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AUTOCOMBUSION SYNTHESIS AND DIELECTICAL PROPERTIES OF Mg^{+2} SUBSTITUTED IN NiCuZn FERRITE

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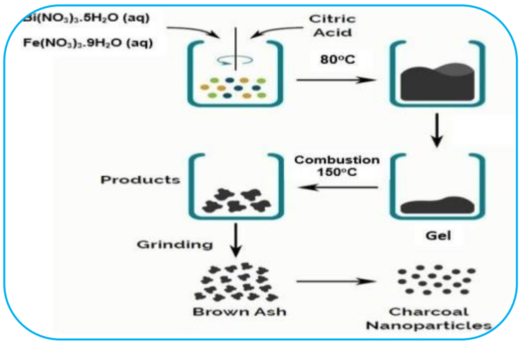
1. ABSTRACT

In order to study the effect of substitution of Mg in Ni Cu Zn ferrite with small concentration. On the electrical properties at low and high frequencies,

The ferrite composition of $[Ni_{0.25-x}Mg_xCu_{0.20}Zn_{0.55}]Fe_2O_4$ *with values x= 0.00, 0.05, 0.1, 0.15, 0.2, 0.25 were synthesized by auto combustion nitrate citrate method. XRD analysis of prepared ferrite powder shows the cubic spinal structure. The resultant powder was calcined at 650* ^0c */ 2hr and the pressed ferrite were sintered at 950* ^0c */ 4hr. Dielectric constant and Complex Dielectric constant were measured . The addition of* Mg^{2+} *results is the frequency was increased, the dielectric constant of all of the ferrites rapidly reduced and reduction in the resistivity of the material. It is believed that electrons in ferrites conduct electricity by hopping from the more electronegative* Fe^{2+} *to the more positive* Fe^{3+}*.The the value of Complex Diectric constant ε'', dropped when the frequency was increased, and after a certain frequency, it replied independently against the frequency, particularly at higher frequency side resistivity with increasing composition of Mg. As the frequency was increased, the dielectric constant of all of the ferrites rapidly reduced.*



KEYWORDS : *small concentration , cubic spinal structure , ferrites conduct.*

2. INTRODUCTION

Electrical studies of Mg^{2+} substituted Ni Cu Zn ferrites, prepared by sol-gel auto-combustion route. In today's world, information technology plays a significant role in everyday life. There is an urgent and growing demand for electromagnetic components that are affordable, have great efficiency, and have a small size. Surface mount devices, also known as SMDs, and MultiLayer Chip Inductors, also known as MLCIs, are two of the components that are used extensively in electronic products. Products that employ these components include video cameras, laptops, cellular phones, and computers. Since NiCuZn ferrites have lower temperatures of sintering and superior electric and magnetic characteristics at higher frequencies, they are the material of choice for most MLCIs.

From the state of art, the excellent permeability and environmental stability of MgCuZn ferrites make them the good electromagnetic materials. As a result of their high electrical resistivity and low dielectric losses,[1-4] Mg-based ferrites are frequently utilized in microwave devices [5]. Both the dielectric loss and the DC resistivity are decreased as a result [7]. In Mg-substituted low-temperature sintered ferrites, the grain size is better when the frequency is greater and the dielectric parameters are lower [8].

3. EXPERIMENTAL DETAILS:

In order to Synthesize Mg^{2+} substituted Ni Cu Zn ferrites, the overall method entails carrying out the following steps: (i) the synthesis of material powder using sol-gel combustion, followed by the creation of pellets and/or toroids; and (ii) investigation/characterization of the developed ferrite material.

