9
Conclusion and Future Scope

The research presented in this dissertation is related to multifunctional metal oxides focusing on ZnO and BFO systems. The primary goal is to investigate and understand the impact of intrinsic and extrinsic defects on properties of ZnO synthesized by different deposition methods for their possible electronic applications. Further, solution derived BFO RRAMs are investigated in different electrode configuration to understand its potential as novel low cost memory devices.

Firstly, we synthesized zinc rich zinc oxide using CVD and compared the results with pristine ZnO synthesized in similar conditions. The structural and microstructural results substantiated that Zn:ZnO films are relatively highly textured along c-axis and the results is confirmed by hexagonal top of SEM morphology. The PL spectra showed that defect density on Zn:ZnO film is enhanced and the reason is attributed to presence of excess zinc. The Mott-Schottky results showed that carrier concentration in Zn:ZnO is two orders of magnitude higher than ZnO which enhances the current flow, supported by I-V curve. The Burstein-Moss shift is observed in Zn:ZnO which is assisted by optical band gap measurements. The Zn:ZnO film showed color emission in light blue region, indicating its potential as blue LEDs.

We optimized solution processed ZnO nanorods for realizing n and p-type conductivity for homojunctions device applications. p-ZnO nanorods are synthesized by doping lithium and cooping lithium and nickel atoms to understand the effects on diode properties. The Li-Ni co-doped homojunctions substantiates higher ON/OFF ratio and lower ideality factor and turn on voltage, indicating a better choice for p-type dopant. The stable diode properties of co-doped homojunctions substantiate its potential to be used in different optoelectronic applications. Further, n-ZnO nanorods/p-Si heterojunction is fabricated to understand its UV detection and LED application capabilities. The results substantiates that the device is capable of sensing UV light however weak response is obtained due to interfacial defects present at the junction. The device emits blue color under UV light supported by results from color calculator, indicating its potential as LED. In spite of these interesting outcomes, there is a wide possibility to explore further the homojunciton and heterojunction devices for opto-electronic applications.

We also optimized solution process for synthesizing phase pure BFO thin films for RRAM applications. The synthesized Ag/BFO/FTO devices substantiates bipolar RRAM characteristic with high ON/OFF ratio and reasonable reproducibility and repeatability. The devices maintained retention window up to 10000 s and showed endurance for 1000 cycles. The operating low voltage substantiates low power consumption and the devices showed similar characteristics after 10 months, indicating their robustness. Devices with aluminium top electrode showed forming free bipolar RRAM characteristic with improved reliability and different switching mechanism governing the device. The studies substantiate the potential of BFO for economical and reliable RRAM applications. The work can be extended to understand the impact of external stimuli such as electric and magnetic field on RRAM characteristics. The integration of BFO with other high bandgap materials in thin film

geometries may be explored for multistate memory applications. The thesis work can be considered as the backbone to realize the six state memory devices in BFO systems with two magnetic, two ferroelectric and two resistive states. However, magnetic, and electric cross-talk among these states will be an issue, which needs to understand towards realizing the six state memory devices based on BFO thin films. Apart from that, both ZnO and BFO can be combined to produce different devices such as solar cells and photosensitive RRAM. For solar cell application, BFO can be used as the absorber material. In Photosensetive RRAM, the light emitted from ZnO can be illuminated on BFO based RRAM to modify its switching properties. However, several issues related to device structure and power requirement has to be optimized before the implementation of such device.