International Journal of Engineering Technology Science and Research
IJETSR
www.ijetsr.com
ISSN 2394 – 3386
Volume 5, Issue 1
January 2018

Preparation and Dielectric Studies on $Co_xSr_{1-x}Fe_2O_4$ NanoFerrities

Ashwini Rayar[1], Ambresh Ambalgi[2], Sharanappa Chapi[1*]
[1]Department of Physics, Jagadguru Tontadarya College,Gadag-Betgeri, Karnataka, India
2Department of Electronics, Mangalore University, Mangalagangotri, Karnataka, India

Abstract: *Nanoscale$Co_XSr_{1-X}Fe_2O_4$ (Cobalt Stransiumnano ferrite) particles were prepared by combustion method using cobalt stransium nitrate as oxidizer and urea as a fuel. The composition is characterized by X-ray diffraction technique (XRD) using Cu-Kα radiation. The XRD study shows the nanocrystalline nature in the prepared ferrite samples. The crystal size is calculated from XRD data by using Scherrer equation and Dielectric studies have been undertaken over a wide range of frequencies (100 Hz - 5 MHz) for Cobalt Stransiumnano ferrites at room temperature. Dielectric properties such as dielectric loss tangent (D), dielectric constant (ε') and dielectric loss factor (ε'') are found to decrease with the increase in the frequency. Observed variations are understood on the basis of Koop's phenomenological model. Further, AC conductivity of the cobalt stransiumnano ferrites was found to increase with the increase in the frequency, which is understood on the basis of electron hopping model.*

Keywords: Co-Srnano ferrites, the Combustion method, Dielectric properties, A. C. Conductivity, XRD

Introduction

In the last few years, ferrites have been the emerging focus of recent scientific research and technological there has been growing research on the investigations of ferrite nanostructures. During the past decades, Ferrites have proved to be good in microwave applications because of their low cost, high resistivity and low eddy current losses[1] microwave absorption materials have received remarkable attention due to their unique electronic and magnetic properties and their potential application in various fields, especially in electromagnetic interference shielding and radar systems. Nanocrystalline ferrite materials are attracting an increasing interest nowadays. Owing to the small characteristic size of their nanostructure, they exhibit novel properties which differ from those of materials with micron-sized features. Recently, Nickel nano ferrite, an important member of ferrite family, has attracted major research interest due to its applications in technological devices such as circulators, isolators, gyrators, phase shifters, filters, and switches and substrates for microwave integrated circuits **[2, 3]**.Various works present the preparation of ferrites using a conventional ceramic powder preparation process, which involves a solid state reaction. This technique has disadvantages, such as the formation of strongly bonded agglomerates, non-homogeneities, such as undesirable phases, abnormal grain growth, poor reproducibility and imprecise control of the cation stoichiometry and ratios. The combustion synthesis technique has proved to be a novel, extremely facile, time-saving and energy-efficient route for the synthesis of ultra-fine powders. The combustion method presents some advantages compared to other methods: reagents are very simple compounds, special equipment is not required and dopants can be easily introduced into the final product. In the present work, Nickel nano ferrites were prepared by solution combustion method and dielectric &a.c. conductivity studies on the as prepared NiFe2O4 nanoparticles have been undertaken over a wide frequency range (100Hz-5MHz) at room temperature **[4].**

2. Experimental

2.1 Synthesis of techniques

The Co-SrFe_2O_4 nano ferrite powder has been prepared by solution combustion method using stoichiometric composition of Co-Sr nitrate as oxidizer and urea as a fuel. The aqueous solution containing redox mixture was taken in a Pyrex dish and heated in a muffle furnace maintained at 500 ± 10 °C. The mixture finally yields the porous and voluminous powder.

2.2 X-ray diffraction studies

The structural characterization of the nano particles was carried out using Philips X-ray diffractometer using CuKα radiation (λ = 1.5406 Å). The average particle size, D was determined from line broadening of reflection using Scherrer formula

$D = k\lambda/\beta \cos\theta$ (1)

Where, k = 0.9 is a correction factor to account for the particle shapes, β is the full width at a half maximum (FWHM) of the most intense diffraction peak, λ is the wavelength of a Cu target = 1.5406 Å and θ is the Bragg angle.