In Autocombustion method typical synthesizes ferrite. for this AR grade nitrates (magnesium nitrate ($Mg(NO_3)_2 \cdot 6H_2O$), nickel nitrate ($Ni(NO_3)_2 \cdot 6H_2O$), copper nitrate ($Cu(NO_3)_2 \cdot 6H_2O$), zinc nitrate ($Zn(NO_3)_2 \cdot 4H_2O$), ferric nitrate ($Fe(NO_3)_3 \cdot 9H_2O$) and citric acid ($C_6H_8O_7$) were obtained from Sigma Aldrich and were used as received. Stoichiometry of the redox mixture for combustion was estimated and held constant based on the total oxidizing and reducing valence of the oxidizer and the reluctant (1:3 mol). In the appropriate quantity of distilled water, the precursors and reagent were thoroughly combined and homogenized. The temperature of the sol was brought up to 100°C. At the predetermined temperature, The highly viscous sol eventually reached the threshold value, which led to the formation of a gel that was subsequently supplemented with water. After then, the gel was subjected to further heat treatment at an even greater temperature (150-200°C). The thick gel continued to foam, and finally, as the water evaporated, the gel started to exhaust into a quick flameless auto combustion process with the evolution of a considerable number of gaseous products; following this, it got auto ignited. The resulting powder was calcinated in air at a temperature of 650°C for 2 h in order to remove any residues of unreacted leftovers while maintaining the pure ferrite material. After that, using a manual pressing machine with a pressure of 1.5 tons/cm^2 and PVA as the binder, the powder was formed into pellets with a diameter of 15 mm and a thickness of 2 mm, as well as toroids with an inner diameter of 1.5 cm, an outer diameter of 2.5 cm, and an average height of 0.3 cm. The pellets and the toroids were both sintered at a temperature of 950°C for 4 h in air. The general composition of the developed ferrites is [$Ni_{0.25-x}Mg_xCu_{0.20}Zn_{0.55}$] Fe2O4with x = 0.00, 0.10, 0.15, 0.20,

4. RESULT AND DISCUSSION.

Dielectric constant as function of frequency (ε′)

At room temperature, the dielectric constant (ε′) of the ferrites is plotted as a function of frequency in Figure - 1

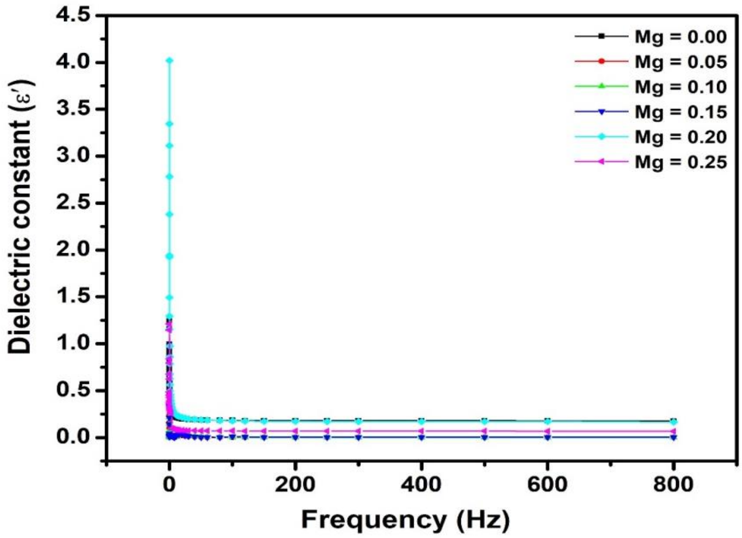


Figure -1 : Dielectric constant (ε′) of the ferrites as a function of frequency.

As the frequency was increased, the dielectric constant of all of the ferrites rapidly reduced, and as the frequency was increased further, they finally reached a value that was constant. This tendency in the dielectric measurement demonstrates that the material has ferromagnetic activity [9]. In addition, the conduction mechanism in ferrites, which is where electron hopping occurs, is primarily responsible for determining the dielectric characteristics of the material.

Complex dielectric constant as function of frequency (ε′′):

In addition to the dielectric constant, the complex dielectric constant, denoted by ε′′, was studied and analyzed as a function of frequency, as shown in Figure - 2. It showed a drop in the value of ε′′, when the frequency was increased, and after a certain frequency, it replied independently against the frequency, particularly at higher frequency side. This phenomenon can be explained by the presence of Maxwell-Wagner interfacial polarisation [10, 11], which is found in inhomogeneous dielectrics. Large values of dielectric constants were reported at low frequencies as a result of the prevalence of Fe^{2+} ions, interfacial dislocations, oxygen vacancies, and grain boundary defects [12]. These factors contributed to the phenomenon.

