

## Supporting Information

### **Metallic Tin Substitution of Organic Lead Perovskite film for Efficient Solar Cells**

Jinjin Zhao,<sup>1,2,†,\*</sup> Liyu Wei,<sup>1,3,†</sup> Chunmei Jia,<sup>1,3,†</sup> Hao Tang,<sup>4</sup> Xiao Su,<sup>1</sup> Yun Ou,<sup>3</sup> Zhenghao Liu,<sup>1,3</sup>  
Chen Wang,<sup>1</sup> Xingyu Zhao,<sup>1,3</sup> Hongyun Jin,<sup>2</sup> Peng Wang,<sup>1</sup> Gang Yu,<sup>1</sup> Guanglei Zhang,<sup>1</sup> and Jinxi  
Liu<sup>1</sup>

1. School of Materials Science and Engineering, Department of Engineering Mechanics, Shijiazhuang Tiedao University, Shijiazhuang 050043, China
2. Engineering Research Center of Nano-Geo Materials of Ministry of Education, China University of Geosciences, Wuhan 430074, China
3. Shenzhen Key Laboratory of Nanobiomechanics, Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences, Shenzhen 518055, China
4. Department of Materials Science and Engineering, University of Washington, Seattle, WA 98195-2120, USA.

† These authors contributed equally to the work.

\* Corresponding authors (emails: jinjinzhao2012@163.com (Zhao J))

