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Synthesis, Electrical, Resistivity, Studies Of Ni-Zn Nano Ferrites By Chemical Co-Precipitation Method

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Abstract:

Ni-Zn ferrite nano particles were prepared by chemical co-precipitation method. Electrical, dielectrical, Restivity studies are reported. The low loss values at higher frequencies show the potential of these samples for high frequency applications. It can be seen from the graphs that dielectric loss in both series is frequency dependent. It is clear from the graphs that the resistivity is observed to decreased with the increment of frequency for all the samples.

Key words: Ni-Zn, Density, Resistivity, Dielectric loss, Nano particles.

Introduction:

In the early days of the electrical core industry, the need for iron and its magnetic alloys. However, at higher frequencies, the standard techniques of reducing eddy current losses, using lamination or iron powder cores, were no longer efficient or cost effective. This realization stimulated a renewed interest in “magnetic insulators” as first reported by S.Hilpert in Germany in 1909[1]. It was readily understood that if the high electrical resistivity of oxides could be combined with desired magnetic characteristics, a magnetic material would result that was particularly well suited for high frequency operation. Research to develop such a material (later called ferrite) was being done in various laboratories all over the world such as by V.Kato, T.Takei, and N. Kawai in the 1930’s in Japan and by J.Shoek of the Philip’s Research Laboratories in the period 1935-45 in Netherlands. By 1945 Snoek had laid down the-basic fundamentals of the physics and technology of practical ferrite material. In 1948, the Neel Theory of ferrimagnetisms provide the theoretical understanding of this type of magnetic material [2]. The transport properties of the nano-materials are predominantly controlled by the grain boundaries than by the grain itself [3-4].We discussed in the last paper [5] Xrd, Tem, Hysteresis properties. In this paper we discuss the electrical, resistivity properties of Ni-Zn ferrites system. Due to this reason, the magnetic materials have explored a wide range of applications and replacing conventional materials. The Conventional solid-state reaction route is widely used for the production of ferrite because of the low cost and suitability for the large scale production. It is simple process, which offers a significant saving in time and energy consumption over the traditional methods.

II Experimental

2.1 Synthesis & Characterisation:

Investigated ferrite samples was prepared by low temperature chemical co-precipitation method, which was already described in our earlier publications [5, 6].In this study, the sintered and electroded nanoferrite samples were characterized for room temperature dielectric constant (ε_{RT}), dissipation factor (charge loss: tanδ) by Solartron Impedance analyzer (model 1260A). The nanoferrites were characterized for DC resistivity through two terminal method by using Keithley Electrometer (model 6149).

III Results and Discussion

3.0: Room temperature dielectric constant (ε_{RT}) and Room temperature dielectric loss (Tan δ_{RT})

Figure 1&2 show the room temperature dielectric constant (ε_{RT}) and room temperature dielectric loss (Tan δ_{RT}) of sintered nanoferrites of $Ni_xZn_{1-x}Fe_2O_4$ (where x= 0.2, 0.4, 0.5, 0.6 and 0.8) synthesized by chemical co-precipitation method, respectively. The variation of the room temperature dielectric constant (ε_{RT}).The mechanism of polarization in polycrystalline ferrites is mainly reported to be hopping of electrons between ions of the same element but in different oxidation states. As the electrons reach the grain boundary on application of an electric field, they pile up and a charge build up takes place, causing interfacial polarization. Because the ferrites are sintered at a relatively low temperature of 1000°C, the possibility of ions existing in different valance states is rather low, reducing thereby the probability of electron hopping and hence of polarization resulting in variable trend dielectric constant with respect to frequency and composition. Polarization is also affected by factors such as structural homogeneity, stoichiometry, density, grain size and porosity of the ferrites. Conductivity in Ni-Zn ferrites can be attributed to electron hopping by cations being formed in the cooling cycle of the sintering process.

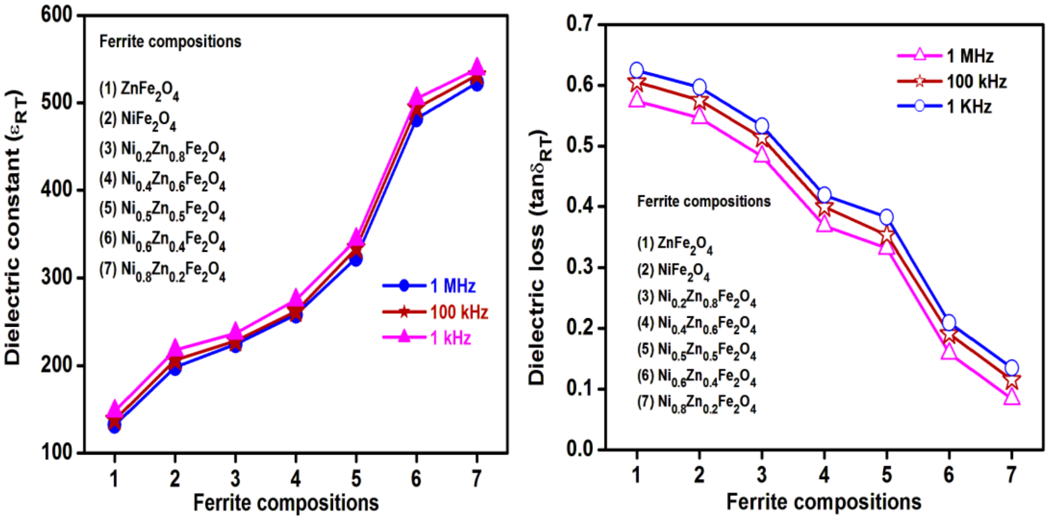

Figure 1&2: Room temperature dielectric constant (ε_{RT}) & Dielectric loss of sintered $Ni_xZn_{1-x}Fe_2O_4$ nanoferrites

