Proceeding of ICNM - 2009

1st International Conference on Nanostructured Materials and Nanocomposites (6 – 8 April 2009, Kottayam, India)

Published by : Applied Science Innovations Private Limited, India.
http://www.applied-science-innovations.com

****

Magnetic, a. c. conductivity and dielectric studies on Nano-sized magnesium ferrite

Arvind Bhavikatti [1]
REC, Bhalki ,
Karnataka state
arvindbhavikatti@gmail.com[1]

Dr. Subhash Kulkarni[2]
JPNCE, Mahabubnagar
AP state
subhashsk@gmail.com[2]

Dr. Arunkumar Lagashetty[3]
AIET,Gulbarga,
Karnataka State
arun_lagshetty@yahoo.com[3]

Abstract: Synthesis of nanosized spinel material is an important part of modern ceramic research.Microwave route for synthesis of ferrites at nano dimension is a technology for ceramic manufacturing which integrates the synthetic technology for information storage materials.Here, microwave firing is used for synthesis of magnesium ferrite materials.Nanosized $MgFe_2O_4$ is synthesized by microwave route using urea as a fuel.Magnesium oxalates and iron oxalates were prepared by dissolving magnesium and iron salt in oxalic acid solution.Then,these two oxalates are irradiated with microwaves using urea as a fuel to get cubic $MgFe_2O_4$ nanoparticles..In this paper, the hysteresis,the variation of a.c. conductivity and dielectric constant with the temprature at selected frequencies has been studied.The loss-related characteristic ε" also reported and discussed.

Key words: Microwave synthesis,Oxalate,Hysteresis,a.c.conductivity,dielectric constant

Introduction: Magnesium ferrite [$MgFe_2O_4$] is an important magnetic oxide with spinel structure [1] ..Magnesium ferrite and allied compounds have found wide spread applications in microwave devices because of their low magnetic and dielectric losses, and high resistivites [2]. Synthesis of nano -sized $MgFe_2O_4$ is important for its magnetic properties, particularly super paramagnetic behavior and super paramagnetic particles and these can be used for different biomedical applications [3].

Magnetic properties: To find saturation magnetization, coercivity, remanance and other related parameters, M-H curves are obtained with Foner vibrating sample magnetometer. The values of saturation magnetization, M_S, remanance ,M_r, coercivity, H_C for $MgFe_2O_4$ have been determined and are listed in Table-1 below.

Table -1

Sample	Hc (Oe)	Mr (emu / gm)	Ms (emu / gm)	Wt.
Mg Fe_2O_4	785.12	6.82	10.80	0.500 gm

Hysteresis loop: Fig [1] shows the M-H curve of magnesium ferrite .The area of the hysteresis loop corresponds to energy loss per unit volume per cycle .Ferromagnetic materials, which have tall, narrow hysteresis loops with small loop areas, are referred to as 'soft' ferrites. Good permanent magnets, on the other hand, should show a high resistance to demagnetization. This requires that they be made with materials that have large coercive field intensities H_C and hence fat hysteresis loops. These materials are referred to as 'hard' ferromagnetic materials .From Table-1, the value of H_C is found to be785.12 Oe and as per this magnesium ferrite may be considered as the hard magnetic material.

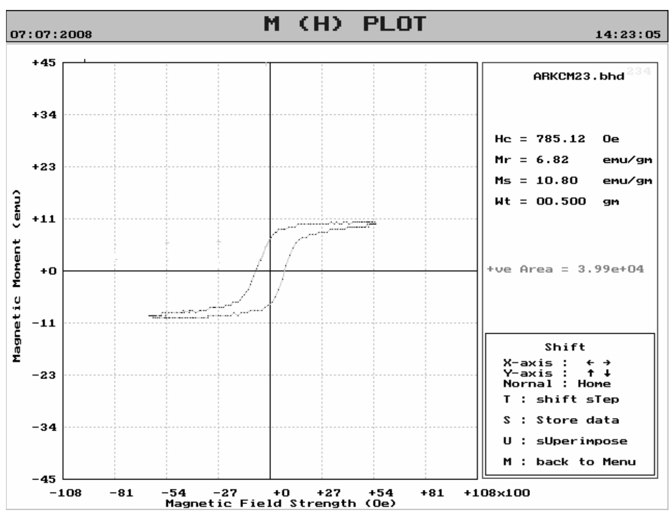

Figure (1) : Hysteresis loop of magnesium ferrite.