2.3 Dielectric measurement

Dielectric measurements were carried out at room temperature using HIOKI 3532-50 LCR HiTESTER impedance analyzer over a wide frequency range from 100Hz to 5MHz. The capacitance value (C), dielectric loss tangent (D) and a. c. conductance (G) were directly obtained from the instrument. The dielectric constant (ε′) and the dielectric loss factor (ε″) and a. c. conductivity (σ) was calculated using the following relations.

$\varepsilon' = cd/\varepsilon_0 A$ (2)

$\varepsilon^{\sim} = \tan\delta\varepsilon'$ (3)

$\tan\delta = \varepsilon^{\sim} / \varepsilon'$ (4)

where c is the capacitance, d the thickness of the sample, A the cross-section area, ε_0 the free space permittivity.

2.4 SEM Study

The microstructural observations have been performed on Ni–Co nano ferrites using the field emission scanning electronmicroscopy (FESEM). make Carl Zeiss NTS GmbH(Germany).

3. Result and Discussion

3.1 X-ray analysis

Figure 1 shows the X-ray diffraction pattern of the Co-$SrFe_2O_4$powder sample. The grain sizes of the sample were evaluated by measuring the FWHM. The XRD pattern of the $Co_XSr_{1-X}Fe_2O_4$nanoparticles of crystalline phases was identified by comparison with reference data from the ICSD card No. 22-1086. Figure 1 shows the X-ray diffraction pattern of $Co_XSr_{1-X}Fe_2O_4$nanocomposites. Analysis of X-ray diffraction pattern revealed the formation of single spinel phase. The average crystallite size of the $Co_XSr_{1-X}Fe_2O_4$nanoparticles determined by the Debye-Scherrerformula $D = \frac{k}{\beta}$, where D is the crystallite size, k = 0.9 is a correctionfactor to account for the particle shapes, b is the full width at a half maximum of the most intense diffraction peak (311) plane, l is the wavelength of a Cu Ka radiation (1.5418 Å) and u is the Bragg angle. The average crystallite size of the prepared sample is around 46 nm. The observed peak at 2θ = 35.63^0 C indicates the semi crystalline nature of nano ferrites present within the sample **[5].**

They all show the reflection planes (111), (220), (311), (222), (400), (422), (511) and (440), corresponding to a crystalline cubic, spinel-type phase. They provide clear evidence of a series of solid between $Co_XSr_{1-X}Fe_2O_4$ nanoparticles. The patterns show a slight shift in peak position towards lower d-spacings**[6].**

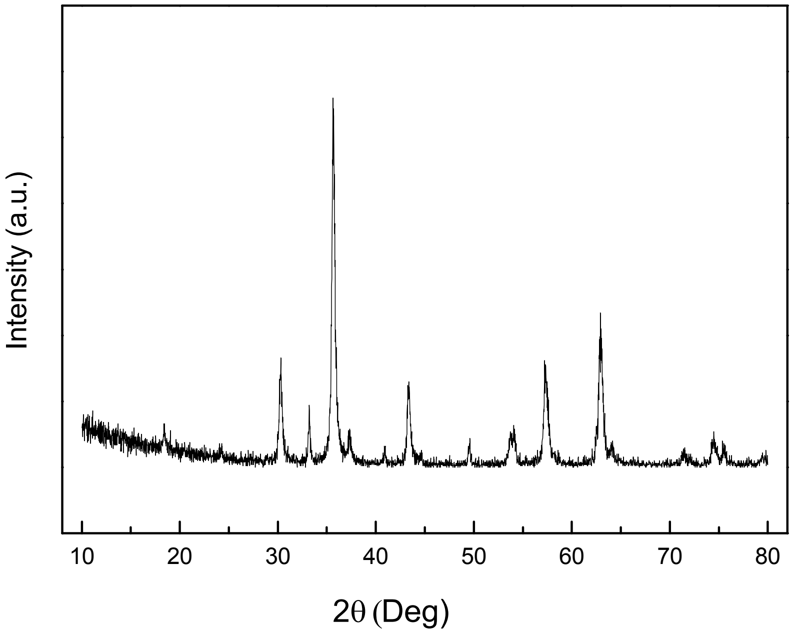

Figure 1.XRD pattern of as prepared $Co_XSr_{1-X}Fe_2O_4$nanoferrite sample.

