Surface passivation to reduce the voltage loss in tin-lead mixed perovskite solar cells

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Introduction

Tin-lead (Sn-Pb) perovskite solar cells (PSCs) are the potential candidate to achieve the high efficiency (>30%) for the single-junction solar cells as estimated by Shockley-Queisser (SQ) limit due to their ideal bandgap of 1.2-1.3 eV [1]. Also, the low bandgap of these materials makes them suitable for their implementation as the bottom cell in the tandem solar cell. Other advantages of these perovskite materials are their broad photon harvesting capability until 1060nm allowing them to use in the development of PSCs with high short circuit current density (Jsc) [2,3]. Despite all the above advantages, it is well known that these materials suffer from rapid oxidation of Sn^{2+} to Sn^{4+} leading to high voltage loss that finally results in poor performance of the PSCs based on these materials. To circumvent such problems, many researchers have recently focused on the use of different strategies such as the use of different reducing agents, the addition of large organic cations into the lattice to form quasi 2D-3D Sn-Pb perovskites, or the use of passivation layers to inhibit the rapid oxidation [2]. In this work, we will report the use of an organic cation which partially includes the effect of all the above-mentioned strategies that led us to improve the reproducibility and stability of the Sn-Pb based PSCs

Results and discussion

Cs^+ added triple cation-based Sn-Pb perovskites, $(Cs_xFA_{1-x}SnI_3)_{0.5}(MAPbI_3)_{0.5}$, were prepared. Different devices such as D1 (without passivation), and D2, D3, and D4 (With passivation) were studied. The voltage loss (0.55V) for the non-passivated device was reduced to 0.45V with overall PCE approaching 20%. The improvement in solar cell performances was supported by XPS, XRD, SEM, PL, and TAS measurements.

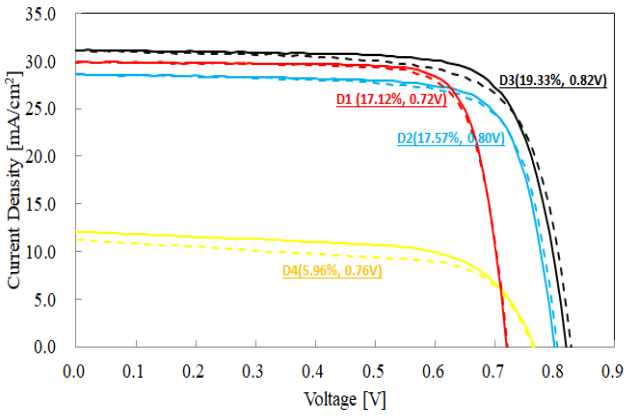

Fig1. IV characteristics of the different devices prepared in the study

References

1. W. Shockley, H. J. Queisser, *J. Appl. Phys.* 1961, 32, 510.
2. J. Tong and K. Zhu et al. DOI: 10.1126/science.aav7911.
3. G. Kapil and S. Hayase et al., *Nanoletters*, 2018, 18, 3600-3607.