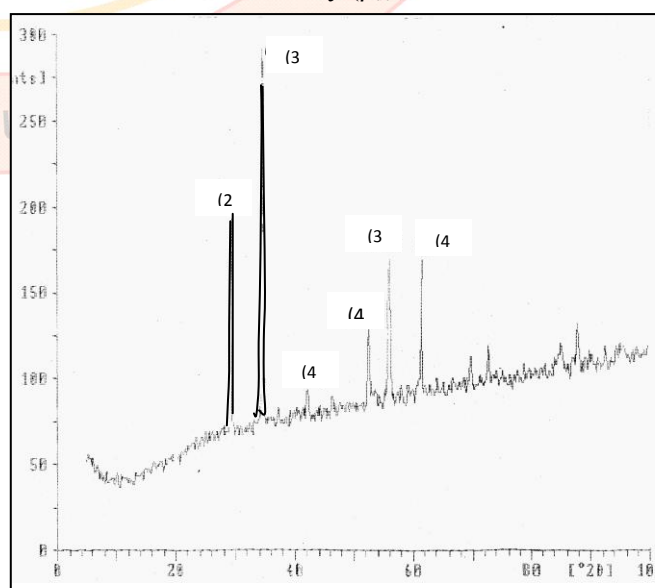
Mixed Cd and Ti substituted Li-Mn ferrites with compositional formula  $\text{Li}_{0.5}\text{Cd}_x\text{Ti}_x\text{Mn}_{0.1}\text{Fe}_{2.4-2x}\text{O}_4$  where x varies as 0 to 0.5 in step of 0.1, were prepared by conventional ceramic method. These samples were sintered at  $1000^\circ\text{C}$ . DC resistivity was measured using two probe method. Dielectric

measurements were studied using LCR meter HP4284A model.

### Result and Discussion

X-ray diffractograms (XRD) for all the ferrites under investigation obtained using Phillips Diffractometer PW1710 model. The XRD for higher resistivity is shown in figure 1. The XRD examinations of samples reveal that all the samples exhibit single-phase spinel structure. No secondary phases are detected in the XRD patterns of samples.

Compositional variation of resistivity as seen in Figure 2 & 3 indicate increase in resistivity with increase in Cd & Ti content.  $\text{Cd}^{2+}$ ,  $\text{Ti}^{4+}$  being composite ion, together localize  $\text{Fe}^{2+}$  ions in the system and tunneling of electrons by transfer mechanism is retarded due to reduction of  $\text{Fe}^{3+}$  ions. Hence, increase in resistivity ( $\rho_{dc}$ ) with increase in x.



**Fig 1. XRD pattern of  $\text{Li}_{0.5}\text{Cd}_{0.5}\text{Ti}_{0.5}$**

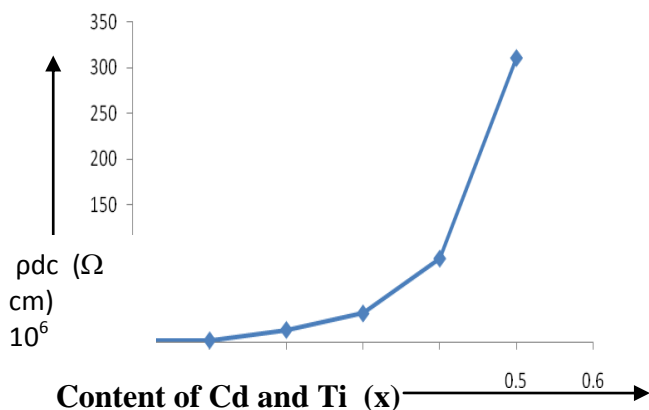


Fig 2. Variation of  $\rho_{dc}$  vs Cd and Ti content (x)

The ac resistivity ( $\rho_{ac}$ ) increase with increase in Cd Ti content. It is obvious as polaron hopping mechanism responsible for conduction in ferrites also explains polarization in ferrites [12]. As increasing X decreases Fe ion concentration there by retarding polaron hopping mechanism resulting in decrease in values of permittivity. The ac resistivity is inversely proportional to either of the permittivity [12-14] and hence it increase with increase in x content.