3.2 Dielectric Properties

The effect of frequency *f* on the dielectric parameters such as dielectric loss (D), dielectric constant (ε′) and the dielectric loss factor (ε″) are studied in the frequency range 100Hz-5MHz at room temperature. All the dielectric parameters (D, ε′ &ε″) are found to decrease with the increase in the frequency. This is the normal dielectric behavior of ferrites, which was observed before for other nano ferrites at room temperature [7,8].

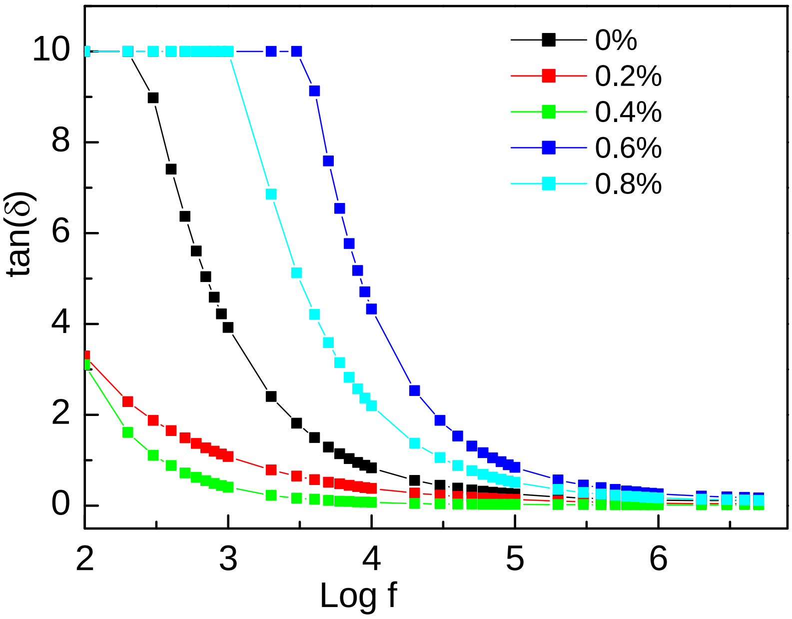

Figure 2. Variation of loss of tangent (tanδ) with frequency of the $Co_XSr_{1-X}Fe_2O_4$nano ferrites

International Journal of Engineering Technology Science and Research
IJETSR
www.ijetsr.com
ISSN 2394 – 3386
Volume 5, Issue 1
January 2018

