Appendix-I

The Thesis is based on the following papers (Published/Accepted/Communicated):

1. International Journal of Engineering Research and Application (IJERA)
   “Structural, Dielectric and Magnetic Behaviour of Cu$^{2+}$ substituted Ni-Zn ferrite by Auto-Combustion Technique”
   V.V.Awati, D.H.Bobade, Mrs S.D.Kulkarni, S.M.Rathod.

   ISSN: 2230-7850, Volume II, Issue X, Nov. 2012, Impact factor- 0.2105
   “Frequency and composition dependent dielectric behaviour of Cu$^{2+}$ substituted nanocrystalline Ni$_{0.8-x}$Cu$_x$Zn$_{0.2}$Fe$_2$O$_4$ ferrites.”
   V.V.Awati, MaheshKumar L.Mane, S.M.Rathod.

   “Fabrication of Cu$^{2+}$ substituted nanocrystalline Ni-Zn ferrite by solution Combustion route, investigation on structure, cation occupancy and magnetic behaviour”
   V.V.Awati, S.M.Rathod, Sagar E.Shirsath, Maheshkumar.

4. JJT University, Rajasthan, CENTUM
   “Fabrication and physical characterization of NiCuZn ferrite nanocrystalline Powders by auto-combustion of nitrate citrate gels.”
   V.V.Awati, S.M.Rathod.

   ISSN: 2228-5326.
   MS : 1644821267914277
   “Influence of Zn$^{2+}$ doping on the structural and surface morphological properties of Nanocrystalline Ni-Cu spinel ferrite.”
   V.V.Awati, S.M.Rathod, MaheshKumar L Mane, K.C. Mohite
Acceptance Letter

It is certify that the paper entitled by “Structural, Dielectric and Magnetic Behavior of Cu²⁺ Substituted Ni-Zn Ferrite by Auto-combustion Technique” is accepted for further publication in International Journal of Engineering Research and Applications (IJERA).

Article would publish with following details:

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Structural, Dielectric and Magnetic Behavior of Cu$^{2+}$ Substituted Ni-Zn Ferrite by Auto-combustion Technique.

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ABSTRACT

Structural and magnetic properties of Cu substituted Ni$_{0.8-x}$Cu$_x$Zn$_{0.2}$Fe$_2$O$_4$ ferrites for x = 0.0 to 0.6 with the step increment of 0.2 prepared by an auto-combustion method have been investigated. The X-ray diffraction pattern of these compositions confirmed the formation of the single phase spinel structure. Further, the XRD have been used to calculate the lattice parameter and grain size. The particle size of the starting powder composition varied from 25 nm to 40 nm. The morphological investigations and nanometric sizes of the samples was studied by using scanning electron microscopy and transmission electron microscopic techniques. Dielectric constant varied from 75 to 3000 with frequency, rise in copper concentration and temperature. All the samples follow the Maxwell-Wagner’s interfacial polarization. Saturation magnetization decreased from 152.15 emu/g to 42.05 emu/g for as burnt samples and from 48.63 emu/g to 43.368 emu/g for samples sintered at 700° C. The influence of Cu substituent on Ni-Zn ferrite is investigated by UV measurement at room temperature and at 700° C. These nanoferrites may have application in core materials and in electronic device technology.

Keywords: Auto-combustion, Dielectric Constant, Ferrites, Nanocrystalline Magnetic materials.

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Certificate of Acceptance

This is to certify that our Editorial, Advisory, and Review Board Accepted Research Paper of Dr. /Shri. /Smt.: V. V. Awati, S. M. Rathod, Maheshkumar L. Mane Topic: Frequency and composition dependent dielectric behaviour of Cu²⁺ substituted nanocrystalline Ni₀.₅Cu₀.₅Zn₀.₅Fe₂O₄ ferrites The Research paper is Original & Innovative it is Done Double Blind Peer Reviewed.

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Pen. H.N. Jyotiba
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FREQUENCY AND COMPOSITION DEPENDENT DIELECTRIC BEHAVIOUR OF CU²⁺ SUBSTITUTED NANOCRYSSTALLINE NI₉₋ₓ CUₓ ZNₓ₀.₂ FE₂O₄ FERRITES

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Abstract:

Dielectric phenomenon have been investigated by synthesizing nano-particles of Niₓ₋ₓ Cuₓ Znₓ₀.₂ Fe₂O₄ ferrites wherein (0.8-x)Ni²⁺ ions have been replaced by xCu²⁺ ions (x = 0.0, 0.6 with steps of 0.2) by sol-gel auto-combustion technique. The crystal phase of samples was confirmed by employing powder X-ray diffraction technique. The variation of dielectric parameters such as dielectric constant (ε'), dielectric loss (ε″) and dielectric loss tangent (tan δ) as a function of frequency and composition have been investigated. The dielectric behavior showed a typical ferrite nature for all compositions. The loss tangent (tan δ) measurements conclude that the conduction mechanism in these samples is due to polaron hopping.

