CHAPTER 6

SUMMARY AND CONCLUSIONS

The major observations and conclusions drawn from the work reported in this thesis are presented along with suggestions for future work.

I. <u>The Dip Technique</u>

The dip technique has been developed as a simple and inexpensive process for the deposition of oxide and sulphide films.

1. For alumina, the technique utilises a starting solution of aluminium nitrate in t-butanol. A substrate withdrawn from this solution gives amorphous alumina films on baking at 550°C. Addition of a little water to the starting solution, a not too-high lifting speed ($\leq$ 2 mm/sec) and a two-step prebaking at temperatures of 65°C and 120°C is a prerequisite for obtaining good quality films. Even under optimum conditions, some ring-like structure is

observed in the micrographs. Which are probably caused by escaping gaseous reaction products.

2. For Tin Dioxide the starting solution contain $SnCl_2$, $2H_2O$ and ethanol. Unlike alumina, no addition of water or prebaking is necessary in this case. However, the liquid film has to be dried in a desiccator before baking to get measurable conductance. The films are poorly crystalline, have a high resistivity and have a featureless microstructure. The high resistivity is thought to be due to the presence of insulating hydrated tin oxides along with small amounts of crystalline SnO_2.

3. Addition of thiourea to the same type of starting solution as used for oxides (metal nitrate in organic solvent) leads to the formation of CdS, ZnS and mixed Cd-Zn S thin films by the dip technique. These films are smooth and uniform. They are also strongly adherent provided the Metal:Sulphur ratio is not less than about 1:1. CdS films are crystalline with the zinc blende structure and those for ZnS amorphous. Mixed Cd-Zn S films are a mixed phase of partially crystalline CdS and amorphous ZnS. Grain size and thickness of the film is dependent on the substrate and number of dippings for the CdS films.

II. Novel CVD method for Transparent Conducting SnO_2 films

A novel CVD method for transparent conducting tin dioxide films has been developed. Here the decomposition of $SnCl_2$, $2H_2O$ (applied in the form of a paste) is utilised to produce $SnCl_4$ vapour, which is subsequently hydrolysed on the heated substrate to yield the desired film. These films are smooth and have a high conductance, especially when doped with antimony. Their adhesion is also good under optimum deposition conditions. The resistivity of the films is in the range $4.5 \times 10^{-3}\,\Omega$ cm to 2.25×10^{-1} Ω cm and average optical transparency, 70-90%.

III. Solid-state Devices

1. Parallel-plate electron multiplier with a gain of 10^7-10^8 are capable of being fabricated by using films produced by the dip technique, where high resistance film of SnO_2 serve as the underlying semiconducting layer and an alumina film on top as the secondary-electron emitter.

2. CdS films deposited by the dip technique can be sensitised by a simple treatment involving dipping in an aqueous solution of $CdCl_2$ and $CuCl_2$ and subsequent baking. These sensitised films can be used for the fabrication of photoconductive cells by evaporation of electrode in a

suitable configuration. A sensitivity of 10 mA/lumen can be easily achieved.

IV. Suggestion for further work

1. To assess the usefulness of the dip technique, it is necessary to prepare films of different materials under various deposition conditions and subsequent characterisation. For example, $Cd_{0.8}Zn_{0.2}S$ films represented here have a mixed phase of crystalline CdS and amorphous ZnS. It would be instructive to investigate deposition conditions could possibly yield a single-phase compound.

2. The dip technique has been shown to produce films, which can be utilised for the fabrication of solid state devices such as PPEM's and PC cells. Further work should aim to extend this work to the case of other devices such as channel electron multiplier, Electroluminescent (EL) cells, Solar cells etc. In each case, attempts should be made to identify conditions for optimum performance of the devices. The increase in grain size as observed for CdS films under $CdCl_2$ treatment would also be a promising line for further investigation and possible improvement in device performance.

3. The simple CVD method for deposition of SnO_2 film should be used for the deposition and study of films using other dopants, such as F, Cl, In, Cd, P.