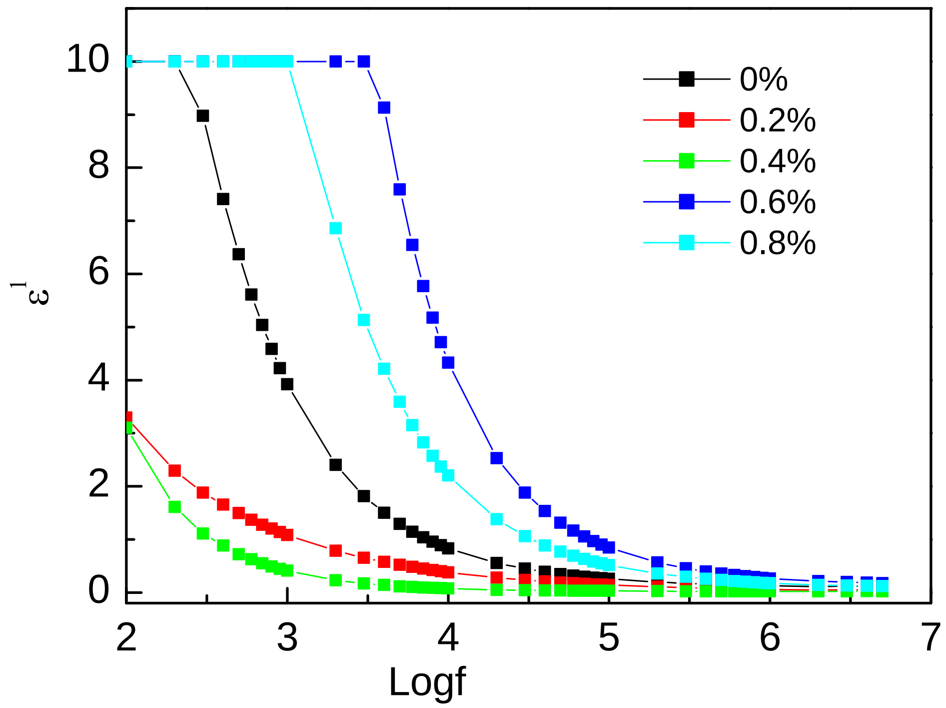

Figure 3. Variation of the dielectric constant (**ε′**) with frequency of the $Co_XSr_{1-X}Fe_2O_4$nano ferrite

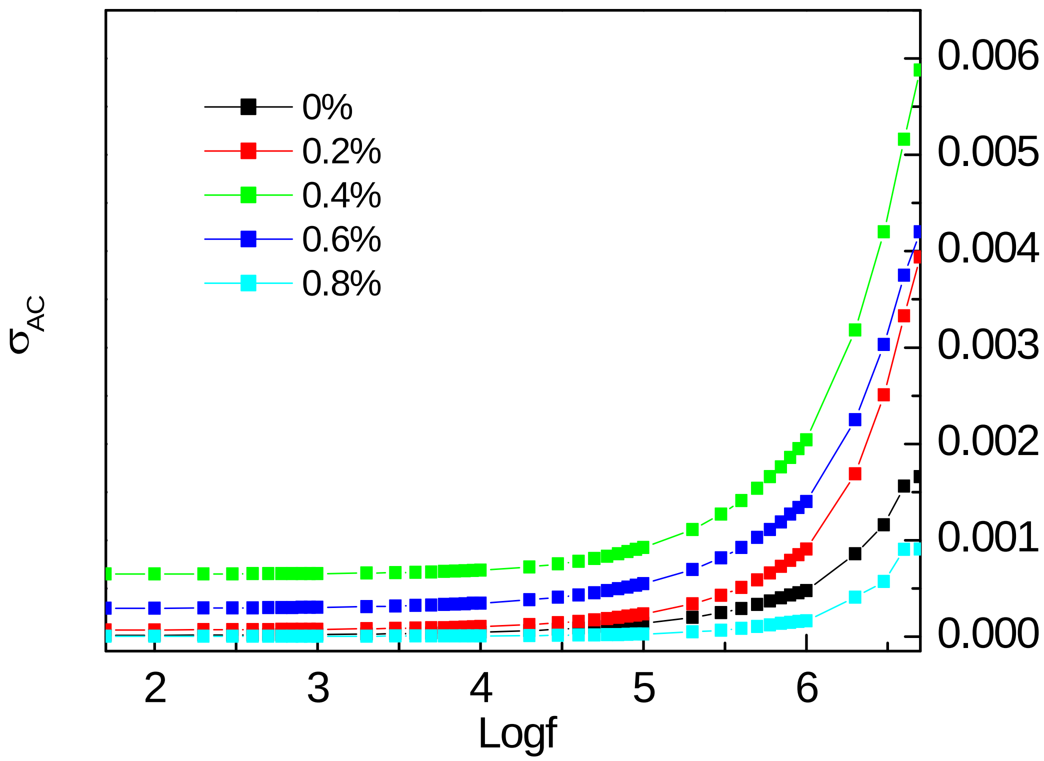

Figure 4. Variation of Sigma AC (σ_{AC}) with frequency of the $Co_XSr_{1-X}Fe_2O_4$nano ferrites

