SUMMARY

The aim of this research was to synthesize and characterize (Bi,Sb)SeI thin films, and use them as an absorber layers in solar cells.

The synthesis of (Bi,Sb)SeI thin films involved depositing Sb_2Se_3 thin films with a thickness of 800 nm onto Mo or FTO substrates by radio frequency magnetron sputtering. The Sb_2Se_3 thin films were then inserted into quartz ampoules with BiI_3 pellets and annealed at 350°C under different argon pressures (300, 500, 700 Torr) and durations (30 and 60 minutes). The prepared films were characterized by SEM, EDX, Raman, photoluminescence, and UV-Vis spectroscopy. (Bi,Sb)SeI thin films were used as absorber layers in a structure of glass/Mo/(Bi,Sb)SeI/CdS/*i*-ZnO/ZnO:Al/Ga-In eutectic. The solar cells were fabricated by first depositing a 40 nm *n*-type CdS buffer layer on the (Bi,Sb)SeI films using chemical bath deposition. This was followed by depositing a 45 nm *i*-ZnO layer and a 700 nm ZnO:Al layer using radio frequency magnetron sputtering.

The characterization results showed that the best quality (Bi,Sb)SeI thin films were synthesized on molybdenum substrates under Ar pressure of 500 Torr for 60 minutes. These films had the most uniform morphology with minimal defects. The film thickness of this sample was 1.5 µm and crystal width 1.3 µm. Other experimental conditions exhibited various shortcomings, including severe cracking, abnormal needle-like cluster formations, or the absence of photoluminescence emission, probably due to poor crystallinity. The films on the FTO substrates were highly inhomogeneous, with varying layer thicknesses, significant cracks and irregular growth of rod-like structures.

Raman spectroscopy of the successful films confirmed the formation of (Bi,Sb)SeI, with observed peaks at 76, 96, 107, 137, 154, 159, 181, 186, and 213 cm^{-1} corresponding to Bi-Se, Bi-I and Sb-Se vibrations. From UV-Vis reflectance spectroscopy analysis, an ideal optical band gap energy of ~1.4 eV was extracted, indicating the potential for high efficiency in solar cells.

Solar cells, fabricated using the thin film synthesized on molybdenum substrate at 500 Torr for 60 minutes, revealed high photoconductivity but no current generation. This is most probably due to pinholes causing shunting paths and/or possible *n*-*n* type junction in solar cells. Further investigation is required to determine the conductivity type of (Bi,Sb)SeI thin films. Optimization of synthesis parameters are necessary to enhance material quality. Under optimized conditions, (Bi,Sb)SeI has the potential to become a highly efficient material for future solar cells.