MICROSTRUCTURAL, ELECTRICAL, MAGNETIC AND MÖSSBAUER INVESTIGATIONS OF TETRAVALENT TIN SUBSTITUTED NICKEL ZINC FERRITES

BY
USHA VARSHNEY

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PREFACE

A wide variety of ferrite materials have been developed for multifarious applications in the electronics and communication industry. The diversity of ferrite properties is so far ranging that it encompasses many applications such as information storage, microwave devices, communication devices, permanent magnetic materials, inductance coils, transformers, inductor cores, relays etc.

As an ideal ferrite capable of covering a complete spectrum of applications cannot be obtained, a compromise has to be made in improving upon one characteristic property at the expense of another property. An extensive work has been done by various workers to upgrade the properties of ferrites by substituting various types and amounts of impurities. It has been shown that by incorporating small amount of tetravalent additive the properties of basic ferrites are significantly influenced. A close survey of literature indicated the necessity of detailed investigations of substituting tetravalent tin impurity in nickel zinc ferrites. The present thesis is based on detailed study of modifications in the

characteristic properties of nickel zinc ferrites by successively increasing the quantity of tin impurity. It is also aimed at an understanding of various mechanisms and physical concepts pertaining to such changes.

A comprehensive investigation has been carried out to determine the microstructural, electrical and magnetic properties and to undertake Mössbauer studies of the following three series of polycrystalline solid solutions of ferrites having the composition $Ni_{1+x-y}Zn_ySn_xFe_{2-2x}O_4$:

(i) $y = 0.1$, $x = 0.1$ to 0.9 varying in steps of 0.1

(ii) $y = 0.3$, $x = 0.1$ to 0.5 varying in steps of 0.1

(iii) $y = 0.5$, $x = 0.1$ to 0.5 varying in steps of 0.1

The brief outline about the contents of this thesis, divided into seven chapters, is given as follows:

The first chapter, entitled "Introduction and Theoretical Background", describes structure of ferrites, reviews effect of tetravalent impurity on various properties of ferrites and aim and scope of the present work. It gives relevant theoretical background and formulations for electrical and magnetic properties of ferrites. It also gives the details of various Mössbauer parameters essential for analyses and interpretation of the Mössbauer spectra.

The second chapter entitled "Experimental Details" deals with the methodology of sample preparation and characterisation techniques used in the present work. The details of various experimental methods, used for studying microstructural, electrical and magnetic properties, have been described. It also includes the description of Mössbauer spectrometer and details of method of analysis of Mössbauer spectra.

As most of the properties of ferrites are highly sensitive to their microstructure, the third chapter presents "Microstructural Properties" of the three series of nickel zinc ferrites doped with tin. The results obtained for characterisation of samples from X-ray diffraction and Auger spectroscopy have been discussed. The details revealed from optical and scanning electron micrographs are also included. The results of theoretical and experimental density and lattice constant have been discussed.

The fourth chapter entitled "Electrical Properties" phenomenologically describes various factors influencing the electrical properties of nickel zinc ferrites when incorporated with tin impurity. The experimental measurements estimate the variation of d.c resistivity as a function of composition, applied field, duration of applied

field and temperature. These variations have been explained and understood on the basis of various models. Also, the variation of conductivity, dielectric constant and loss factor has been discussed as a function of frequency of a.c. field.

The fifth chapter entitled "Magnetic Properties" aims at investigating the inductive characteristics of these ferrites which signify importance of these magnetic materials for any technological considerations. The effect of tetravalent tin additive on saturation magnetisation, Curie temperature, magnetocrystalline anisotropy, initial permeability and magnetic losses has been discussed. The variation of initial permeability and loss factor has been studied as a function of frequency. The variation of temperature factor and percentage disaccomodation has also been discussed from the point of view of stability ofthese ferrites. A comparison of the above mentioned magnetic parameters has been given as a function of tin as well as zinc concentration for all the three series of ferrites.

The sixth chapter entitled "Mössbauer Studies" forms a part of general Mössbauer investigations aimed at elucidating information about the site occupancy and ionic distribution giving rise to internal nuclear magnetic

field at Fe^{57} nuclei in these ferrite samples as a function of tin as well as zinc concentration. The technique has got the advantage of yielding information about the local magnetism around iron ions thus complementing macroscopic magnetic measurements. The dependence of isomershift, line width, quadrupole splitting, relaxation effects, spin correlation time, anisotropy energy and occupancy ratio has been given as a function of tin concentration and interpreted to derive inferences about type of ordering, deviation from stoichiometry, magnetic linkages, occupany ratio etc. It also includes the discussion of observed variation of nuclear magnetic field as a function of tin as well as zinc concentration on the basis of various models.

The seventh chapter entitled "Conclusions and Suggestions" presents summary of new results obtained from present investigations and suggestions for further work in the field.

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