CHAPTER 7

Summary and Outlook
7.1. Summary

Development of p and n type transparent conducting oxides will open up new and exciting applications. The active devices that are transparent to visible light including diodes, transistors and field effect transistors can be fabricated. Comparing the surface features of sputtered and PLD films clearly indicate that the films obtained by PLD are smoother. Room temperature deposition is also possible with PLD. Though off axis sputtering gives films with smoother surfaces PLD still has the advantage of being able to deposit films at room temperature. Pulsed laser deposition can be used to deposit thin transparent films on flexible plastic substrates. Active transparent devices can be fabricated on flexible substrates at room temperature.

The carrier concentration and the film thickness need to be optimised for better device performance. The deposition of individual layers can be optimised for smooth surfaces thereby improving the p – n interface. This would also improve the device performance.

The delafossites are less transparent than ZnO thin films. Devices fabricated with ZnO homojunctions have better transmittance than the devices fabricated with delafossite/ZnO heterojunctions.

Trying to develop p type ZnO by understanding the basic mechanism of p type conductivity in those films would be a worthwhile exercise. The setup that was fabricated to measure the thermopower can be modified to measure other transport properties thereby giving valuable insight to the conduction mechanism in p type ZnO. Slight modification in the sample preparation and setup can give in addition to the Seebeck coefficient, Hall coefficient, Resistivity and Nernst coefficient. This would reveal the fermi level, the density of states effective mass and energy dependent scattering parameter related to a relaxation time. Measuring these coefficients over different temperatures would provide valuable insight into the transport phenomena in thin film samples.
In summary off axis sputtering and PLD with 355nm can produce smooth films. These methods can be used to deposit p and n TCO films with smooth surfaces. The junctions formed would give good device performance. Room temperature deposition of thin films is possible with PLD. Transparent active devices can be deposited on flexible plastic substrate at room temperature by PLD.

All oxide devices are being fabricated and they use of the potential advantages of transparency, high temperature performance and radiation hardness[3]. Transparent thin film transistor (TFT) utilising TCO as channel layer has several merits compared to flat panel displays. The oxide TFT has advantage over the semiconductor FET in high voltage, temperature tolerances and are insensitive to visible light radiation.. UV–LED is a typical active device utilising optical transparency and p–n junction. Although ZnO is a known UV emitter at room temperature. Near UV emission has been achieved by p type SrCu2O2 and n type ZnO.[4]. Improving the device that was fabricated in the present study will yield UV emitting LEDs.

Oxide semiconductors exhibit higher carrier mobilities even in amorphous form compared to the amorphous elemental semiconductors. The TCOs, such as ZnO and SnO2, the conduction band minimum(CBM) are mainly made of s orbitals with a large principle quantum number n. These s orbitals have a large spatial size and form hybridation even with second neighbour metal cations. This means TCOs can have good electric conductivity at high carrier densities. Thus amorphous oxide semiconductors are insensitive to local strained bonds and electron transport is not effected significantly. [5] amorphous semiconductors based devices have uniform characteristics so that large displays can be fabricated on flexible substrates. The amorphous semiconductor (InGaZnO) based TFT have high mobility (>10 cm² V⁻¹ s⁻¹) and large on off current ratios ( >10⁵) [6] Amorphous semiconductors are better suited to be grown on flexible substrates than conventional semiconductors. Development of transparent
electronics on flexible substrate would be greatly facilitated by developing the amorphous semiconductor devices. Flexible and transparent electronics are becoming a reality and will find applications in advanced optoelectronic applications such as wearable computers and displays attachable to windows.

The oxide electronics on flexible substrates have advantages like flexibility, light weight, ruggedness and low cost. The successful of fabricating all oxide based thin films transistors, LED and other electronic components on flexible substrates is a key technique to realise flexible transparent electronics. The horizon of flexible and oxide electronics is much closer and it opens up new applications that have never been thought of before.

### 7.2 References


