FABRICATION AND CHARACTERIZATION OF ANTIMONY SELENIDE THIN FILM SOLAR CELLS

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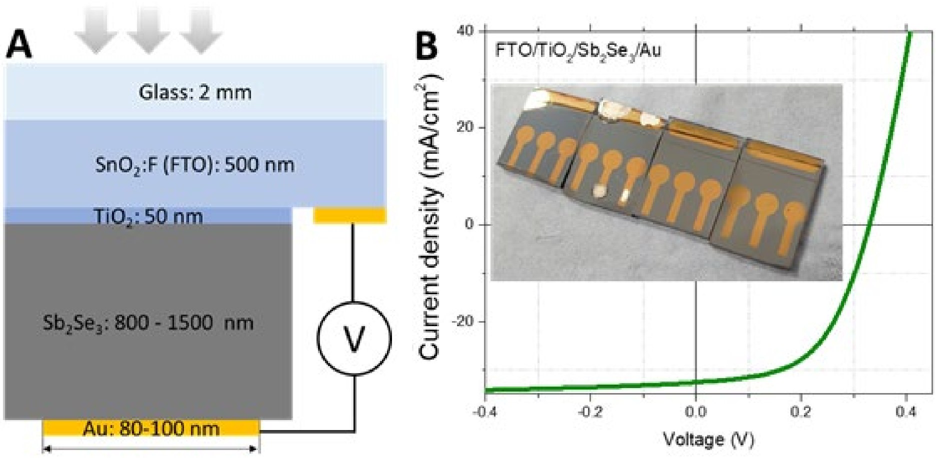
Antimony selenide (Sb_2Se_3) has recently gained a world-wide interest as potential photovoltaic (PV) material. Earth-abundant with low toxicity composition makes this material attractive for sustainable PV. In addition, Sb_2Se_3 has a very high light absorption coefficient, suitable band gap for single-junction solar cell application and technologically amiable – low crystallization temperature and single phase. $Sb_2(S,Se)_3$ technology is undergoing a rapid development reaching over 10% very recently, however many challenges still remain that have not been coped with, and could potentially lead to higher power conversion efficiencies.

There are many suitable synthesis methods for formation of Sb_2Se_3 thin films. The major ones are: vapor transport deposition, rapid thermal evaporation, thermal evaporation, close-space sublimation, hydrothermal deposition and spin-coating. Each of them provides a unique advantage(s) owing to their design. For example, very rapid deposition rates are achieved in rapid thermal evaporation and close-space sublimation techniques due to small distance between target and substrate. With hydrothermal deposition method very compact and fully covered films are deposited thanks to slow reaction rate and therefore high conformity. In this work, authors have chosen the vapor transport deposition method. This method is easily scalable, versatile, simple and inexpensive equipment and high degree of freedom for experimental parameters. Here, we investigate how deposition parameters affect Sb_2Se_3 thin film morphology, structure, orientation and composition. We present how the design of the deposition was gradually improved to achieve desired morphology, orientation and quality in reproducible manner. Finally, solar cells have been fabricated and their performance characterized. We found that substrate temperature played a key role in device performance.



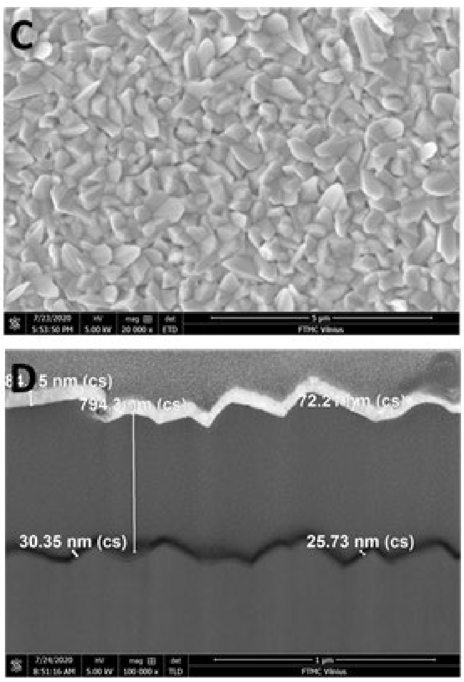


Fig. 1. A. Schematic representation of superstrate Sb_2Se_3 solar cell structure based on TiO_2 buffer layer. B. J-V curve of the champion solar cell. Inset- the optical image of standard Sb_2Se_3 solar cells. C. Top SEM image of the Sb_2Se_3 thin films synthesized under optimized conditions. D. Cross sectional SEM image of Sb_2Se_3 solar cell.