

## Multiple monovalent cation for lead/tin mixed perovskite solar cells

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### Introduction

One of the approaches to improve the efficiency and stability of perovskite solar cells is to use the mixture of monovalent cations such as cesium(Cs<sup>+</sup>), formamidinium [(CH<sub>3</sub>(NH<sub>2</sub>)<sub>2</sub><sup>+</sup>, FA<sup>+</sup>], methylammonium [(CH<sub>3</sub>NH<sub>3</sub>)<sup>+</sup>, MA<sup>+</sup>] etc. on the A position of ABX<sub>3</sub> perovskite crystal structure [1]. Sn based solar cell gives an alternative to Pb free solar cells to reduce the toxicity concern [2]. But 100% Sn based perovskite solar cells showed poor efficiencies so far. Hence, in the work we proposed Sn/Pb perovskite solar cells by combining with multiple monovalent cation to evaluate the stability and efficiency.

### Experiment

Solar cells fabricated were (FASnI<sub>3</sub>)<sub>0.6</sub>(MAPbI<sub>3</sub>)<sub>0.4</sub> (①FAMA), (CsI)<sub>x</sub>[(FASnI<sub>3</sub>)<sub>0.6</sub>(MAPbI<sub>3</sub>)<sub>0.4</sub>]<sub>1-x</sub> (as (Cs)<sub>x</sub>(FAMA)<sub>1-x</sub>). The FAMA precursor solution was obtained by mixing stoichiometric amounts of FASnI<sub>3</sub> and MAPbI<sub>3</sub> perovskite precursors in mixed N,N-dimethylmethanamide (DMF):dimethyl sulfoxide (DMSO). CsI in DMSO was prepared as stock solution and added finally with different concentration 5%, 10% and 15% to FAMA precursor; hence, the triple cation based solar cell finally fabricated were ② (Cs)<sub>0.05</sub>(FAMA)<sub>0.95</sub>, ③ (Cs)<sub>0.10</sub>(FAMA)<sub>0.90</sub> and ④ (Cs)<sub>0.15</sub>(FAMA)<sub>0.85</sub> respectively.

### Results and discussion

Figure 1 shows IPCE spectrum for different solar cells reaching to 1050 nm. Addition of Cs(5%) showed increase in PCE from 10.26% (FAMA) to 11.66%. This improvement in efficiency was clearly observed in IPCE as well. Cs(5%) containing solar cell exhibits more than 60% absorption at 900 nm with a high photocurrent of 28 mA/cm<sup>2</sup>.

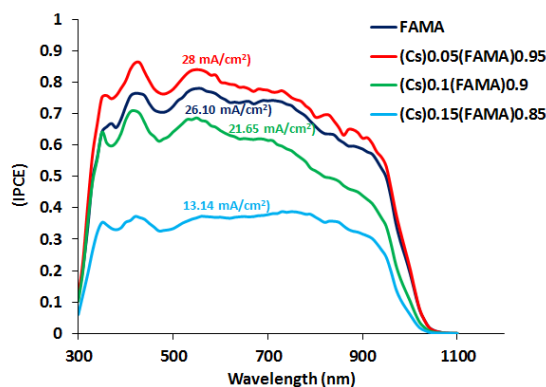


Figure 1. IPCE showing effect of Cs<sup>+</sup> in photocurrent generation

### Reference

1. M. Saliba & M. Gratzel *et al*, *Energy & Environ. Sci.*, 2016, **9**, 1989-1997.
2. Y. Ogomi & S. Hayase *et al*, *J. Phys. Chem. Lett.*, 2014, **5**, 1004-1011.