SUMMARY

Glass is one of the oldest synthetic materials used by man and knowledge of glass has been acquired over many centuries. Scientific study of glasses began with Faraday and others at the beginning of the nineteenth century. Today, it is still a rapidly developing subject, both in the development of new glassy materials with special properties and in the application of new scientific methods to improve our understanding of structure and properties of glasses.

The thesis entitled, ""Preparation of Transition Metal Based Borate Glasses and Their Optical and Structural Characterization"" is a detailed account of the preparation of glasses, XRD confirmation, structural, optical and thermal studies of the prepared glass samples.

The thesis is divided into six chapters. Chapter 1 provides a general introduction to amorphous materials (especially glasses). A brief history and a glance over glass families is given. The discussion about thermodynamics of glass formation and theories of glass formation is included. In this chapter the discussions have been made on account of review of literature.

In chapter 2 a proper review of literature has been given according to the properties of glasses which depend upon the composition, structure, cooling rate of glass melts and doped oxides. The changes in properties of the glasses upon addition of transition metals have been discussed. One of the major driving forces for the development of such new glasses is the demand for high optical non-linearity with reduced cost and a higher damage resistance. The achieved objectives of present investigations has been given at the end of the chapter.

In chapter 3, the experimental techniques for the preparation and characterization of glasses have been discussed. The construction and working of presently used instruments have been discussed for the understanding of underlying principles of present studies. The method of preparation of glass samples for the present research work has been given. The formation of glass phase confirmed
through X-ray diffractograms of the prepared samples has also been reported in this chapter.

In chapter 4, structural properties of the prepared glass systems have been reported. Density and molar volume measurements have been given in the first part of the chapter. Increase in BO$_4$ groups at the expense of non-bridging oxygen in the glass network on increasing the transition metal content seems to consolidate their structure, maintaining homogeneity of the glasses and thus increasing density. Correlations with the findings of other characterization results have been made. The result seems to be in accord with the other studies. In the other part of this chapter, FTIR spectra of the prepared different glass series have been discussed in detail. The results and discussion of these have been presented in the form of tables and graphs. The FTIR analysis has revealed the local structure peculiarities of the glass system and reported the contribution of each component on the structure and has pointed out the role of the transition metal ions as a modifier of the glass network. FTIR studies show that the groups like BO$_3$ and BO$_4$ act as network structural groups while sodium and transition metal ions appeared in interstitial positions. As the concentration changes, BO$_3$ group starts converting into BO$_4$ groups or there is formation of non-bridging oxygens, justifying the role of transition metals as network modifiers.

In chapter 5, the optical properties of glasses via study of UV-VIS spectra have been reported. The values for optical band gaps, width of tails have been calculated and results are presented in form of tables and graphs. Decrease in bandgap has been reported to be due to formation of four co-ordinated boron units which is also implied by FTIR spectra. There must be some change in bonds which is reflected by lowering of band gap values. The noticed change may also arise from the photon- lattice interaction. The decrease in bandgap is also due to decrease of NBO and also the formation of bridging oxygen that changes the absorption characteristics. This is in accordance with our results for density i.e. the formation of BO$_4$ units at the expense of BO$_3$ units. In some of the prepared samples there is an increase in band gap which directs increase in NBO’s. The other studies also support the results of present glass samples.

In chapter 6, thermal properties of the present samples have been reported through DTA studies. This is done to ensure the practical applicability of prepared
samples, to know the working glass range of the samples. The glass transition temperature, glass crystallization temperature and hence glass formation ability of the prepared glass system have been determined. The change in glass transition temperature depends on density of covalent cross linkage, oxygen density of the network and number and strength of the cross-links between oxygen and the cations. The increase/decrease in glass transition temperature is also in accordance with our previous FTIR and density results. The observed increase marks the decrease in oxygen density of the network due to conversion of $\text{BO}_3$ to $\text{BO}_4$ groups, as discussed for results for other studies.

Towards the end, the proposal for the future scope of the work has been discussed and the related references have been given.