Abstract

Multifunctional metal oxide semiconductors have numerous physical and chemical properties which make them interesting and most explored material for various applications in electronic industries. Zinc oxide (ZnO) and Bismuth ferrite (BFO) are two such materials which we have chosen for the scope of this thesis. The primary goal of this thesis is to understand the effect of defects on the properties of materials, synthesize homojunctions and develop electronic devices such as UV detectors, resistive random access memories (RRAM) with different electrodes. This work explores different deposition techniques, optimization of materials properties and concept of device design.

The first experiment in this thesis is carried out to investigate the effect of excess zinc on the properties of ZnO. Defects plays significant role on the properties of ZnO and one such defect is zinc interstitials which acts as shallow donor. We have synthesized excess zinc containing zinc oxide using CVD method and have done a comparison of obtain properties with pristine zinc oxide obtained under similar conditions. The structural, microstructural and optical characterizations supported the presence of excess zinc in interstitial octahedral voids. The electrical characterization substantiated presence of shallow interstitial atoms in zinc rich zinc oxide which resulted in increased carrier concentrations and a shift in band gap. This is up to our knowledge first kind of study to analyse the influence of excess zinc on zinc oxide.

Further, we synthesized ZnO nanorods based homojunctions using solution method by doping lithium and co-doping lithium and nickel atoms to understand p-ZnO stability and diode characteristics. The co-doped sample shows better on/off ratio, lower turn on voltage, low ideality factor and series resistance. The better performance of co-doped sample is attributed to lithium nickel complex formation which increases the solubility of the acceptor atoms. We also synthesized n-ZnO nanorods/p-Si heterojunction to understand its UV sensing capability. The device emitted blue light under UV illumination which is supported by the results obtained from CIE color calculator.

We explored RRAM characteristics of BFO synthesized by a simple solution method. Optimization is done to obtain phase pure BFO thin film at relatively lower temperature. RRAM studies on Ag/BFO/FTO showed that the devices offer well on/off ratio, retention window, retention time, endurance and reliability. The device is robust as it showed similar characteristics after several months from device fabrication. Further, we investigated the effect of aluminium electrode on the RRAM properties of BFO which substantiated a better reliability than previous device with different switching mechanism. These studies indicate the potential of solution processed BFO in RRAM application, reducing the cost of manufacturing.