

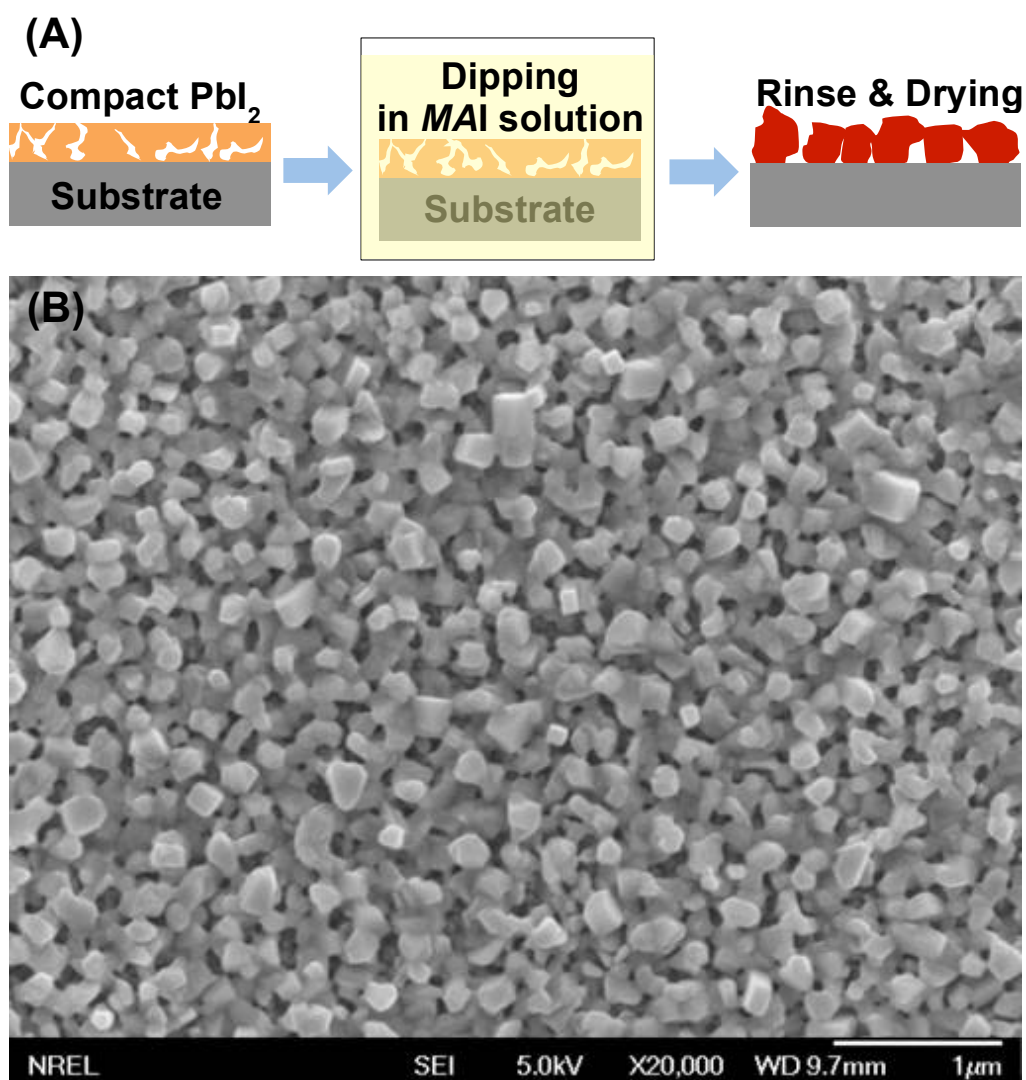
### Electronic Supplementary Information

#### **Growth Control of Compact $\text{CH}_3\text{NH}_3\text{PbI}_3$ Thin Films *via***

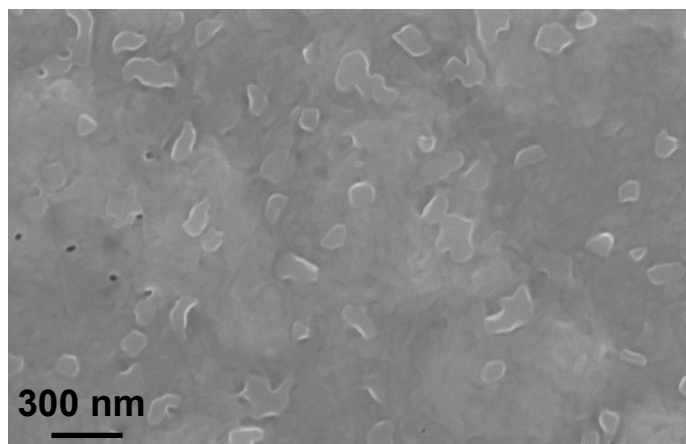
#### **Enhanced Solid-State Precursor Reaction for Efficient Planar Perovskite Solar Cells**

Yuanyuan Zhou, Mengjin Yang, Alexander L. Vasiliev, Hector F. Garces, Yixin Zhao,  
Dong Wang, Shuping Pang, Kai Zhu\*, and Nitin P. Padture\*

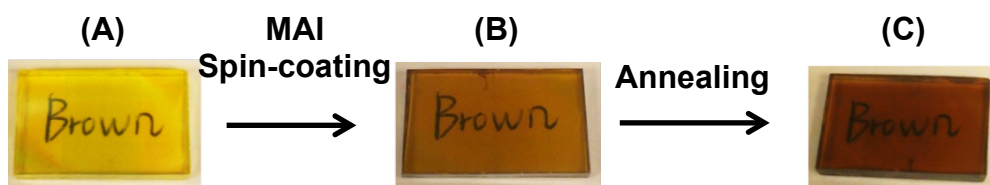
\*kai.zhu@nrel.gov \*nitin\_padture@brown.edu



