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Structural, Electric and Dielectric Properties of $MgFe_2O_4$ Ferrite Processed by Solid State Reaction Technique

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ABSTRACT : $MgFe_2O_4$ ferrite with excellent magnetic, electrical and dielectric properties has been synthesized by solid state reaction technique. The excellent combination of magnetic and dielectric properties of $MgFe_2O_4$ ferrites can be used to fulfill the future demand for high-frequency applications. High value of dc resistivity (10^7 Ω cm) makes this ferrite more effective in high frequency applications. The electrical and dielectric properties of these materials depend on the synthesis conditions such as sintering temperature, heating rate, cooling rate and composition. The structural, electric and dielectric properties have been investigated by means of X-ray diffraction, Keithley 2611 system and impedance analyzer respectively. The dielectric properties of $MgFe_2O_4$ ferrite have been studied as a function of frequency and temperature. The mechanisms responsible to these results have been discussed in this paper.

Keywords: Ferrite; Resistivity; Dielectric loss; Dielectric constant.

I. INTRODUCTION

Ferrites have been the emerging focus of recent scientific research and technological point of view [1]. Ferrites have proved to be good in microwave applications because of their low cost, high resistivity and low eddy current losses. The excellent combination of electric and dielectric properties of $MgFe_2O_4$ ferrites can be used to fulfill the future demand for high-frequency applications [2]. High value of dc resistivity (10^7Ω-cm) makes this ferrite more effective in high frequency applications. The values of dielectric loss factor in the presently studied ferrite at room temperature are of the order of 10^{-3}.

II. EXPERIMENTAL DETAILS

$MgFe_2O_4$ ferrite has been synthesized by solid state reaction technique. The sample was dried and calcinated at 1173 ctric constant and dielectric loss factor were determined by Agilent Technologies 4285A Precision LCR meter. The dc resistivity of the sample at room temperature was measured by using a Keithley 2611 system.

III. RESULTS AND DISCUSSION

A. Structural Study

XRD patterns of the prepared ferrite powder obtained on calcination at 1373 K shows a typical single-phase inverse spinel structure and are shown in Fig. 1. The diffraction peaks are quite sharp because of the micrometer size of the crystallite.

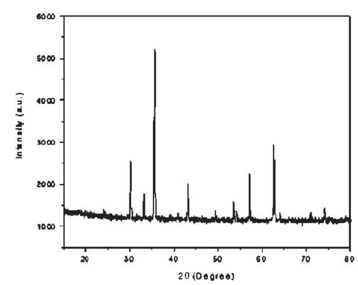

Fig. 1. XRD patterns of $MgFe_2O_4$ sample sintered at 1373K.

B. Dielectric Study

Fig. 2 shows the variation of dielectric constant with frequency at different temperatures. The dielectric constant decreases initially with an increase in frequency followed by the appearance of the resonance with peaks occurring at higher frequencies. Initial decrease in dielectric constant with frequency can be explained by the phenomenon of dipole relaxation [2,3]. The resonance may arise due to the matching of the frequency of charge transfer between $Fe^{2+} \leftrightarrow Fe^{3+}$ ions and that of the applied electric field. Fig. 3 shows the variation of dielectric constant with temperature at different frequencies. The dielectric constant increases with temperature at all frequencies. The hopping of the charge carriers is thermally activated with the rise in temperature; hence, the dielectric polarization increases, causing an increase in dielectric constant. Fig. 4. shows the variation of dielectric loss with frequency at different temperatures. The dielectric loss factor decreases initially with increase in frequency followed by the appearance of the resonance with peaks occurring at higher frequencies. The decrease in dielectric loss with increase in frequency is in accordance with the Koop's phenomenological model [4].

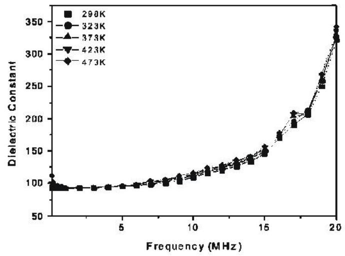

Fig. 2. Variation of dielectric constant of $MgFe_2O_4$ ferrite with frequency at different temperatures.

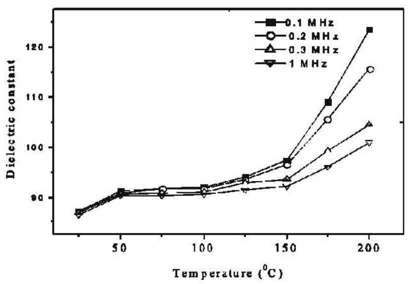

Fig. 3. Variation of dielectric constant of $MgFe_2O_4$ ferrite with temperature at different frequencies.

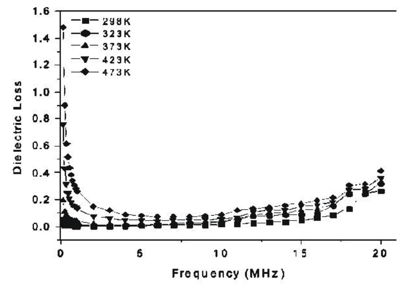

Fig. 4 Variation of dielectric loss of $MgFe_2O_4$ ferrite with frequency measured at different temperatures.

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