Chapter - 8

Summary and Conclusions
8.1 Summary and Conclusions

Present work is on the development of highly conductive and transparent CdO thin films using Spray Pyrolysis technique. First changing the substrate temperature and precursor concentration treatment for enhancing the conductivity of CdO, this is called as “Zero-Energy Process” Enhancing the conductivity of the CdO thin film by doping of different elements such as Cu, Fe, Mn and Ti.

Deposition parameters of CdO thin films like molarity, spray rate, precursor concentration, substrate temperature were optimised to get good quality and large area thin films. Highly transparent and conducting CdO thin films were prepared at different substrate temperatures and different precursor concentration using spray pyrolysis technique. The CdO thin films were polycrystalline nature with cubic crystal structure and the CdO thin films show that the strong preferential orientation along (111) and (200) direction, while increasing the substrate temperature the peak intensity of CdO film was increased. Average optical transmittance of more than 80% observed for pure CdO thin films. The minimum resistivity of $3.78 \times 10^{-3} \Omega \text{cm}$ is obtained for the substrate temperature of 523 K with the precursor concentration of 0.1 M. The maximum ethanol gas sensitivity 33.45% is observed for the substrate temperature of 573 K. The XRD patterns confirmed that all the films are polycrystalline and exhibit the cubic crystal structure and the preferential growth orientation is shifted from (200) to (111) direction for doping of Cu, Fe, Mn and Ti. XPS measurements were confirmed the chemical binding states of the Cu, Fe, Mn and Ti doped CdO thin films.

Optical transmittance and optical band gap values decreased with increasing the doping concentrations of Cu, Fe, Mn and Ti. 1 wt% of Ti doped CdO thin film shows a minimum electrical resistivity of $8.57 \times 10^{-4} \Omega \text{cm}$. Ethanol gas response of 33.45% is observed for pure CdO thin films at the substrate temperature of 573 K. Fe doped CdO
thin films show the maximum ethanol gas response of 56.12% for 1 wt% of Fe concentration. The hydrogen gas response of 42.54% is observed for 1 wt% of Cu doped CdO thin film. Among these dopants (Cu, Fe, Mn and Ti) Ti doped CdO thin films show minimum resistivity and it was used as working electrode towards the detection of \(H_2O_2\) without the use of any further modification, electrode cleaning, drop casting, drying and binder selection. Ti: CdO shows long-term stability and 92% of initial response after one month of storage. Ti: CdO/ITO displayed very fast amperometric response behaviour toward \(H_2O_2\) and low detection limit of 0.4 M.

8.2 Future Scope of Study

Home-made spray pyrolysis setup has been constructed, there is enough room for further modifications in the automated system. In the present system, temperature and pressure control has not been interfaced to the computer. If such modifications could be incorporated, better uniformity and repeatability could be achieved. In addition, methods to improve the throughput of the process so as to minimize wastage of chemicals and reduce deposition time need to be taken up. One major limitation of sprayed deposited CdO thin film is its high transmittance and minimum resistivity at near stoichiometric compositions which is generally used for TCO and sensor applications. Doping the material will help in overcoming this limitation. Not much work has been done in this direction.