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Evaluation of a proposed barium di-silicide tandem solar cell using TCAD numerical simulation

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Abstract

Barium di-silicide ($BaSi_2$) material has attracted noteworthy interest in photovoltaics, thanks to its stability, abundant nature, and excellent production feasibility. In this current work, a two-terminal (2T) monolithic all-$BaSi_2$ tandem solar cell is proposed and explored through extensive TCAD simulation. A $BaSi_2$ bottom sub-cell with a bandgap of 1.3 eV, and a $Ba(C_xSi_{1-x})_2$ top sub-cell with a tunable bandgap are employed in the design. It was found that a bandgap of 1.8 eV, which corresponds to $x = 0.78$, is the optimum choice to obtain the maximum initial power conversion efficiency (η) of 30%. Then, the tandem performance is optimized by investigating the impact of doping and the thickness of both absorber layers. Further, the current matching point is monitored whilst altering the thickness of the top cell resulting in $\eta = 32.83\%\%$, and a short-circuit current density (J_{sc}) of 16.47 mA/cm^2. Additionally, we have explored the influence of the defect density in the absorbers, and the work function of contacts on the performance parameters. All TCAD simulations are accomplished using the Silvaco Atlas package under AM1.5G illumination.

Keywords Tandem solar cell · Barium di-silicide · Current matching · TCAD simulation · Power conversion efficiency

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