GENERAL CONCLUSIONS

The investigations carried out and discussed in the various chapters have enabled the author to arrive at certain conclusions on the growth and etch phenomena of metals, in general, and antimonay in particular. These have been presented at the end of each chapter.

Studies on preferred orientation presented in the Chapter V is the first work of its kind on antimony. Antimony behaves in its own way and the preferred orientation exhibited is found to depend on the growth rate of the crystal. The results are in contrast to those of bismuth, the next element of group V in the periodic table, of the same structure and properties. When the growth rate increases beyond a certain limit, there exists no preferred orientation at all. This also explains why the probability of obtaining single crystal by random nucleation is less at higher growth rates, i.e. nuclei of different orientations have the same probability of survival and the result is a polycrystal. The practical application of the results will be found when crystals of definite orientations are required to be grown, especially in deformation studies.

Vapour grown crystals on the other hand show a definite tendency for the (111) plane to be perpendicular to the growth direction. This agrees well with the existing theories of growth from vapour phase, which predict after considering the vapour-solid equilibrium and the condition of minimum surface free energy, the existence of a plane of closest packing at the interface. In the melt grown crystal thermal conduction is an important factor in growth of crystals, in vapour phase growth it does not appear to be so.

It has also been possible to observe a growth spiral for the first time. This spiral of multi-atomic step height has been shown to be the result of interaction between a number of dislocations. Triangular growth features, with oriented over growth at dislocation sites have an orientation opposite to that of the parent crystal. These are indications that the topography of the surface is dependent on the supersaturation at the vapour-solid interface.

In the use of the etching method with chemicals for revealing dislocations, the choice of the reagent and purity are important. Slight variations in composition of the etchant is likely to affect the results. In addition, the purity of the metal has a radical influence on the pit formation at dislocation sites. This has been shown to be one of the main causes for the contradictory results reported by various workers.

Further more, the correspondence between etch pits and dislocations is difficult to establish in metals. There has been enough evidence that the etch pits are produced at dislocation sites, but whether each dislocation produces a pit and each pit corresponds to a dislocation is not well established and evidences are to the contrary. Some reagents reveal pits even along multimolecular steps like cleavage lines and also along impurity sites. Reagents which are found to develop pits along cleavage lines should not be used for dislocation study. In attributing pits to dislocations, counterpart matching of pits on the cleaved surfaces and repetition of the etch pattern, are helpful. However, it is difficult to get counterpart matching of the unetched faces themselves due to nonuniform distribution of stress during cleavage. Spacing of pits along low angle boundaries, pile-ups and intersecting boundaries offer facility for the direct correlation between theoretical estimates and experimental results. Most of the reagents are useful for the (111) plane only and do not produce pits on the other planes. This is a draw back and makes it impossible to calculate the bulk density of dislocations which can be compared with other studies.

Thermal etching has been successfully used to reveal dislocations. In this method the choice of the temperature is of utmost importance, otherwise it will lead to erroneous results. This has been shown byusing low temperature. Terraced pits are the last stage of etching and are the results of preferential etching in the lateral direction becoming more prominent compared to the removal of the material in the vertical direction. When counts of individual pits is of importance, this method is more useful than chemical etching since it gives better defined pits. There has been difference between pit density in chemical and thermal etching.

The author is aware of the various limitations in the work reported here. In the growth of crystals from vapour it has not been possible with the existing set up to measure supersaturation and growth rate and observations are purely comparative and based on circumstantial evidences. Results and conclusions from etching are also most qualitative. In many cases only the probable cause has been pointed out, and this does not eliminate the other causes.

The present results indicate that there is a wide scope for further work on the subject. Complete study of growth process from vapour phase with suitable modification of the set up to permit quantitative measurement of supersaturation, growth rate, etc., will help to understand the crystal growth in a better way. Similarly incorporating suitable modification so that the actual growing interface can be observed and the temperature gradient measured as the crystal is growing will give results which are more reliable. A detailed study of etch phenomena including study of deformed crystals and suitable comparison by other methods such as X-ray topography, X-ray diffraction, etc., may be more useful to establish correlation between etch pits and dislocations. Development of etching techniques which permit measurements in all planes is necessary to estimate the bulk density of dislocations.