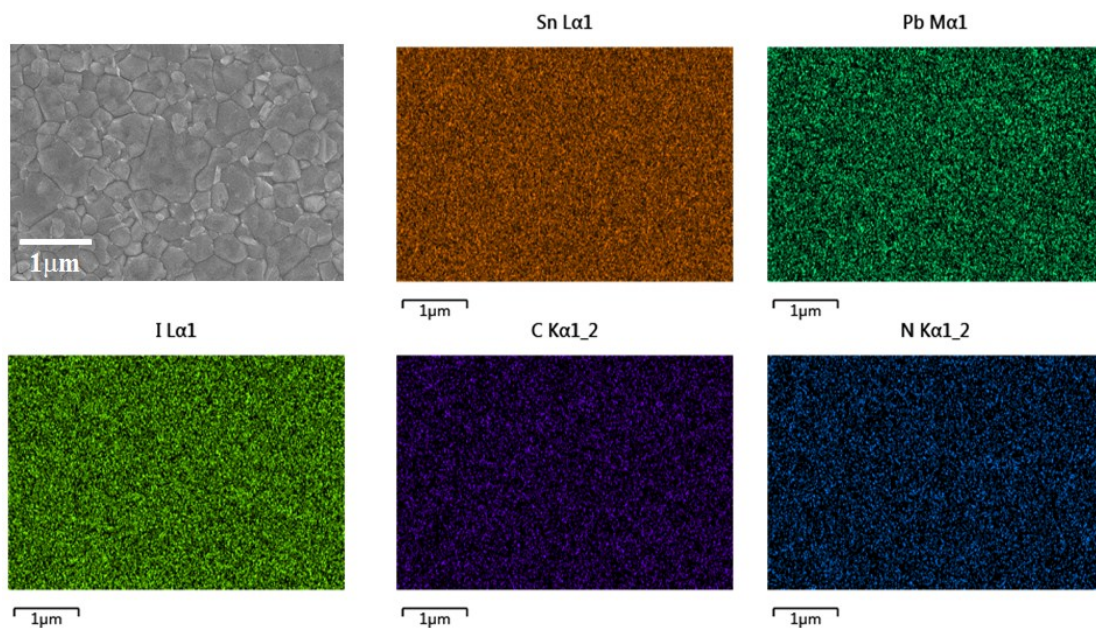


Fig. S1 The SEM-EDS mapping of MASn<sub>x</sub>Pb<sub>1-x</sub>I<sub>3</sub>-1d

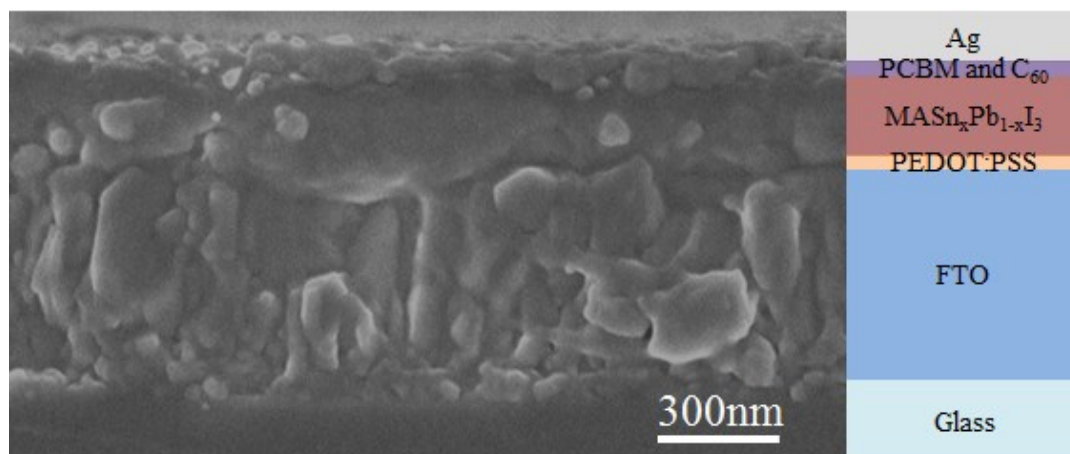


Fig. S2 Cross-sectional SEM image of FTO/PEDOT:PSS/ MASn<sub>x</sub>Pb<sub>1-x</sub>I<sub>3</sub>-1d/ PCBM/C<sub>60</sub>/Ag device structure

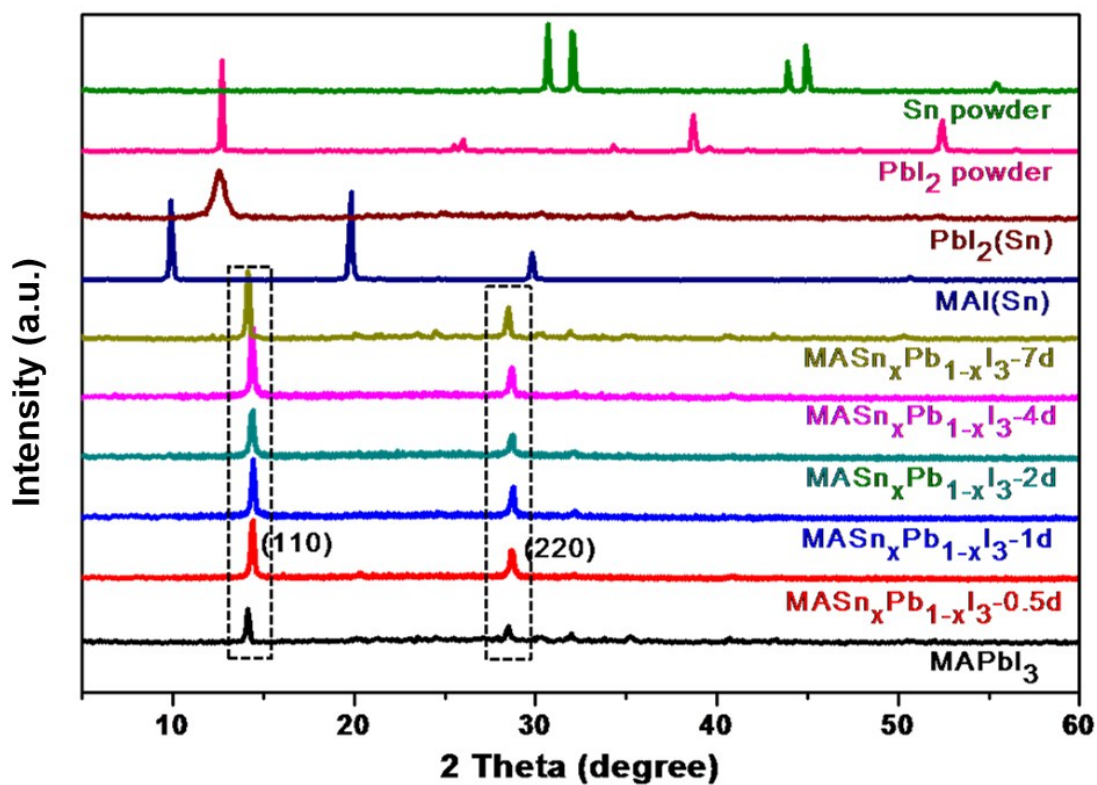


Fig. S3 XRD patterns of PbI<sub>2</sub> film and MAI film reacted without/with Sn metal and filtered, respectively, and starting materials Sn powder, PbI<sub>2</sub> powder, and MASn<sub>x</sub>Pb<sub>1-x</sub>I<sub>3</sub> with different Sn substitution time, 0d (MAPbI<sub>3</sub>), 0.5d, 1d, 2d, 4d, and 7d.

