CHAPTER 12

GENERAL SUMMARY AND CONCLUSIONS
The present investigation whose results are compiled in the form of this thesis deals with the growth, structure and properties of ternary thin films of AgSbTe$_2$ and AgSbSe$_2$. The interest in these films is relatively new and no studies (except for the lone brief communication on AgSbTe$_2$ as mentioned in chapter 1) have so far been reported, other than those presented here. The present studies are therefore justified in aiming at the growth and characterization of these films. This chapter summarizes various results obtained during these
studies and also points out certain aspects which need further investigation.

AgSbTe$_2$

The compound was synthesized by stoichiometric mixing and melting of the pure individual elements. The formation of single phase was confirmed by X-ray powder diffraction. The ternary compound thus obtained, when evaporated thermally in vacuum was found to lead to the formation of a polycrystalline two phase film (AgSbTe$_2$ + Ag$_2$Te) irrespective of the rate of evaporation. It was attributed to the fractional loss of volatile Sb$_2$Te$_3$ during the evaporation. Nevertheless, single phase, polycrystalline ternary thin films of AgSbTe$_2$ could be obtained by a suitable addition of Sb$_2$Te$_3$ to the starting material and subsequent condensation on alkali halide cleavage surfaces. The amorphous films formed on amorphous substrates like glass and carbon were found highly resistive in nature and an amorphous to crystalline transformation could readily be obtained on electron beam heating or thermal annealing. However, the
ternary films were found stable only up to a temperature of about 200°C above which they dissociated. The thermal annealing up to 200°C enhanced the grain growth without bringing any improvement in the crystallinity or orientation. Epitaxial growth could not be achieved on alkali halides because a slight rise in the substrate temperature caused dissociation and formation of two phase films. There is no ambiguity regarding the incongruent evaporation of AgSbTe$_2$. Consequently the composition of the vapour and hence of the condensate may not be the same as that of the source material. A better understanding of the nature of evaporation, say, by means of mass spectrometry and thereby the growth of epitaxial layers under conditions as near as possible to thermodynamic equilibrium with a minimum loss of material is required. Suitable techniques like flash evaporation, three temperature method, hot wall epitaxy, etc., can be chosen.

Well annealed and polycrystalline single phase AgSbTe$_2$ films formed on glass substrates were
films were obtained. The substrate temperature was also found to have a pronounced influence on the crystallinity of these films. A perfect (100) parallel orientation could be obtained on alkali halide cleavage surfaces at 200°C. Detailed investigations of initial stages revealed that epitaxy was a post nucleation growth controlled phenomenon in these ternary films. It was observed that monophase and crystalline AgSbSe$_2$ films could easily be prepared by the method of interdiffusion in the thin film couple Ag$_2$Se-Sb$_2$Se$_3$. These studies clearly demonstrate the relative ease with which one can grow AgSbSe$_2$ films and the stability of these films over AgSbTe$_2$ films.

The success met in obtaining single phase, stable and crystalline AgSbSe$_2$ films was, however, counteracted by the difficulties encountered in electrical studies. The films were found P-type semiconductors with activation energy of 0.45 eV. However, detailed studies could not be made on these films during the present
investigation, owing to the high resistivity or low mobility of the carriers. Controlled addition of impurities may be of some help in this regard. The entire field of electrical studies in these films is thus wide open for further exploration.