MÖSSBAUER SPECTROSCOPIC AND OTHER PHYSICAL STUDIES IN SODIUM AND BARIUM BORATE GLASSES CONTAINING IRON

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DEDICATED TO

Shri Vishwanath Kanodia,

Founder, Bal Charitra Nirman Sabha

Mahendragarh, who lit for me the

Lamp of Inspiration to find for

myself the path to Enlightenment.

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PREFACE

Inorganic oxide glasses are the oldest known non-crystalline materials, made perhaps as early as 2500 B.C by firing soda and sand, as proved from archeological findings in Indian and Egyptian regions. These glasses are of great technological importance due to their structural versatility and wide applications. Presently, the glasses of any strength one wishes to have between the metal and honey, of any conductivity between that of metals and insulators, of any magnetic characteristics between that of air and ferrites, and of uses right from the detector of nuclear radiation to the source of powerful laser beam have been successfully developed by the suitable material preparation techniques[1]. Among inorganic oxide glasses, borate glasses are of great significance as is evidenced by the presence of B_2O_3 as an important ingredient in commercially important glasses such as crown glass, flint glass and other borosilicate glasses. $BaO-B_2O_3$ has been the most widely used non-volatile flux system for the top-seeded growth of materials such as yttrium iron garnet and ferrite[2]. Borate glasses, however, are hygroscopic and for many purposes this is disadvantageous but in instances where the glass can act as host to elements which are required to be stored in damp environment, advantage may be taken of this property[3]. These glasses are of academic interest too, because of the occurrence 'boron anomaly' in them.

Compared to silicate and phosphate glasses, little work has been done on borate glasses containing iron. Addition of iron makes these glasses often electronically conducting-their conductivity lying in the semiconducting range and superparamagnetic[4]. However, sometimes iron occurs as a troublesome impurity and hence an accurate knowledge of its behaviour is important. Since it is a transition metal, other magnetic and optical properties may be studied in conjunction with the Mossbauer absorption in order to give a rather complete picture of its behaviour. The study of magnetic and other related properties of transition metal ions in glasses affords a powerful method of investigating glass structure. This subject, amorphous magnetism, the magnetic behaviour of amorphous systems, is developing into an active field where the concept of spin glass is well established[5].

While tremendous amounts of experimental time have been expanded on the study of behaviour of iron in glass, its structural role is still unclear.

In the present work a systematic study on the following series is made using Mossbauer spectroscopic, infrared (IR), electron paramagnetic resonance (EPR), dc resistivity and differential thermal analysis (DTA) techniques in order to get complete picture of the structure of these glasses.

(i) $x_1\ Na_2O.(1-x_1-y)\ B_2O_3.\ y\ Fe_2O_3$; $0.045 \leq x_1 \leq 0.450$,

$0.05 \leq y \leq 0.15$.

(ii) $x_2\ BaO.\ (1-x_2-y)\ B_2O_3\ y\ Fe_2O_3$; $0.10 \leq x_2 \leq 0.70$,

$y = 0.10$.

and (iii) $(1-y)(BaO\ 2\ B_2O_3).y\ Fe_2O_3$; $0.10 \leq y \leq 0.60$.

The presented work is divided in the following chapters.

Brief introduction to borate glasses is given in Chapter I. A theoretical background of various studies is also included in this chapter. Existing controversies and aim of the present work have also been given.

Chapter II deals with the methodology of samples preparation and their characterization. A brief description of various experimental methods used in the present work is also given in this chapter.

In Chapter III, the results of Mössbauer spectroscopic studies of series (i) are discussed.

The Mössbauer spectroscopic results of series (ii) and (iii) are discussed in Chapter IV.

Chapter V concerns with the results obtained by IR, EPR, dc resistivity and DTA studies. The results of these studies are compared with one another and with those of Mössbauer studies, wherever possible in order to get better insight in understanding the mechanisms involved.

Chapter VI presents a brief account of summary of the results, conclusions drawn and suggestion for further work.

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