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ABSTRACT

The development of nanocrystalline ferrites is a subject of concern, both for the scientific value of understanding the properties of materials and for the technological significance of enhancing the performance of existing materials. To meet the demand of high performance devices an important step is to synthesize ferrites in nanoscale form. Below the critical size these nanocrystals exist in a single domain state so that the domain wall resonance is avoided and the material can work at higher frequencies. The growing interest is due to their chemical stability, biological compatibility, their relative ease of preparation and a number of applications associated with them. The main reason behind their applicability is the ease with which they can be detected and manipulated by the application of an external magnetic field. Their response times are dependent on size strongly, thus introducing the possibility of synthesizing particles to yield application tailored response times.

This thesis comprises of seven chapters, chapter 1 presents a brief introduction to ferrite nanomaterials. The size induced changes in the magnetic properties of nanomaterials has also been discussed in general. Chapter 2 describes the necessary theoretical background and the experimental details for various techniques. Chapter 3 presents a detailed investigation of structural, dielectric, ac conductivity, impedance, magnetic and power loss properties of Cd and Ni co-substituted lithium ferrite having general formula $Li_{0.35-0.5x}Cd_{0.3}Ni_x Fe_{2.35-0.5x}O_4$ prepared using citrate precursor method. The value of tanδ and ac conductivity was found to decrease and the value of permittivity increased up to ~$7x10^3$ for x = 0.02, which is useful for power application of ferrites. A reduction in power loss was also obtained with Ni substitution in $Li_{0.35-0.5x}Cd_{0.3}Ni_x Fe_{2.35-0.5x}O_4$ ferrite even up to 1 MHz. This is very important feature for power applications of ferrites. **Chapter 4** deals with the changes induced by Al substitution in the structural, dielectric, ac conductivity, impedance and magnetic properties of $Li_{0.5}Al_xFe_{2.5-x}O_4$ ($0.0 \leq x \leq 0.4$) ferrite synthesized using citrate gel auto-combustion

method. It has been confirmed from the results that permittivity of Al substituted lithium ferrite improves and shows a maximum value (~$7x10^5$) at 100 Hz for sample with x = 0.1. **Chapter 5** presents the study of structural, dielectric, ac conductivity, impedance and dc resistivity properties of $ZnFe_{2-x}Cd_xO_4$ ferrite prepared by using egg-white method. Effect of sintering temperature was also investigated on different properties of $ZnFe_{2-x}Cd_xO_4$ ferrite. **Chapter 6** presents a detailed procedure for the synthesis of superparamagnetic $Mn_{0.5}Zn_{0.5}Fe_2O_4$ ferrite nanocrystals by coprecipitating the metal salts in reverse micelles. Core-shell nanocomposites composed of $Mn_{0.5}Zn_{0.5}Fe_2O_4$ ferrite as core and conjugated polymer PANI as shell have been synthesized by in situ emulsion polymerization of Aniline with $Mn_{0.5}Zn_{0.5}Fe_2O_4$ nanocrystals in DBSA. It was observed that on nanocomposite formation with PANI, $Mn_{0.5}Zn_{0.5}Fe_2O_4$ nanocrystals undergo a transition from being superparamagnetic to ferromagnetic. An increase in $Mn_{0.5}Zn_{0.5}Fe_2O_4$ content in the polymer matrix leads to higher magnetic losses, which in turn improves the absorption of microwaves. As a result, nanocomposites of PANI/ferrites with core-shell type morphology are promising as new types of microwave absorptive materials. **Chapter 7** summarizes the results obtained in the present investigation on ferrites for different applications. The work for future has also been discussed in this chapter.