ABSTRACT

ZnTe (Zinc Telluride) is an II-VI compound semiconductor having a direct bandgap in the range of 2.21 - 2.26 eV at room temperature. The material has been extensively studied for its applications as a non-linear optical material and optoelectronic devices, including solar cells, photodetectors, and light-emitting diodes. However, depending on the synthesis process, ZnTe can be used for highly mismatched alloys as an electron/hole transfer intermediate layer, hydrogen storage, selective photodetector, and resistive switching applications. The current thesis focused on mainly two aspects; synthesis of ZnTe from ZnO/Te thin films for fundamental study, and use of ZnTe thin films as p-type materials for ZnTe/TiO_2 p-n heterojunction fabrication for photodetector and resistive switching device. ZnTe was synthesized from ZnO/Te bilayer using thermal annealing, ion implantation and co-deposition techniques. The ZnTe nanocrystals synthesized from ZnO/Te thin films using ion beams and thermal annealing was used to understand phonon anharmonicity, thermal conductivity, and highly mismatched alloy applications. The anharmonic phonon dispersion has been demonstrated through red-shift and broadening of all modes (1LO,2LO,3LO) from temperature-dependent Raman measurements. The intense photoluminescence and cathodoluminescence illustrate the compound-specific light emission, which can be useful for optoelectronic applications. An optimized parameter has been used to synthesize stoichiometric ZnTe using co-deposition techniques to fabricate heterojunction with sputtered TiO_2 thin films. The incorporation of Au atoms via low energy ion implantation at the interface of p-n heterojunction of ZnTe and TiO_2 modifies the electrical properties that enhance charge carrier trapping. The higher concentration of Au leads to distinct multistage SET and RESET resistive switching behaviors of ZnTe/TiO_2 heterojunction, highlighting the potential for tunable semiconductor devices. Finally, a ZnTe/TiO_2 heterojunction thin-film photodiode was fabricated, demonstrating high sensitivity for broadband photo-sensing applications. The heterojunction reveals diode-like behavior from I-V measurements. It has been demonstrated that the photodetector is suitable for 325, 532, 633, 785, and 1064 nm laser wavelengths. The photodiode exhibited high quantum efficiency, responsivity (up to 50 mA/W) and detectivity (around 10^{12} Jones), indicating its potential applications for measuring laser power across the UV to NIR spectrum.