



Numerical study of flexible perovskite/Si tandem solar cell using TCAD simulation

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Abstract

This work presents the design of a monolithic thin-film tandem solar cell (TSC), that comprises of a front perovskite (PVK) sub-cell along with a rear thin Si sub-cell. The study begins by calibrating the individual sub-cells versus experimental studies, resulting in a power conversion efficiency (*PCE*) of 12.70% regarding the front cell and 24.47% regarding the rear cell. When combining the two sub-cells in a PVK/Si configuration, the initial tandem achieves an efficiency of 22.36% and a short-circuit current density (J_{sc}) of 15.29 mA/cm². To enhance the functionality of the proposed TSC, we design the top hole transport layer to achieve a suitable valence band offset and inspect the influence of altering the defect concentration of the front sub-cell absorber and the thicknesses of both absorbers to maximize the *PCE*. The optimized TSC, under the current matching circumstance, shows an improved J_{sc} of 19.25 mA/cm² and a *PCE* of 32.25%. All performed simulations are conducted by employing a Silvaco Atlas device simulator with one Sun spectrum illumination (AM1.5G, 1000 W/m²). This TCAD simulation study offers potential ways to advance low-cost, efficient thin-film TSCs that are suitable for flexible applications.

Keywords Thin film · Perovskite · Silicon · Tandem · VBO · Current matching · TCAD

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