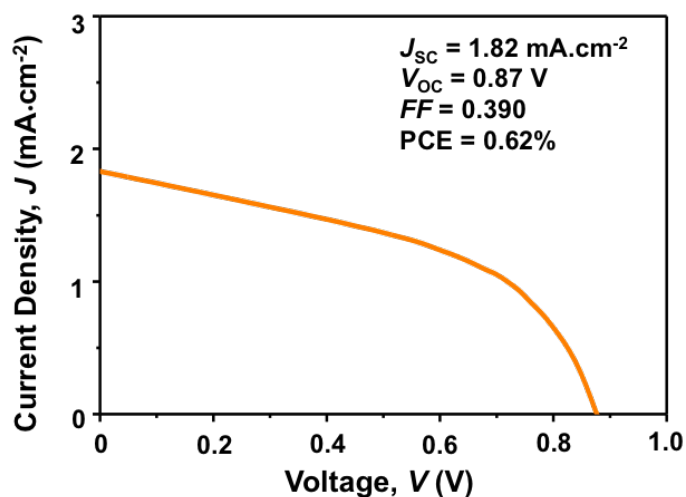
**Fig. S1.** (A) Schematic diagram depicting the conventional “two-step” method for fabrication of perovskite thin films and (B) typical SEM morphology of a  $\text{MAPbI}_3$  thin film processed using this conventional “two-step” method.



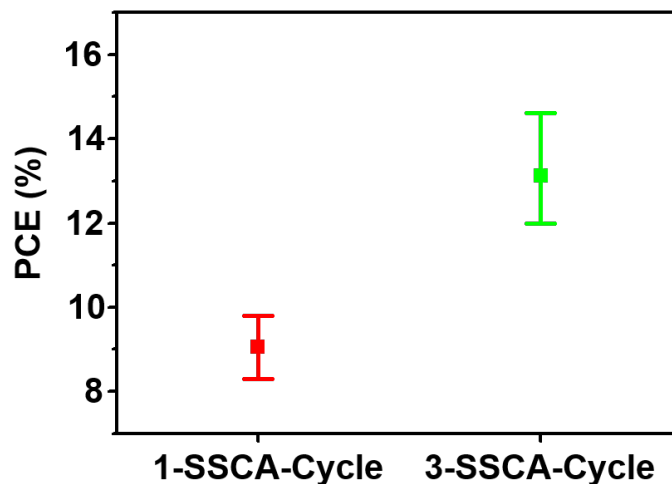
**Fig. S2.** SEM micrograph of top surface of  $\text{PbI}_2$  thin film spin-coated from  $\text{PbI}_2$  solution (in DMF) and dried at  $130^\circ\text{C}$ .



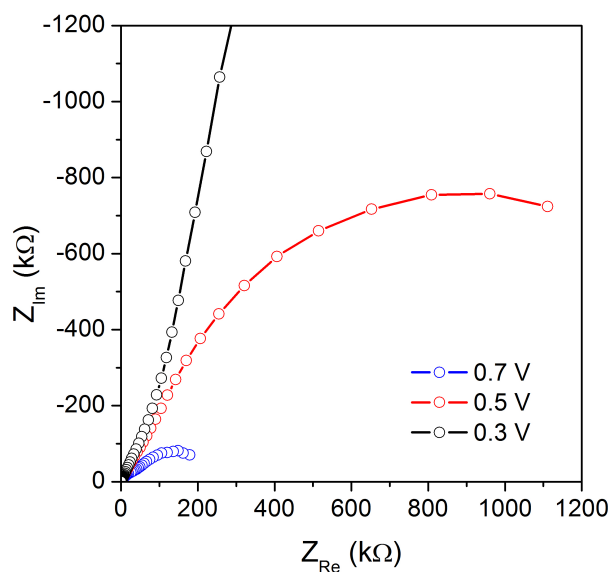
**Fig. S3.** Photographs of thin films: (A) spin-coated  $\text{PbI}_2$ , (B) after MAI spin-coating, and (C) after annealing at  $150^\circ\text{C}$ .



**Fig. S4.**  $J$ - $V$  characteristics of PSC with  $\text{MAPbI}_3$  thin film, containing significant amount of  $\text{PbI}_2$ , deposited using the conventional “two-step” method, and the solar cell performance parameters



**Fig. S5.** Maximum, minimum and average PCEs of 15 PSCs each.



**Fig. S6.** Typical Nyquist plots of the impedance responses for a typical planar perovskite cell with three different bias voltages. The impedance spectra are dominated by a large semicircle at low frequencies. The model used for impedance analysis has been previously discussed in detail.<sup>S1, S2</sup>

## References

- (S1). Juárez-Perez, E. J.; Wußler, M.; Fabregat-Santiago, F.; Lakus-Wollny, K.; Mankel, E.; Mayer, T.; Jaegermann, W.; Mora-Sero, I. Role of the Selective Contacts in the Performance of Lead Halide Perovskite Solar Cells. *J Phys. Chem. Lett.* **2014**, *5*, 680-685.
- (S2). Christians, J. A.; Fung, R. C. M.; Kamat, P. V. An Inorganic Hole Conductor for Organo-Lead Halide Perovskite Solar Cells. Improved Hole Conductivity with Copper Iodide. *J. Am. Chem. Soc.* **2014**, *136*, 758-764.