Dielectric measurements: The dielectric measurements were made using two-probe method. The pellet of magnesium ferrite was coated with silver paste on both sides to have better electrical contacts. Dielectric constants were calculated from the capacitance measurements made on Hewlett-Packard 4192, in the frequency range 1 KHz-1MHz using precision LCR meter. The dielectric behavior for the present samples can be explained on the basis that the mechanism of polarization process in ferrites is similar to that of conduction process [4].

a. c. conductivity [σ_{ac}]: The a.c. conductivity was measured at four different frequencies 1 KHz, 10 KHz, 100 KHz and 1 MHz as shown in fig [2].From fig [2], it is observed that, the a.c.conductivity decreases with increasing frequencies. A fall in σ_{ac} is observed at higher frequencies .Similarly, the effect of temperature on the a.c. conductivity of magnesium ferrite were studied in the temperature range 0^0C-700^0C It was observed that, the conductivity decreases with the increase of temperature. Peaks of a.c. conductivity were observed to shift towards higher temperature indicating a fall in conductivity.

Dielectric constant [ε´]: It can be seen from fig [3] that, the valve of ε' increases up to 10 KHz and decreases thereafter with increasing frequency. This is a normal dielectric behavior of ferrimagnetic materials, which may be due to the interfacial polarization as predicted by Maxwell – Wagner (Wagner 1913). Similarly, it can be seen from fig [3] that, ε' increases with increasing temperature, until reaching a maximum, then decreases with temperature, until reaching a maximum then decreases with further increase in temperature. Moreover, the maximum value shifts towards higher temperatures with increasing frequency.

