Chapter 6
Summary and Conclusions

In the present work we have made an attempt to develop undoped and doped tin oxide film using a new precursor combination in sol-gel and spin-coating technique. We have optimized the method to obtain good quality films. The optical transparency and electrical conductivity of the films grown by our method were comparable to those grown by spray pyrolysis [1,3] and sol-gel dip coating methods [2]. The quality of the films was improved further by repeating the coating process to obtain multi-layered undoped as well as doped tin oxide films. Electrical properties and optical properties of the films have been used for characterizing the films. Electrical properties were presented in terms of sheet resistance and resistivity. Optical properties of the films were presented in terms of absorption edge, absorption due to direct and indirect transitions. Films were exposed to energetic electron beam radiation to investigate the effect of e-beam on the electrical and optical properties.

Brief but detailed descriptions of sol-gel technique and spin-coating method of growing thin films from alkoxide sols were presented. The parameters, which affect the quality of the film while preparing the sol and spin coating, were also described. These parameters have been carefully tuned to get good quality films. Tin oxide films were doped with antimony, aluminium and zinc. For doping, sols were prepared with different molar
concentrations. These impurities were chosen to investigate the possibility of carrier conversion in tin oxide film because non-stoichiometric tin oxide is n-type semiconductor. With the change in the carrier concentration the absorption edge is also expected change as free carriers in a semiconductor sample are directly involved in the light absorption process.

Sheet resistance of tin oxide film decreased when doped with antimony (donor dopant). Whereas it increases in the case of aluminium and zinc (acceptor dopants) doped films. Multicoatings films show low sheet resistance and resistivity. Absorption edges for direct and indirect transitions in tin oxide films shift towards either higher or lower energy region depending upon the type of dopant. Also the optical parameters shift towards lower energy region with increasing number of coatings. Application of the tin oxide films mainly depends upon their electrical and optical properties. These properties observed by are in agreement with films developed by dip coating [2] and spray pyrolysis [1,3].

In the present study we have also attempted to investigate, for the first time, effects of energetic electron beam radiation on electrical optical properties of tin oxide films. The possible damages on thin films or similar target materials were briefly reviewed. We have presented results depicting effects of radiation on films with different dopants, doping concentrations and number of coatings. When exposed to e-beam radiation, films showed observable variation in the electrical and optical properties. Information regarding e-beam induced variation in their electrical and optical properties are useful in deciding their compatibility in electron radiation environment.
The sheet resistance of all the films increased with increasing radiation dose which is in contrast to that seen with transition metal oxides [4]. The films with single coating are greatly affected whereas films with multi-coating were affected to a lesser extent. It is found that as the radiation dose increases the increment in the damage decreases. This implies that effect of e-beam irradiation has a saturation level beyond which its effect on properties of material decreases. Thus, the assumption[5,6] that damage is proportional to accumulated radiation dose and deposited energy seems to be not applicable to tin oxide films. The radiolysis process is not applicable to tin oxide films because they fired at relatively high temperature prior exposure. The extent of deviation in the electrical properties varies with dopant concentration especially in the case of p-type dopants. The majority charge carriers will be p-type when doped with aluminium and zinc.

The quality of the films grown by sol-gel and spin coating technique can be improved by adjusting other controllable parameters like ambient atmosphere and purity of starting materials. Various characterization methods can be employed to streamline the processing. In the study of radiation damage, in situ measurements for temperature of the sample, electron relaxation mechanism and radiolysis would be useful in understanding the mechanism of damage on thin films.
References