

Deposition temperature controlled growth of tin monosulfide thin films for thin film solar cell application

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Tin(II) monosulfide (SnS) is a promising p-type earth-abundant material that has the potential applications in photovoltaics as a low-cost and non-toxic absorber layer for thin film solar cells (TFSCs) because of its direct bandgap of 1.2-1.4 eV and indirect bandgap of 1.1 eV with a high absorption coefficient of $> 10^4 \text{ cm}^{-1}$ and high free carrier concentration in the order of $10^{14} - 10^{18} \text{ cm}^{-3}$. [1, 2] Theoretically, the maximum conversion efficiency of 32% can be achieved for a single-junction SnS-based TFSCs, while the existing SnS cells have only reached at 4.36%. [1, 3] However, though SnS has several advantages, but it is difficult to obtain a SnS thin film with pure-phase due to the easy formation of other secondary phases like SnS_2 and Sn_2S_3 . Therefore, till date, several growth techniques have been adopted for synthesizing pure-phase of SnS thin film.

In this study, a temperature controlled vapor phase deposition process was used to deposit SnS films as the absorber layer from SnS powder by using a horizontal furnace. The influence of SnS powder source temperature as well as substrate temperature was studied to obtain the optimal condition for the growth of phase-pure SnS thin films. A substrate temperature dependant growth was observed at the final phase of the as-grown SnS films and figure 1 is SEM image of deposited thin films. Furthermore, several properties of SnS thin films such as, structural, optical and electrical properties were studied in detail for its final application in TFSCs.

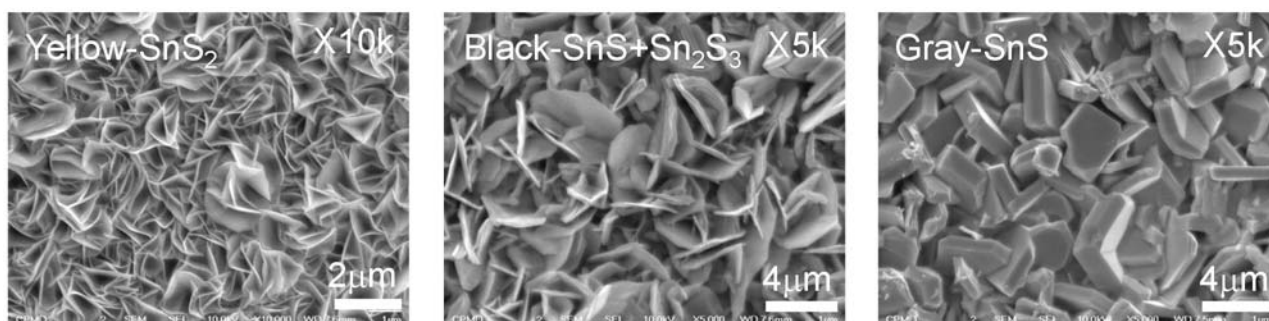


Figure 1. Sn_xS_y Phases changed by growth temperature, SEM image

References:

- [1] R.E. Banai, M.W. Horn, and J.R.S. Brownson, Sol. Energy Mater. Sol. Cells, **150**, 112 (2016).
- [2] P. Sinsermsuksakul, K. Hartman, S. Bok Kim, J. Heo, L. Sun, H. H. Park, R. Chakraborty, T. Buonassisi, and R.G. Gordon, Appl. Phys. Lett., **102**, 053901 (2013).
- [3] P. Sinsermsuksakul, L. Sun, S.W. Lee, H.H. Park, S.B. Kim, C. Yang, and R.G. Gordon, Adv. Energy Mater., **4**, 1400496 (2014).