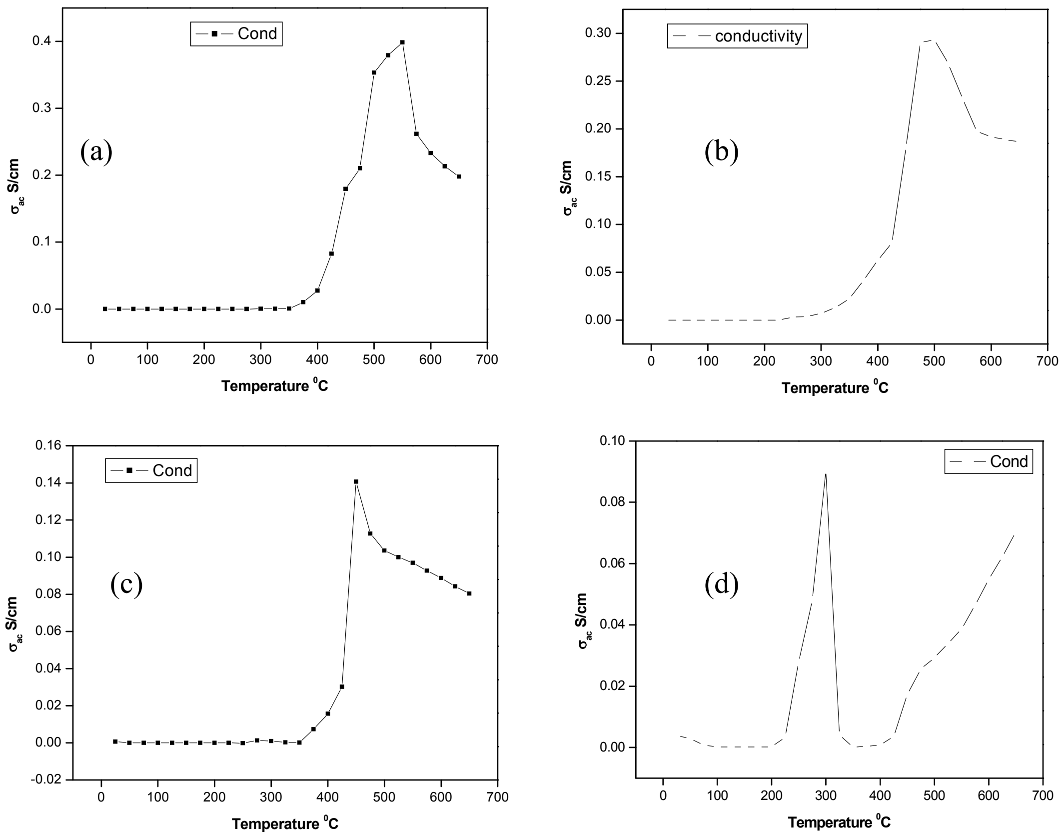

Fig [2] Shows the variation of a.c.conductivity [σ_{ac}] with temperature at selected frequencies [a]1KHz [b] 10KHz [c] 100KHz and [d]1MHz

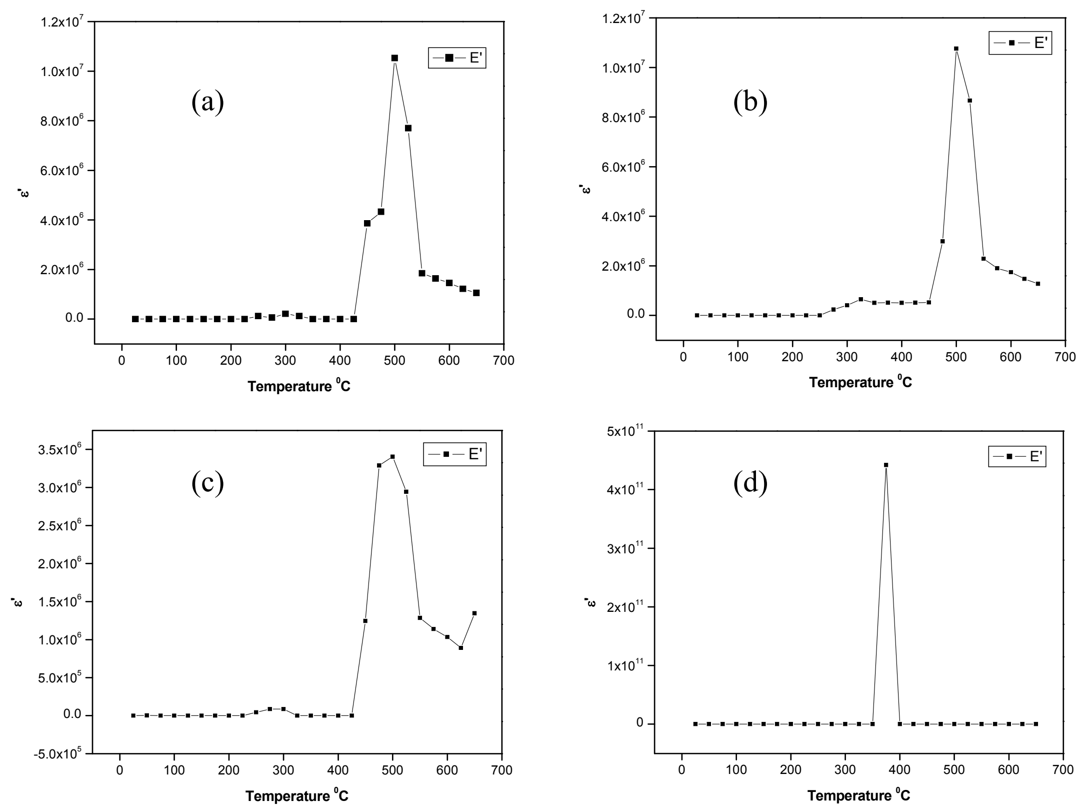

Fig [3] Shows the variation of dielectric constant ε´ with temperature at selected frequencies [a]1KHz [b]10KHz [c]100KHz and [d]1MHz

Dielectric loss [ε´´]

The dependence of dielectric loss ε” on frequency is shown in fig (4).It is clear the ε” remained constant up to 10 kHz and later decreased with increasing frequency. As the frequency increases, ε" reduces. As the frequency is further increased, loss increases reaching a maximum. Similarly from fig (4), it is observed that, as the temperature increases up to 400^0 C, the ε" remains constant. With further increase of temperature beyond 400^0 C, the loss decreases .However at higher frequencies and at temperature of around 360^0 C a maximum loss is observed.

