Modeling and Simulation of High Efficiency Eco-Friendly Perovskite-$CZTSe_{1-x}S_x$ Solar Cell

© D. Jalalian [1], A. Ghadimi [2]¶, A.K. Sar Kaleh [1]

[1] Department of Electrical Engineering, Rasht Branch, Islamic Azad University, Rasht, Iran
[2] Department of Electrical Engineering, Lahijan Branch, Islamic Azad University, Lahijan, Iran

¶ E-mail: ghadimi@liau.ac.ir

Received October 7, 2020
Revised October 7, 2020
Accepted for publication November 3, 2020

In the present paper, a Pb-free and eco-friendly perovskite solar cell (PSC) with a new structure of glass|TCO|TiO_2|$CZTSe_{1-x}S_x$|$CH_3NH_3SnI_3$|back contact has been modeled and simulated by SCAPS-1D package. To verify the simulation process, an experimental report on Pb-free PSC was simulated initially. Then, the costly Spiro-OMeTAD layer as the common hole-transport material (HTM) was eliminated. To overcome the possible deficiencies related to lacking of HTM plus management of the incident light, the economic and eco-friendly $Cu_2ZnSn(Se_{1-x}S_x)_4$ ($CZTSe_{1-x}S_x$) layer was added in the front of perovskite layer followed by optimizing the parameters. By optimization, the power-conversion efficiency of 17.57%, open-circuit voltage Voc of 0.85 V, short-circuit current density Jsc of 29.22 mA/cm^2, and fill factor of 70.47% were obtained. Meanwhile, very high quantum efficiency was achieved in the visible region of spectrum.

Keywords: solar cell, Pb-free perovskite, $CZTSe_{1-x}S_x$, non-toxicity, simulation.

Full text of the paper will appear in journal SEMICONDUCTORS.