Numerical, study, lead, free, $CsSn_{0.5}Ge_{0.5}I_3$, perovskite, solar, cell, SCAPS-1D

Abstract

Lead free perovskite solar cells (PCS) are becoming a distinctly predominant area of study due to the toxicity and stability hurdles of the lead halide perovskite. Current lead-free perovskites are also plagued with low efficiency. This work is concerned with the design and analysis of $CsSnGeI_3$ that is a viable competitor to lead based perovskites by SCAPS-1D simulator (ver.3.3.08). The primary solar cell's structure is FTO/PCBM/ $CsSn_{0.5}Ge_{0.5}I_3$ / spiro-OMeTAD/Au which achieved a power conversion efficiency (*PCE*) of 7.11% [1]. To enhance device performance, the effect of optimizing absorber layer defect density (1×10^{15} cm^{-3}) and thickness (700–800 nm), doping concentration of absorber layer (1×10^{15} cm^{-3}), variation of Electron Transport Material (ETL) and Hole Transport Material (HTL) parameters (effect of CBO and VBO and doping concentration) and potential material options for ETL and HTL are studied. The results of the simulation are as follows; maximum power conversion efficiency (*PCE*) 18.79%, short circuit current density (J_{sc}) 27.05 mA/cm^2, open circuit voltage (V_{oc}) 0.87 V and fill factor (*FF*) 79.25%. By choosing appropriate material parameters, improving fabrication and encapsulation processes, $CsSn_{0.5}Ge_{0.5}I_3$ proves to be an environmentally friendly solar cell with high efficiency.