SUMMARY OF THE FINDINGS

Nanocrystalline spinel ferrites are technologically important because of their wide applications, and it is believed that the production of ferrites will increase year by year as their applications become more and more diverse. Unlike many other materials, they possess both high permeability and moderate permittivity at high frequencies. Due to their low eddy current losses, there exists no other material with such a wide range of applications in electronics in terms of power generation, conditioning and conversion.

Nickel ferrite and nickel based mixed ferrite nanoparticles are of technical importance due to numerous applications in electronics. These are promising materials for use in telecommunication equipments, computer peripherals, and other electronic and microwave devices. Nickel ferrites have low eddy current losses and good magnetic properties, which make them suitable for the core material of power transformers. Nickel ferrite nanoparticles are widely used for improving the quality of magnetic resonance imaging, targeted drug delivery, ferrofluids and gas sensors. It is well known that the desired electrical and magnetic properties of soft ferrites can be tailored by the addition of suitable divalent, trivalent or tetravalent cations in to the spinel lattice. Incorporation of small amount of rare earth metal ions in to the spinel ferrites may lead to structural distortion due to their large ionic radius and to induce strain and significantly modify the microstructural, electrical and magnetic properties.

Through this project, terbium doped and samarium doped nanocrystalline Ni-Cd mixed ferrite samples were successfully synthesized using sol-gel technique. The changes happened in the properties of Ni-Cd ferrite because of the rare earth doping has been thoroughly investigated. The major findings of the study are as follows.

Terbium substitution resulted in an increase in the particle size and a reduction in the lattice parameter of Ni-Cd mixed ferrite. Magnetic characterization reveals that the saturation magnetization can be enhanced by minor terbium doping and the maximum saturation magnetization is obtained for the sample with $x=0.06$. Coercivity shows slight decrease by terbium doping. DC resistivity study showed usual semiconducting nature for all the compositions. However, terbium doped samples exhibited metallic behaviour at the low temperature region. Resistivity of Ni-Cd ferrites is observed to increase slightly by terbium doping up to x = 0.02 and further doping has resulted in a reduction in resistivity. The decrease in resistivity above x = 0.02 may be due to a cationic redistribution that can be confirmed by further investigations. Dielectric as well as AC conductivity study supports the findings in the DC resistivity. Hence increased magnetization and slight increase in resistivity is achieved in Ni-Cd ferrites by minor terbium doping.

Properties of Ni-Cd ferrites are found to affect considerably by samarium substitution. Even though the samarium ions are of large ionic radius, Sm^{3+} ions are found to dissolve well in the spinel lattice. The lattice constant of the samples is observed to decrease with samarium concentration which indicates the possibility of some cationic redistribution by the doping. Doping inhibited grain growth and hence the grain size is found to decrease with samarium content. Unlike terbium doping, samarium substitution has resulted in a decrease in the saturation magnetization of Ni-Cd ferrite. DC resistivity of all the compositions is decreased with increasing temperature, which shows the usual semiconducting nature of ferrites. Samarium substituted samples exhibited increased resistivity compared with Ni-Cd ferrite. All the samples revealed the normal dielectric behaviour of ferrite. The observed decrease in dielectric loss by samarium doping is explained in terms of the increase in resistivity of the samples.