3.3 Scanning Electron Microscopy Analysis (SEM)

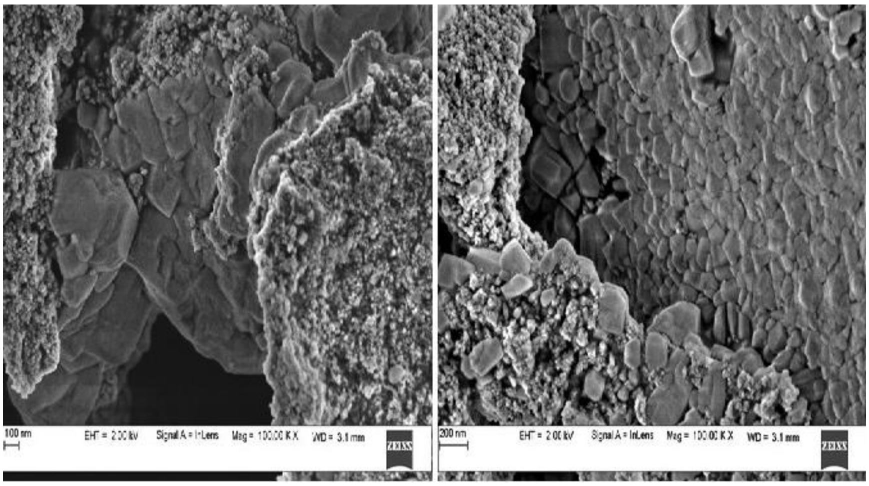

Figure 5. SEM micrographs of $Co_xSr_{1-x}Fe_2O_3$nanocomposites

The microstructural morphology observations have been performed on $Co_xSr_{1-x}Fe_2O_3$nanocomposites using Scanning Electron Microscope (SEM). Figure 3 shows the SEM image of $Co_xSr_{1-x}Fe_2O_3$nanocomposites. The SEM image displays the distribution of the $Co_xSr_{1-x}Fe_2O_3$ nanoferrites particles. $Co_xSr_{1-x}Fe_2O_3$nanocomposite is flaky and appears as aggregates of irregular shapes with diameter ranging from 35-65 nm

CONCLUSIONS

NanoscaleCo-Sr ferrite nanoparticles were prepared using combustion technique. The average crystallite size of the sample is found to be 64.11 nm. Analysis of the X-ray diffraction pattern revealed the nanocrystalline nature of the as prepared sample. The dielectric loss tangent, dielectric constant and dielectric loss factor parameters are found to decrease with the increase in the frequency. The a. c. the conductivity of the Cobalt-Stransiumnano ferrite is found to increase with an increase in the frequency. The electrical conduction mechanism in the nickel nano ferrite is understood on the basis of the electron hopping model.The SEM image of the synthesized Co–Srnano ferrites, which confirms the nanoscale range of the prepared Co–Sr ferrites.

Reference

[1] J. Chand, S. Verma, P. Kumar and M. Singh, Structural, Electric and Dielectric properties of $MgFe_2O_4$ Ferrite processed by solid state reaction technique, International Journal of theoretical and applied science (2011).

[2] K. C. Patil, M. S. Hegde, Tanu Rattan and S. T. Aruna, "Chemistry of Nanocrystalline Oxide Materials, Combustion synthesis, Properties and Applications" World Scientific Publishing, 2008.

[3] S. K. Kulkarni, Nanotechnology Principles, and Practices, Capital publishing company, 2009.

[4] Soibam I, phanjoubam S, Prakash C. Magnetic and M€ossbauer studies of Ni substituted LieZn ferrite. J MagnMagn Mater 2009;321:2779.

[5] B. SubhashKondawar,A. I.Nandapure,B. I.Nandapure, Adv. Mat. Lett. 2014, 5, 341.

[6] B. J. Madhu, V. JagadeeshaAngadi, H. Mallikarjuna, S. O. Manjunatha, B. Shruthi, R. Madhu Kumar,Dielectric Behavior and A. C. Conductivity Studies on Nickel Nanoferrites Synthesized by Solution Combustion Method,Advanced Materials Research Vol. 584 (2012) pp 299-302

[7] B. J. Madhu, E. Melagiriyappa, G. D. Prasanna, H.S. Jayanna and B. Nagappa " Dielectric studies on $Mg_xZn_{1-x}Fe_2O_4$ nanoparticles synthesized by combustion method" in, Synthesis and characterization of Nanostructured materials, Macmillan Advanced Research Series, Macmillan Publishers India Ltd**.**, 2010, pp. 295-298.

[8] A. T. Raghavender and K. M. Jadhav, "Dielectric properties of Al-substituted Co ferrite nanoparticles", Bull. Mater. Sci., 32 (2009) 575-578.