ABSTRACT

Title of thesis: - Study of Electric and Magnetic properties of ferrites and their application in suppression of electromagnetic pollution

Modern electronic equipment of mostly high-speed digital circuitry, switching devices, memories & sensitive semiconductors circuits is very susceptible to electromagnetic interference, which increases the danger of malfunctioning and damage of the electrical and electronic equipment. In order to eliminate or minimize the impact of this problem, there had been an ever need to find magnetic materials which could efficiently handle the electromagnetic interferences (EMI). Ferrites can be characterized as high frequency, current operated, low Q series loss element. As a part of the strategy for controlling EMI, ferrites play an important role as absorptive filters. As their excitation frequency approaches ferromagnetic resonance, a loss property increases dramatically.

Magnetic materials belonging to Mn-Zn and Ni-Zn ferrites widely used in electrical and electronic equipments as noise suppressors have been investigated extensively. Mn-Zn ferrites are known to posses' high initial permeability but low resistivity, generally used for frequencies less than 50MHz. Ni-Zn ferrites posses' higher resistivity but relatively much lower initial permeability used above 30 MHz for the suppression of EMI. It is realized to develop ferrites, which cover the entire frequency band of 1MHz to 1000MHz, which will be helpful to suppress the conducted and radiated transient. Transient is characterized as high amplitude and wide bandwidth noise.

Lithium ferrites are useful in a variety of microwave devices. The basic lithium ferrite formula can be molecularly engineered to provide wide range of magnetization values, a wide range of resonance and high resistivity. Literature on the lithium –zinc ferrite for the suppression of electromagnetic noise is not easily. In the present work following series of samples are prepared and investigated for the EMI suppression application:

$Li_{0.25-x/4}\ Zn_{0.5-x/2}\ Ni_x\ Mn_{0.1}\ Fe_{2.15-x/4}\ O_4$ with x=0 - 0.5 in the step of 0.1 Series 1
$Li_{0.25-x/4}\ Zn_{0.5-x/2}\ Mg_x\ Mn_{0.1}\ Fe_{2.15-x/4}\ O_4$ with x=0 - 0.5 in the step of 0.1 Series 2

The conventional ceramic method has been used for synthesizing ferrites. A comprehensive study of micro-structural, electrical and magnetic properties are made. The generated result can be considered to be useful for tailoring the material for the suppression of electromagnetic interference. The details of the work carried out by author are compiled in the thesis.

XRD analysis of all the samples of both the series confirms single-phase formation, without any evidence of un-reacted ingredients or second phase, which ensure a right quality of the materials for the device fabrication. Lattice constant for the series have been found to decrease with the increase of substitution level x in the composition formula. The results of theoretical and experimental densities have also been discussed. The surface morphology of the fractured

surfaces of samples is studied. It has been observed that grain size decreases with the increase of substitution level x. The effect of sintering temperature has also been investigated.

DC resistivity of all the compositions has been investigated. It has been observed that resistivity increases with increase in Mg and Ni substitution. The temperature variation curves of all the sample shows linear region. Activation energy has been calculated for both the series. It is observed that activation energy increases with the increase of the substitution level x. Possible conduction mechanisms contributing to this process have been discussed. Dielectric properties of magnesium and nickel substituted lithium – zinc-manganese ferrites have been investigated as a function of frequency, temperature and composition.

Magnesium substituted lithium – zinc-manganese and nickel substituted lithium-zinc-manganese ferrites have been investigated for their magnetic properties. An initial increase followed by a subsequent decrease of saturation magnetization with increase in magnesium and nickel substitution is observed. Curie temperature is observed to increase with increase in magnesium & nickel substitution level. Initial permeability is observed to decrease with increase in magnesium and nickel substitution level. Permeability spectra have been studied for both the series, real and imaginary permeability decreases and resonance frequency increases with the increase of substitution level. The real and imaginary permeability increases but the resonance frequency decreases with the increase of sintering temperature. Real and imaginary permeability and impedance measured from 100 KHz to 110MHz. Insertion loss measured from 500 KHz-1000MHz with 3, 6 and 8 turns of winding.

The electrical and magnetic properties of ferrites show that the Ni and Mg substituted Li-Zn-Mn ferrites possess all the characteristics of ferrites used for electromagnetic compatibility applications. High resistivity high magnetic saturation, wide frequency bandwidth (1-1000 MHz), high Curie temperature, high impedance and insertion loss of ferrite core are the indispensable parameters for the suppression of the electromagnetic interference/ noise. All the compositions used found effective for the suppression of conducted emission, radiated emission, electrical fast transients, electrostatic discharge and damped oscillatory wave (1MHz).

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