KEYWORDS:

Ferrite, Crystal phase, Dielectric properties, sol-gel auto combustion method.
Fabrication of Cu$^{2+}$ substituted nanocrystalline Ni–Zn ferrite by solution combustion route: Investigations on structure, cation occupancy and magnetic behavior

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ABSTRACT

The reactivity of Cu$^{2+}$ ion concentration in Ni–Zn spinel matrix fabricated using solution combustion route has been investigated. The specimens of nanocrystalline Ni$_{0.8-x}$Cu$_x$Zn$_{0.2}$Fe$_2$O$_4$ ($x = 0.0$ to $0.6$ with steps of 0.2) exhibits single phase cubic structure. The detailed studies shows the physico-chemical stability, crystal structural stability, surface morphology and magnetic properties as a function of Cu$^{2+}$ ion concentration were performed. The annealing treatment does not alter the crystal structure but increases the crystallinity of the samples. The cation occupancies of the prepared materials were estimated by using X-ray diffraction (XRD) data analysis. The morphological investigations of the samples were studied by using field emission scanning electron microscopy (FE-SEM) technique. The crystallographic analyses of all the compositions were systematically investigated by Fourier transform infrared spectroscopy (FTIR). The saturation magnetization (M–H plots) at room temperature with field 10 kOe exhibits strong influence of Cu$^{2+}$ ion content and annealing temperature.
FABRICATION AND PHYSICAL CHARACTERIZATION OF NiCuZn FERRITE NANOCRYSTALLINE POWDERS BY AUTO-COMBUSTION OF NITRATE CITRATE GELS.

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ABSTRACT

Structural and magnetic properties of Cu substitute d $\text{Ni}_{0.8-x}\text{Cu}_x\text{Zn}_{0.2}\text{Fe}_2\text{O}_4$ ferrites for $x = 0.0$ to 0.8 with the step increment of 0.2 prepared by an auto-combustion method have been investigated. The X-ray diffraction pattern of these compositions confirmed the formation of the single phase spinel structure. Further, the XRD have been used to calculate the lattice parameter and grain size. The particle size of the starting powder composition varied from 6 μm to 61 μm. The morphology of nanoferrites was studied using scanning electron microscopy. The dielectric constant varies with frequency and temperature. All the samples follow the Maxwell-Wagner’s interfacial polarization. Saturation magnetization decreased from 70.725 emu/g to 65.436 emu/g. These nanoferrites may have application in core materials and in electronic device technology.

Keywords: Ferrites, Auto-combustion, Dielectric Constant, Saturation Magnetization.

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Influence of Zn$^{2+}$ doping on the structural and surface morphological properties of nanocrystalline Ni-Cu spinel ferrite

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Abstract

Ni$_{0.25}$Cu$_{0.75}$Zn$_x$Fe$_2$O$_4$ (0.0 ≤ x ≤ 0.2) ferrite nanophase was achieved by sol-gel auto-combustion technique. The as-prepared samples were thermally characterized by thermogravimetry-differential thermal analysis to obtain firing temperature of the materials. The X-ray diffraction pattern indicates the formation of a single-phase cubic spinel structure and shows strong influence of the incorporation of Zn$^{2+}$ metal ions on the spinel structure. The annealing treatment does not alter the crystal structure but increases the crystallinity of the samples. The morphological investigations and nanometric sizes of the samples were studied by scanning electron microscopy and transmission electron microscopy. The crystallographic texture due to annealing and Zn$^{2+}$ ion doping was systematically investigated by Fourier transform infrared spectroscopy.

Keywords: Ferrite, Crystal structure, Annealing treatment, Morphology

PACS: 7550.Gg, 74.25.Ld, 43.35.Gg

Background

The development of civilization has been intimately linked with the ability of human beings to work with advanced magnetic nanomaterials. Nanocrystalline magnetic particles with specific properties can be synthesized by different chemical techniques [1–4]. These properties are strongly dependent on their shape, size, crystallinity, and distribution of the cations among the tetrahedral (A) and octahedral (B) sites of the spinel structure. The use of nanoparticles for desired applications has attracted considerable attention in recent years because nanoparticles provide high surface area-to-volume ratios [5,6]. Magnetic particles are gaining interest due to a variety of technological applications such as high-density information storage nanodevices, ferrofluids, magnetic refrigeration, residential cooling, and biomedical applications like magnetic separations, biosensors, resonance imaging, hyperthermia, and targeted and controlled drug delivery. In this regard, spinel ferrites are particularly important because of their excellent magnetic properties that can be tuned to suit the requirement using chemical manipulations [7–11]. However, the development of novel techniques for improvements of the magnetic and the structural properties of soft magnetic spinel ferrites has been the objective of numerous studies in past decades.

Recently, Ni-Cu-Zn spinel ferrites with nanometric dimensions were extensively studied in order to develop multilayer chip inductors [12–15]. Many methods such as sol-gel auto-combustion technique [16], chemical co-precipitation [17], citrate precursor method [18], oxalate precursor technique [19], and ceramic method [20] are used to prepare Ni-Cu-Zn spinel ferrite. Among them, the sol-gel auto-combustion method, has unique advantages such as excellent composition control, low temperature process, low production cost, and better results.

In the present investigation, we report the sol-gel auto-combustion synthesis of Ni-Cu-Zn ferrite. The Ni-Cu spinel ferrite material allows the introduction of Zn$^{2+}$ cation in the spinel matrix, which causes the change in the structure and surface morphology considerably. Optimization of Zn$^{2+}$ concentration with respect to Ni$^{2+}$ will be investigated. Correlation between compositions of Ni-Cu-Zn spinel ferrites and sintering temperatures on