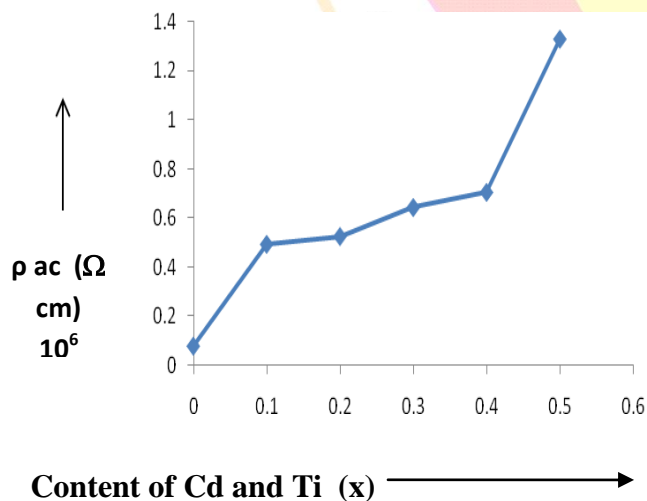


Fig 3. Variation of  $\rho_{ac}$  vs Cd and Ti content (x)

**Conclusion**

The composite non- magnetic ion substitution especially in Li-Mn ferrite is reported for the first time. Mixed Li-Mn ferrites were ignored for the last 3 decades inspite of their application at microwave frequencies as stated before. Therefore

the study on preparation and electrical characterization of such materials is essential. The present work has made an attempt and observations reported are increase of composite ion content has an effect of reducing the Fe ion responsible for conduction and polarization in ferrites. Hence increase in dc and ac resistivity with content of x is observed.

**References**

- 1.R.P.Patil, B.V.Jadhav, M.R.Kadam, D.R.Patil, P.P.Hankare,“ LPG gas sensing application of lithium ferrite” Mater.Focus, 5(2016) 46-50
2. Raul Valenzuela,Novel Applications of ferrites. Physics Research International Volume 2012
- 3.E Brtmejo, J. Chassing, D. Bizot, M.Quarton, Sci. ENG. B.22(1994) 73
4. G. F. Dionne, J. Appl. Phys. 45 (1975) 3926.
5. J. L. Dormann, M. Nogues, J. Mater. Sci. 2 (1990) 1223
6. S. A. Mazen, A.H. Watik, S. F. Mansour, J. Mat. Sci. (1987) 4177
7. S. A. Mazen, A.E. ABD-EL-Rahiem, B.A. Sabrah, J. Mat.Sci. (1987) 4177
- 8.G.A.Aravind, M. Raghasudha, D. Ravinder, “Electrical transport properties of nano crystalline Li-Ni ferrites” science Direct J Materimionics 1 (2015)348-356
9. N. F. Mott, “ Metal-Insulators Transitions” Tayler and Francis, London (1994)157
10. N. I. Klinger, SamaKhavlov, Phys. Stat. Solid. B. 79 (1997) 9.
11. M Bhagvantha Reddy, Mat. Sci. Eng. B14 (1992) 63.
- 12 . P. P. Hankare, R. P. Patil, U. B. Sankpal, S. D. Jadhav, I. S. Mulla, K. M.Jadhav, B. K. Chougule, “ Magnetic & dielectric properties of nanophase manganese- substituted lithium ferrite”,J. Magn. Master, 32(2009)
- 13.K.K.Patankar,Ph.D. Thesis ,Shivaji University Kolhapur (2001)
14. Dipti, P. Kumar, J. K. Juneja, S. Singh, K. K. Raina, C. Prakash, “Improved dielectric & magnetic properties in modified lithium-ferrites”, Ceram. Int. 41 (2015) 3293-3297.