ABSTRACT

The work of several researchers on high frequency multilayer chip inductors revealed that the most important characteristics of materials used for such applications are high permeability in the radio frequency range, reasonable saturation magnetization, high dc resistivity, high Curie temperature, high quality factors, low dielectric constant and low loss. Among the mixed spinel ferrites, Ni-Zn ferrite has been found to be the best suitable material for MLCI applications. However, the use of Ni-Zn ferrite as a superior material for MLCI applications has been limited due to its moderate initial permeability in the working frequency range. Further increasing demand for higher density circuits in electronics required the continued miniaturization of components and efforts have been made to produce electronic components in surface mount device form. In surface mount devices like a multilayer chip inductor, in order to reduce the number of layers it is desirable that the material should have higher values of magnetic permeability. But Snoek's law limits the operating frequency of higher permeability materials. The frequency up to which a ferrite can be operated in a device is known as critical frequency which depends on number of parameters like dc resistivity, saturation magnetization, grain size and magnetic anisotropy constant. Small sized single domain nanograins with increased resistivity, higher permeability are favorable for the shifting of operating frequency.

The processing of Ni-Zn ferrite nanoparticles has been carried out using Sol-gel method using polyvinyl alcohol (PVA) and polyethylene glycol (PEG) as

chelating agents. The observed changes in various physical parameters of the basic ferrite samples processed using PVA, PEG have been presented in the thesis.

X-ray diffraction analysis for the basic samples revealed the formation of single phase spinel structure in all the samples annealed at temperatures higher than 400^{o}C. Particle size, saturation magnetization, coercivity measurements have been made using transmission electron microscopy and vibration sample magnetometer.

Ni-Zn ferrite samples incorporating copper in small amounts in place of nickel have been processed using PEG as chelating agent to understand the influence of microstructure on permeability and magnetic losses. X-ray studies of Ni-Cu-Zn ferrite samples showed that copper is entering into the lattice. FTIR and VSM measurements suggest the entry of copper into octahedral site. Scanning electron microscopy technique employed to study the grain size variations in the Ni-Cu-Zn ferrite samples exhibited that the grain size has been observed to increase for all the copper substitutions. The permeability increased with increasing copper content upto x=0.18 and decreased for higher concentration. But as the grain sizes and particle sizes are observed to be large for these samples resulting in the lowering of resistivity. Attempts have been made to control the grain size by changing the method of preparation.

In an attempt to have superior properties the same compositions have been processed using PVA as chelating agent and characterized. FTIR and Mossbauer studies have showed that copper enters into octahedral sites. As the grains were small the sizes could not be determined using low resolution SEM. FESEM technique has been adopted to study the grain morphology and the grains have been observed to take anisotropic shapes like 1D rods, flowers, spikes and belts. The permeability and DC resistivity of Ni-Cu-Zn ferrite samples have been observed to increase throughout the series with increasing copper content. The Ni-Cu-Zn nanoferrite samples processed using PVA as chelating agent have been proved to exhibit superior properties over bulk materials of similar compositions towards MLCI applications. Basing on the enormous data obtained from several experiments, the cation distribution has been proposed.