ABSTRACT

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TITLE- "Devices' application using oxides and chalcogenides nanomaterials"

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Nanocomposites and inorganic nanomaterials, primarily oxides and chalcogenides, were synthesised by me for my thesis. I looked into their potential use in metal-semiconductor (MS) devices here.

For the very first part of my thesis hydrothermal synthesis and characterization of tin (IV) oxide (SnO_2), a famous and intriguing metal oxide semiconductor, are the primary goals of the first section of this study. I next synthesised a reduced graphene oxide (rGO)-SnO_2 composite, taking into account both graphene's outstanding electrical conductivity and its challenging synthesis and applications. We next characterised this composite in detail. The manufacturing of the MS junction was facilitated by the successful existence of the Schottky barrier, which was achieved by obtaining the optimal band gap value for both pure SnO_2 and its composite with rGO. To further understand how rGO affected the electrical characteristics of this device, a comparative analysis of charge transport qualities was also conducted. The composite-based diode showed higher device performance according to the Schottky diode parameters, such as photosensitivity and detectivity values.

Learning everything there is to know about the rGO-SnO_2 based Schottky device and how it works was the next step in the research process. Thus, the characteristic of the current voltage as a function of temperature was investigated, and the inhomogeneity of the height of the junctional barrier was explained using the concept of the Gaussian distribution. It was also found the value of the modified Richardson constant.

In the next work another popular metal oxide named Zinc Oxide (ZnO) was synthesized. In this particular work the effect of synthesis procedure in different properties of material was thoroughly discussed with help of different characterization like XRD, SEM, FTIR, and UV-Vis. Later betterment of particular synthesis procedure was proved by using the material in MS device and by studying different measurements and extracting different parameters of the fabricated devices.

Later an important chalcogenide material having a special (pyrite) structure namely cobalt sulfide (CoS_2) was hydrothermally synthesized. As Annealing of synthesized material leads recrystallization in material, there is a huge possibility to be affected by annealing and variation in annealing temperature. Based on the fact I tried to compare different properties and performance in device application of the material before annealing and after annealed with different temperature.

Finally, synthesis and characterization of another chalcogenide material, Molybdenum diselenide ($MoSe_2$) was done. The synthesis procedure adapted here solvothermal. Here, I tried to study the effect of lowering the solvothermal temperature. At a very low temperature of 120˚C the successful synthesis of the material was reported. Then the samples were applied in device application and current-Voltage as well as impedance spectroscopy (IS) method was employed to the devices. The IS analysis depicts the effect of both grain and grain boundaries on the conduction mechanism. The various dielectric and electric parameters show a great dependence on the applied frequency. The picture of variation in ac conductivity with frequency for each sample was drawn. The extracted dc conductivity proved the betterment of the material synthesized in a particular temperature of 150˚C.

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