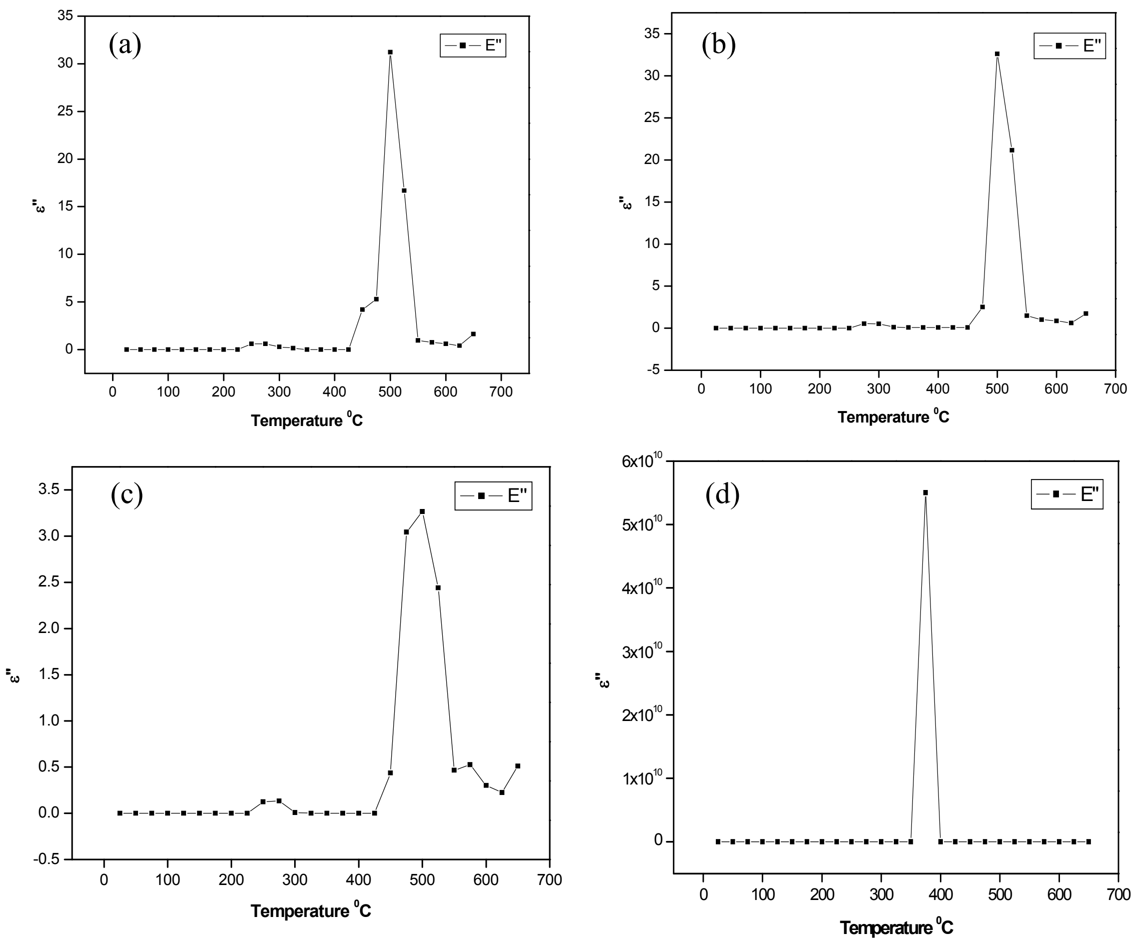

Fig [4] Shows the variation of dielectric loss ε" with temperature at selected frequencies [a]1KHz [b] 10KHz [c] 100KHz and [d]1MHz

References :

[1] A.Goldman, Modern Ferrite Technology, Van Nostrand, New York 1990

[2] K.S.Rane, V.M.S.Vernekar, P.Y.Sawant, Bull.Mater.Sci.Vol.24, No 3, June 2001, 323.

[3] Chen.Q, Zhang.z.J, Appl.Phys.Lett.73, 3156(1998)

[4] A.N.Patil, M.G.Patil, K.K.Patanka, V.L.Mathe, B.P.Mahajan, S.A.Patil, Bull. Mater.Sci. Vol.23, No 5, October 2000, 448.