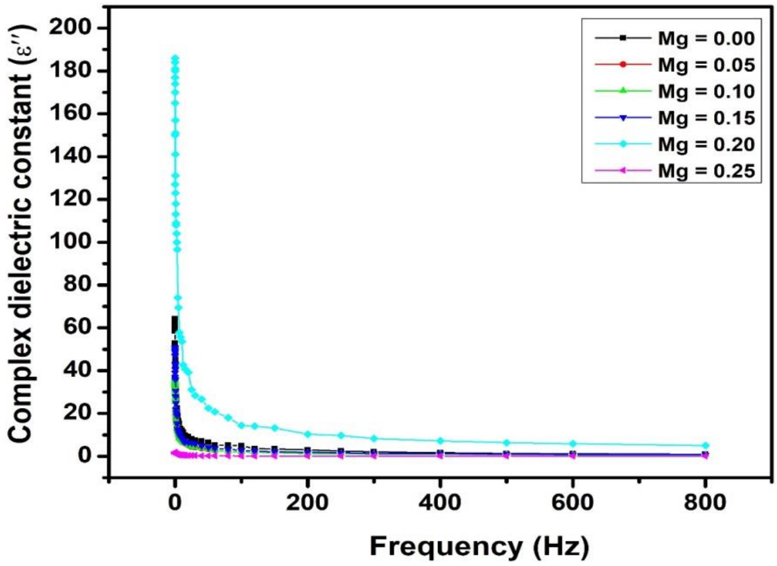


Figure 2 : Complex dielectric constant (ε′′) of the ferrites as a function of frequency.

Following Table 1 gives an account of complete picture of electrical properties of developed ferrite.

Table 1 : Compositional data of DC Resistivity, Curie temperature, Dielectric constant, Complex dielectric constant, Dielectric loss factor (tanδ), AC Resistivity of the developed ferrites $[Ni_{0.25-x}Mg_xCu_{0.20}Zn_{0.55}]Fe_2O_4$.

Mg Content (x)	DC Resistivity (Ω cm)	AC Resistivity (Ω cm)	Curie Temperature from DC resistivity (ºC)	Dielectric constant (ε’)	Dielectric constant (ε”)	Dielectric loss factor (tanδ)
0.00	2.8×10^5	6.4×10^{10}	210	18.25	4.88	0.02391
0.05	3.3×10^3	2.17×10^8	205	9.00	4.89	0.02641
0.1	3.1×10^3	1.1×10^8	180	21.40	1.24	0.03352
0.15	1.3×10^3	1.05×10^8	160	23.20	9.93	0.02619
0.2	1.2×10^3	8.35×10^8	159	12.14	12.20	0.03115
0.25	1.1×10^3	8.9×10^6	140	7.00	17.90	0.03803

5. CONCLUSIONS:

In conclusion, we have synthesized a straightforward and facile synthesis technique for the fabrication of spinel-type Mg^{2+} substituted NiCuZn Nan crystalline ferrite using a citrate gel auto-combustion process. The substitution level of Mg is varied in the range of 0 to 0.25, where the system is $[Ni_{0.25-x}Mg_xCu_{0.20}Zn_{0.55}]Fe_2O_4$ with a step x = 0.05. A single-phase ferrite material with a high density and a dense microstructure was produced using the citrate gel method. Citrate gel method yielded a single-phase ferrite material with high density and dense microstructure. dielectric and magnetic properties of the ferrites are discussed. The microstructure was strongly influenced by the addition of Mg^{2+}. As the frequency was increased, the dielectric constant of all of the ferrites rapidly reduced, and as the frequency was increased further, they finally reached a value that was constant. This tendency in the dielectric measurement demonstrates that the material has ferromagnetic activity

The presence of Mg^{2+} can be observed to have an impact on the electrical resistivity and Dielectric constant sa well as Complex Dielectric constant. Large values of dielectric constants were reported at low frequencies as a result of the prevalence of Fe^{2+} ions, interfacial dislocations, oxygen vacancies,

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