Abstract

Nanomaterials are emerging as building blocks for all the present and future technologies. The quasi one- and two-dimensional materials are gaining importance as next generation field emitters. Field electron emission (FE) is referred as quantum mechanical tunnelling of electrons under the influence of external electric field. The metal oxide nanomaterials are potential candidates as field emitters. Tin oxide, an inorganic semiconductor, finds numerous applications as gas sensor, oxidation catalyst, transparent conductor etc. The thermal and electrical stability along with mechanical robustness has prompted the field emission study of SnO₂ nanowires. SnO₂ is intrinsic in nature and becomes conducting due to the non-stoichiometry imparted during the synthesis. The oxygen defects present also contribute to the conductivity. In order to obtain enhancement in the FE properties, gadolinium doped SnO₂ nanowires are studied. The thermal evaporation method is used for the synthesis of nanowires. The economics and ease of large-scale synthesis of SnO₂ (doped and undoped) nanowires makes them suitable from industrial applications as electron sources.

Following the graphene invention, the study of graphene-like two-dimensional layered structures, especially metal dichalcogenides, became a hot area amongst the scientific world. The 2D layered materials are gaining growing interest due to their inherent interesting properties making them suitable for various micro/nanoelectronic devices. The availability of large surface and faster electronic transport confined along a single plane has motivated their FE study. The layered structure is suitable for field emission based display devices. The study of electrical transport properties of layered WS₂ reports it to be comparable with that of MoS₂. Thus, 2D layered WS₂ has triggered a significant research interest as field emitter. The two dimensional tin sulfide has excited researchers due to its novel property of photoconductance. Hence, photo-assisted field emission of pristine SnS₂ nanosheets has been explored. The study of reduced graphene oxide nanocomposites with SnS₂ and WS₂ is carried to achieve improved field emission properties. The research work is presented as the thesis comprising of six chapters. A brief outline is given as below.

Chapter I: The first chapter is an introductory chapter, which includes the motivation for the research undertaken. Detail theory and mechanism of Field emission (FE) is discussed. Field
Abstract

emission from semiconductors and its applicability is also briefed. The related literature on survey of field emission investigations on 1D and 2D nanomaterials is presented.

Chapter II: The chapter describes various techniques of synthesis of nanomaterials. Broadly, the synthesis routes fall into two categories; the physical and the chemical route. The thermal evaporation and the hydrothermal methods, adopted for the synthesis of 1D nanowires (pristine and Gd doped SnO$_2$) and 2D nanosheets (WS$_2$ and SnS$_2$) respectively, are described in details. The experimental set-up is described along with the Vapor-Liquid-Solid (VLS) and Ostwald’s ripening growth mechanisms. Various characterization techniques are also presented in short. The field emission setup and the vacuum processing have also been described.

Chapter III: This chapter includes the actual experimental field emission work on undoped and Gd-doped SnO$_2$ nanowires. The material study regarding the structural and electronic properties of SnO$_2$ and gadolinium is presented. The synthesis parameters along with the detail analysis of various characterizations performed has been discussed. A systematic independent study of field emission investigations on pristine and Gd-doped SnO$_2$ is carried out. The chapter ends with the conclusions drawn from the individual and comparative FE properties of both the emitters.

Chapter IV: Chapter IV is an important chapter which includes FE investigation on a single SnO$_2$ nanowire. The study was carried out for the realistic analysis of the FE mechanism observed in semiconducting SnO$_2$. The process of obtaining a single nanowire for FE study is described. A detail analysis of the observed nature of the J-E and FN plot is presented. A model based on the band structure of SnO$_2$ is proposed for the analysis of the nature of current density verses applied field (J-E) and the Fowler Nordheim (FN) plot.

Chapter V: This chapter comprises of FE studies from the two dimensional nanosheets of WS$_2$ and SnS$_2$. The composite of WS$_2$ and SnS$_2$ with reduced graphene oxide has been investigated in order to obtain superior FE properties. The enhancement observed in case of composites is explained on the basis of increased surface roughness and work function modulation. An interesting photosensitive field emission has been observed for pristine SnS$_2$ nanosheets. The systematic FE study with visible light illumination on the emitter surface is performed. The photoswitching and the photosensitive FE behavior are explained on the basis of a proposed model.
Chapter VI: The results based on the experiments performed are summarized and the future scope has been discussed.