3.1 Room temperature DC-Electrical Resistivity (ρ_{RT}):

Figures 3 represent the DC-electrical resistivity (ρ_{RT}) of sintered nanoferrites of $Ni_xZn_{1-x}Fe_2O_4$ (where x= 0.2, 0.4, 0.5, 0.6 and 0.8) nano ferrites synthesized by chemical co-precipitation method, respectively. It is clear from the graphs that the resistivity is observed to decreased with the increment of frequency for all the samples in both series, however in series 2, the trend changed to decrease from x=0.5 to x=0.7. It was shown that for conduction by small polarons, dc conductivity increases with frequency [08, 09]. Also, the trend in the variation of DC electrical resistivity leads to the possibility that the conduction mechanism in ferrites is due to an exchange or hopping of electrons between Fe^{2+} and Fe^{3+} ions at the octahedral site as the distance between the two neighbouring octahedral sites is minimal [10]. The hoping of electron results in the local displacement of charges that causes polarization. The frequency of this exchange depends on the Fe^{3+}/Fe^{2+} ion pairs present on octahedral (B) sites [11]. On replacement of Fe^{3+} ions by Cr^{3+} ions, which are reported to have strong preference for the octahedral (B) site [12], a decrease in Fe^{3+}/ Fe^{2+} ion pairs at the octahedral sites results in enhancement in the electrical resistivity of the doped (Cu) ferrite and can be explained by electrons hopping mechanism [13].

However, the ρ value continues to rise for the samples and decreasing with frequency implying the mobility of electrons could be restricted at the frequency higher than 1 kHz. Our results are in agreement with the literature studies [7].Thus this investigation summarizes the increase the electrical resistivity of the nano ferrites are suitable for use in high frequency applications and as data storage devices. The dominant mechanism for electrical conduction in ferrites is the hopping mechanism.

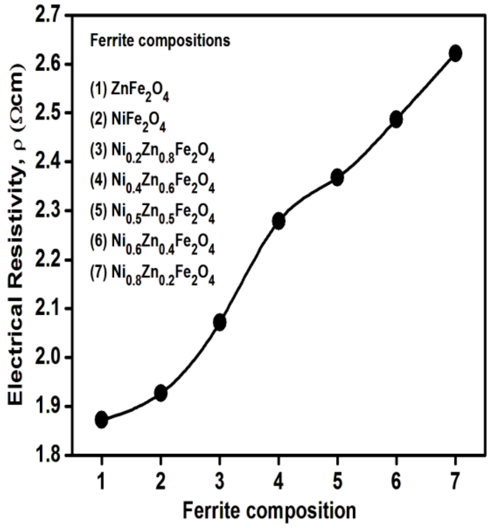

Figure 3: Room temperature electrical resistivity (ρ_{RT}) of sintered $Ni_xZn_{1-x}Fe_2O_4$ nanoferrites

References:

[1] R.A. Waldron, Ferrites, D.Van Nostrand Company Ltd. (1961)

[2] L. Neel, Annales, de Physique 3, (1948) 137

[3] N. Hari Kumar, Nakiraboina, Venkatesh, G.Aravind, Shyamsunder goud, T.Somaiah, D.Ravinder IOSR Journal of Applied Physics (IOSR-JAP).Volume 7, Issue 1 Ver. I (Jan.-Feb. 2015), PP 79-83.

[4] Ahmed M.EI-Sayed, Esmat M.A.Hamzawy, Monatshefte fur chemie 137(2006)1119-1125.

[5] B. Suryanarayana, V Raghavendra, K. Chandra mouli International Letters of Chemistry, Physics and Astronomy Vol. 60 (2015) pp 20-24.

[6] B. Suryanarayana, V Raghavendra, K. Chandra mouli Journal of Applicable Chemistry 2015, 4 (4): 1237-1242

[7] Hai-Bo Wang, Jin-Hong Liu, Wen-Feng Li, Jian-Bo Wang, Li Wang, Li-Jing Song, Shi-Jun Yuan, Fa-Shen Li, Journal of Alloys and Compounds 461 (2008) 373-377.

[08] D. Adler, J. Feinleib, Phys. Rev. B 2 (1970) 3112.

[09] S.S. Chougule, D.R. Patil, B.K. Chougule, J. Alloys Compd. 452 (2008) 205.

[10] Lee, S. H.; Yoon, S. J.; Lee, G. J.; Kim, H. S.; Yo, G. H.; Ahn, K.; Lee, D. H.; Kim, K. H. Mater. Chem. Phys. 1999, 61, 147.

[11] Chae, K. P.; Lee, J. G.; Kim, W. K.; Lee, Y. B. J. Magn. Magn. Mater. 2002, 248, 236-240.

[12] Sharma, R. K.; Suwalka, O.; Lakshmi, N.; Venugopalan, K.; Banerjee, A.; Joy, P. A. Mater. Lett. 2005, 59, 3402.

[13] El-Sayed, A. M. Mater. Chem. Phys. 2003, 82, 583.