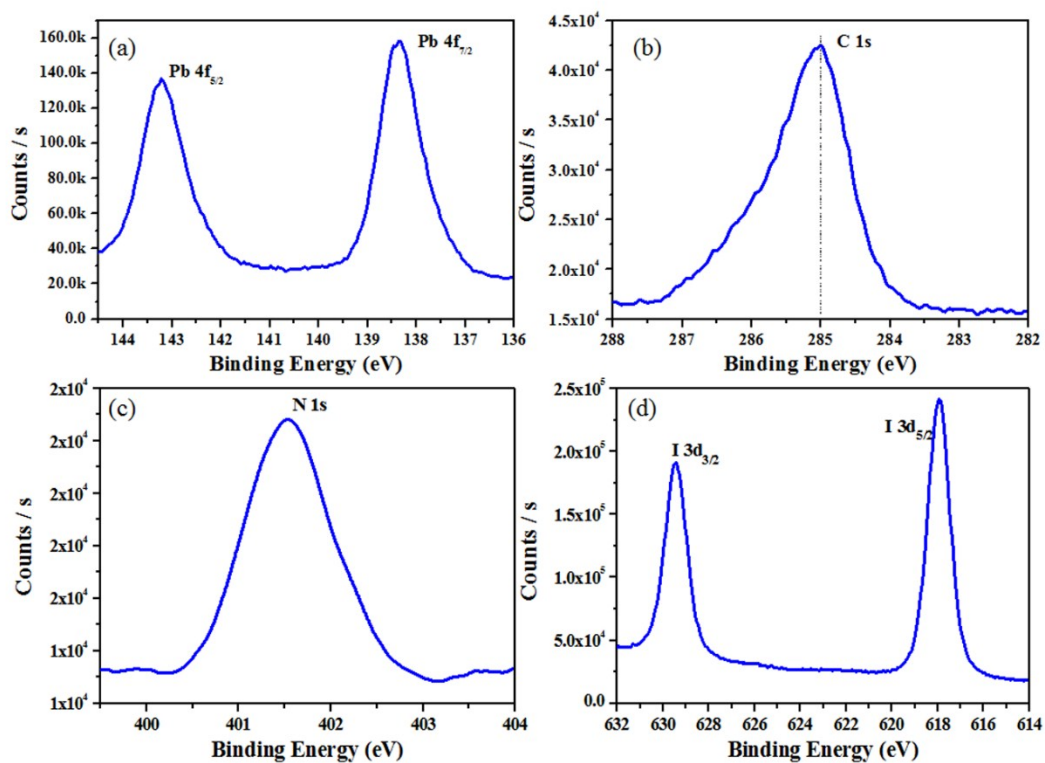


Fig. S4 XPS spectra of MASn<sub>x</sub>Pb<sub>1-x</sub>I<sub>3</sub>-1d

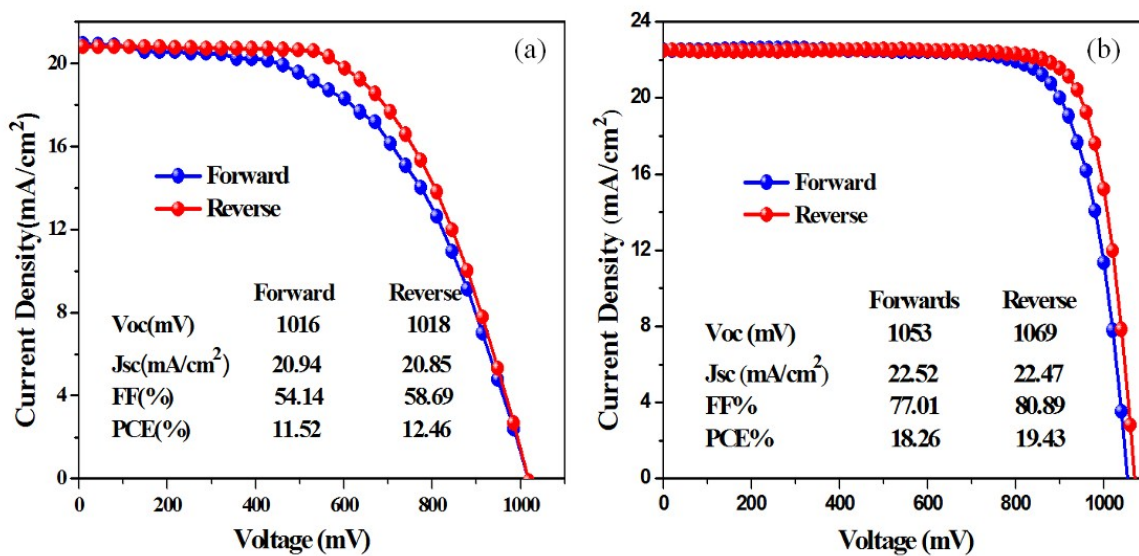


Fig. S5 J-V curve of (a) MASn<sub>x</sub>Pb<sub>1-x</sub>I<sub>3</sub>-1d and (b) MAPbI<sub>3</sub>

