Development of close space sublimation deposited antimony selenide solar cells.


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Antimony selenide solar cells are an emerging thin-film technology of growing interest. They benefit from a direct ~1.17eV bandgap, containing no scarce materials, have a simple phase chemistry and an interesting 1D nanoribbon grain structure. Despite the first respectable device efficiency being reported as recently as 2014 and the relative paucity of research, they have already reached efficiencies in excess of 7.6%. Due to the similarity of the superstrate device architectures to CdTe Solar cells, the possibility exists to adopt CdTe deposition techniques to fabricate Sb$_2$Se$_3$ solar cells. Close space sublimation (CSS) has long been established as technique which produces the highest quality CdTe solar cells and as a result has been utilized industrially. It therefore seems a natural progression to adopt it’s use for the deposition of Sb$_2$Se$_3$ layers.

This work will report on the development of a new CSS route to Sb$_2$Se$_3$ fabrication, capable of producing devices of >6.5% efficiency and with V$_{OC}$ values in excess of current champion devices. We will discuss the distinct materials and device differences between CSS cells and thermally evaporated equivalents, as well as the relative merits and difficulties associated with the CSS technique. This will include analysis of electrically active defects within the material, the role the 1D crystal structure plays in film growth and how the form of the Sb$_2$Se$_3$ films may be varied from nanowires to compact thin films by careful control of deposition conditions. We will demonstrate that this new deposition route offers huge potential to aid the development of this technology and will signpost the key challenges than need to be addressed to further improve Sb$_2$Se$_3$ solar cells.