SCAPS-1D optimization of perovskite/silicon tandem solar cells

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Tandem solar cells are widely considered the industries next step in photovoltaics because of their excellent power conversion efficiency [1]. Since halide perovskite absorber material was developed, it has been feasible to develop tandem solar cells that are more efficient. Due to Shockley-Queisser limit, the efficiency of a single-junction solar cell is scarcely to exceed 33.16% under sun illumination (AM 1.5 G) [2]. For a perovskite/Si tandem of PCE 28%, due to weak incident flux reaches the bottom cell, the contribution of the silicon cell is only 6% (compared to 22% for the perovskite cell) in a 4-contact configuration. In this work, we have carried out a computation optimization of the performance of perovskite/silicon tandem configuration solar cells using SCAPS-1D software. We have investigated the impact of the thickness of the perovskite and other key operating parameters of the cell such as temperature, series and shunt resistances. SCAPS-1D was further used to simulate the improvement of bottom cell absorption using conversion carbon layer. The obtained results have shown that under satisfactory simulation conditions, the open circuit voltage, fill factor and current density of the tandem perovskite/silicon solar cell can be improved, with a remarkable increase in the conversion efficiency.

[1]. Chapin DM, Fuller CS, Pearson GL. A new silicon p-n junction photocell for converting solar radiation into electrical power. J Appl Phys. 1954; 25:676.

[2]. Roland Ernst, PV Magazine, December 20, 2022