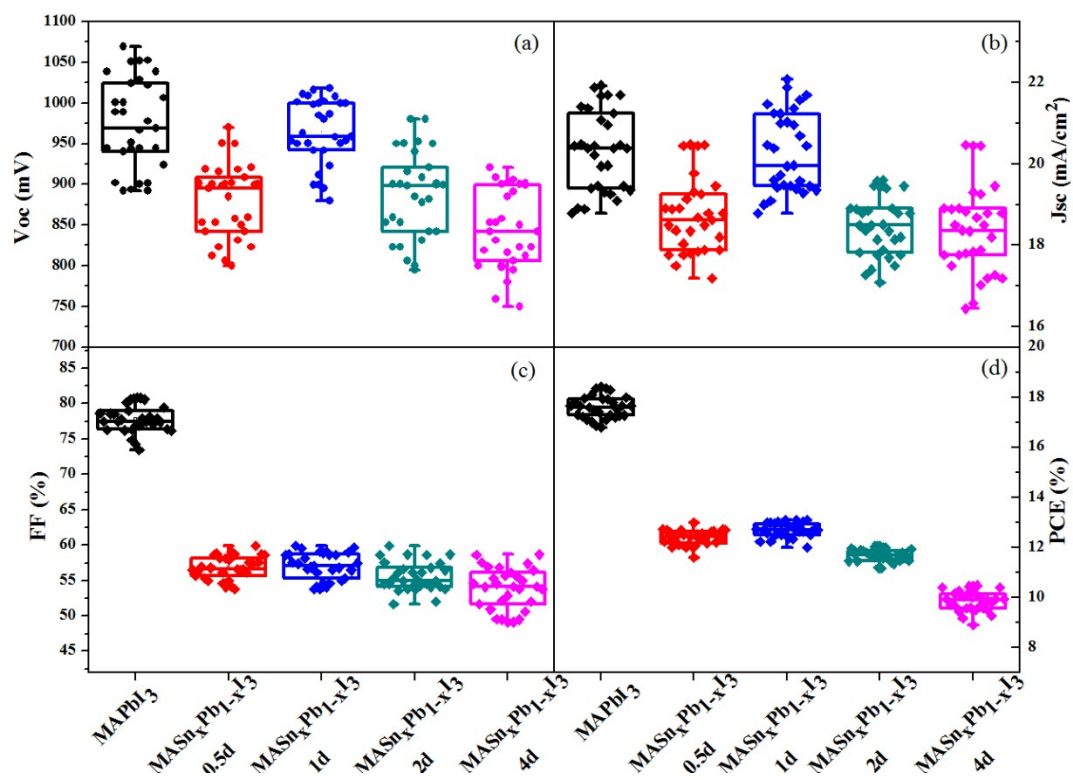


Fig. S6 Average photovoltaic parameters of MASn<sub>x</sub>Pb<sub>1-x</sub>I<sub>3</sub> perovskite solar cells: (a) Voc, (b) Jsc, (c) FF, and (d) PCE.

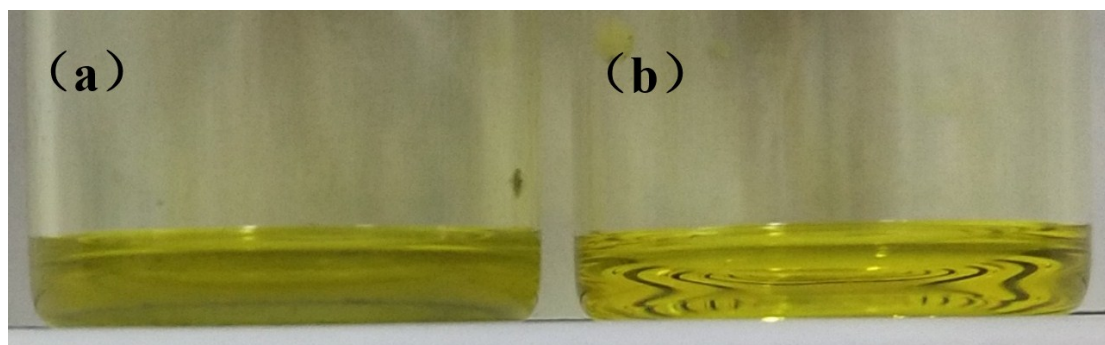


Fig. S7 The photograph of MASn<sub>x</sub>Pb<sub>1-x</sub>I<sub>3</sub>-7d (a) and MASn<sub>x</sub>Pb<sub>1-x</sub>I<sub>3</sub>-1d (b)