Highly efficient lead/tin mixed perovskite solar cells by interface modification

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Introduction

Tin-lead (Sn-Pb) alloyed perovskite solar cell (PSC) shows high photocurrents due to its broad absorption spectrum, reaching the far infra-red wavelength around 1050 nm [1,2]. Assuming an ideal voltage loss of 0.4 V, theoretically a voltage of ~0.8 V can be achieved. But as reported earlier [2], Sn based solar cell undergoes a self-oxidation from Sn^{2+} to Sn^{4+}, creating many trap states within perovskite and at the interface as well, which reduces the V_{oc}. In this work, we decreased the voltage loss by interface modification, and increased the V_{oc} of solar cell to 0.75 V with photoconversion efficiency (PCE) of 17.6% utilizing the same absorber layer.

Experiment

Solar cells fabricated were ITO/PEDOT:PSS/FAMA/PCBM/C_{60}/BCP/Ag, consisting an absorber layer of $(FASnI_3)_{0.6}(MAPbI_3)_{0.4}$ (FAMA)[1]. The FAMA precursor solution was obtained by mixing stoichiometric amounts of $FASnI_3$ and $MAPbI_3$ perovskite precursors in mixed N,N-dimethylmethanamide (DMF):dimethyl sulfoxide (DMSO). The solar cell performance was checked with and without of phenyl-C61-butyric acid methyl ester (PCBM) to know the effect of interfacial engineering.

Results and discussion

Figure 1 shows the variation of PCE with the different concentration of PCBM deposited on the top of absorber layer (FAMA). Without use of PCBM, the average efficiency was not more than 13%. However, a coating of very thin layer of PCBM (1mg/ml) increased the average PCE more than 15%. The best results were obtained with 5mg/ml concentration of PCBM. As shown in Fig.1, the PCE was reduced with higher concentration as a result of increased thickness of PCBM layer.

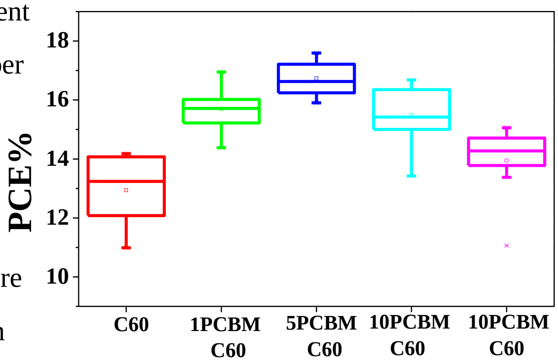

Fig1. PCE of devices prepared with different concentration of PCBM

Reference

1. D. Zhao & Y. Yan et al, *Nat. Energy.*, 2017, **2**, 1-7.
2. Y. Ogomi & S. Hayase *et al*, *J. Phys. Chem. Lett.*, 2014, **5**, 1004-1011.