SUMMARY

InBi belongs to the family of III – V compounds and has a tetragonal unit cell in the ditetragonal bypyramidal point symmetry group (i.e. 4/mmm) and p4/nmm space group with c/a = 0.9546. It is not a semiconductor like other III – V compounds but its low melting point (109.5 ^{0}C) and easy cleavage make it attractive for basic studies. Therefore with an intention to study the effects of impurity on the crystal growth, perfection, hardness and electrical properties of bulk and thin films, this work was undertaken and the results are reported. Many workers have grown single crystals of InBi with other impurities by various methods. The thesis presents a systematic study of crystal growth, hardness, optical and electrical properties etc.

The thesis is presented in four parts. Part A contains general information, which provides the basic background for the present work.

Chapter 1 of this part discusses various aspects of crystal growth in general and of crystal growth from melt in particular.

Chapter 2 deals with general aspects of chemical etching of a crystal surface and as a tool to reveal line imperfection, i.e., dislocations in crystals.

Hardness of crystals is the main focus of the present study. Chapter 3 gives a qualitative survey of various techniques and empirical theories involved in this field. Particularly, a diversity of results reported in literature has been emphasized to indicate the complexities of this property.

Chapter 4 gives general information on InBi crystals with regard to the structural and various electrophysical properties available in literature.

The 5^{th} and last chapter of this part deals with the experimental techniques used during the course of the present work. The techniques include crystal growth, etching, optical microscopy hardness indentation, thin film preparation and electrical measurements

Part II consists of two chapters. Chapters 6 presents study of growth of $InBi_{1-x}$ Sb_x and $InBi_{1-x}$ Se_x single crystals by the zone melting and syringe pulling methods. The effects of zone passes on perfection of the crystals have been studied. The effect of Sb /Se concentration on the dislocation density of the crystals also has been studied. The results indicate that as the number of zone levelling passes increases, the perfection of the crystal increases. With increasing Sb /Se concentration the dislocation density of the crystal increases. A simple crystal growth method, viz, syringe pulling, has been found to yield crystal perfection comparable to the one obtained by the zone melting method this method is found to yield a preferred orientation of the cleavage plane parallel to the growth axis. For layer mechanism of crystal growth is found effective.

Chapter 7 deals with chemical etching as applied to revealing dislocations. Development of two new etchants to reveal dislocations intersecting the cleavage plane (001) of $InBi_{1-x}Sb_x$ and $InBi_{1-x}Se_x$ crystals has been detailed. The relative merits and demerits of these etchants have been discussed. It has been found that among the two etchants, the most reliable etchant for $InBi_{1-x}$ Sb_x and $InBi_{1-x}$ Se_x cleavages are, respectively,

1. 1 part solution A + 20 part CH_3COOH, where solution A is 1 part saturated solution of citric acid + 1 part conc. HNO_3 (70%) + 10 part H_2O.

2. 1 part solution A + 10 part CH_3COOH, where solution A is 1 part conc. HNO_3 (70%) + 5 part H_2O.

Part III is devoted to the study of Vickers hardness of the cleavage planes of $InBi_{1-x}Sb_x$ and $InBi_{1-x}Se_x$ crystals. Chapter 8 deals with the hardness studies. The variation of hardness with applied load has been studied in detail. The effect of cold working on the load dependence of hardness and the effect of zone passes on hardness have been investigated. Particularly, the observed complex low load

dependence of hardness has been explored in light of the above investigations. The results indicate that the hardness peaks occurring in often the low load range may be explained in terms of deformation induced coherent regions. For both the crystals, grown with 30 zone levelling passes, it is observed that hardness is reduced compared to that of crystals grown with 8 zone levelling passes. This has been explained to be a result of improved perfection. The surface anisotropy of hardness of these crystals is in correspondence with the symmetry of the crystals. Both Sb and Se doped crystals exhibit nearly the same degree of this anisotropy.

Part – IV of the thesis is devoted to the optical study of the systems under consideration. Chapter – 9 discusses the results obtained in both single crystalline and thin film studies of $InBi_{1-x}Sb_x$ and $InBi_{1-x}Se_x$ (X = 0.2, 0.3, 0.4). The optical absorbance spectra of $InBi_{1-x}Sb_x$ and $InBi_{1-x}Se_x$ (X = 0.2, 0.3, 0.4) (both single crystalline and thin films), were obtained using FTIR spectrometry. This includes the effects of film thickness on optical band gap. The variations of resistivity and associated activation energy with film thickness have also been studied.