

**Electronic Supplementary Information (ESI)**

**One-step solution deposition of CsPbBr<sub>3</sub> based on precursor engineering  
for efficient all-inorganic perovskite solar cells**

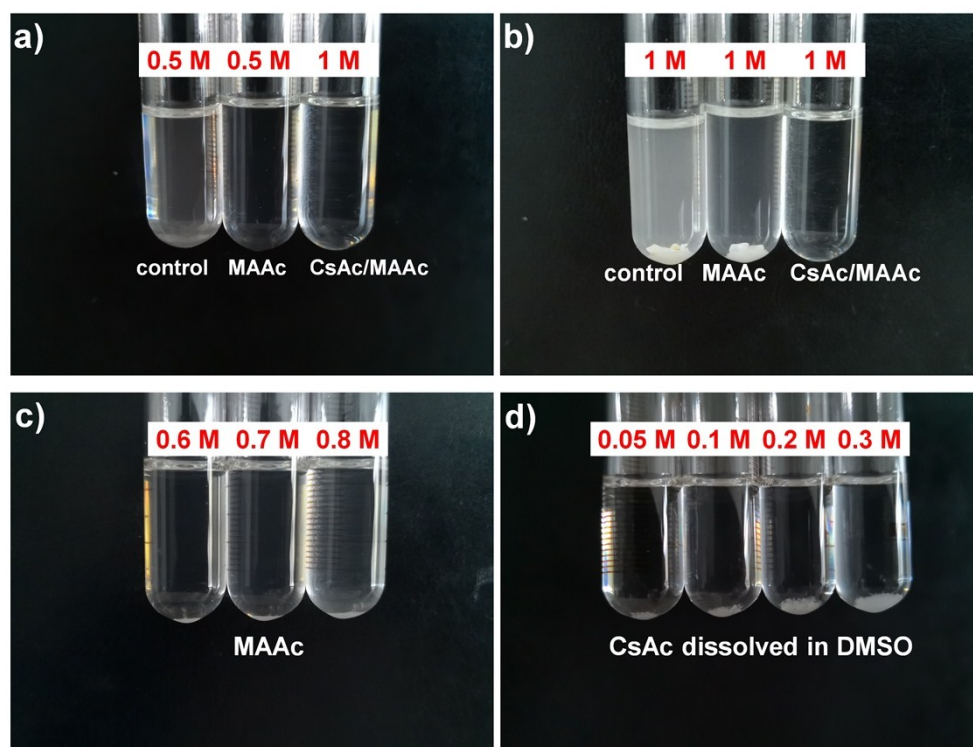
Dewei Huang, Pengfei Xie, Zhenxiao Pan, Huashang Rao\* and Xinhua Zhong\*

College of Materials and Energy, South China Agricultural University, 483 Wushan Road,  
Guangzhou 510642, China

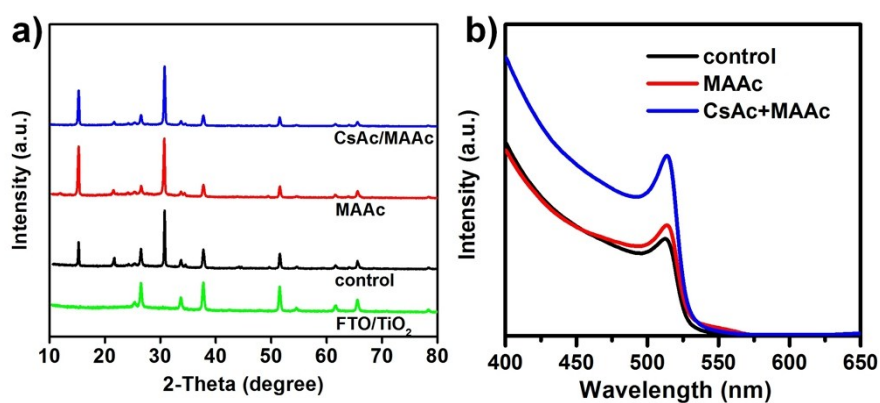
\*Corresponding authors

E-mail: raohsh@scau.edu.cn (Dr. H. Rao)

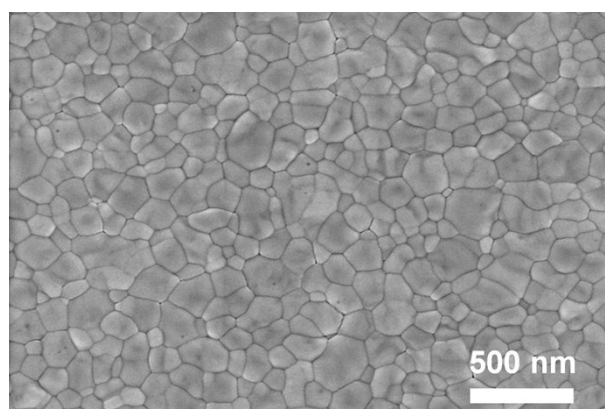
zhongxh@scau.edu.cn (Prof. X. Zhong)



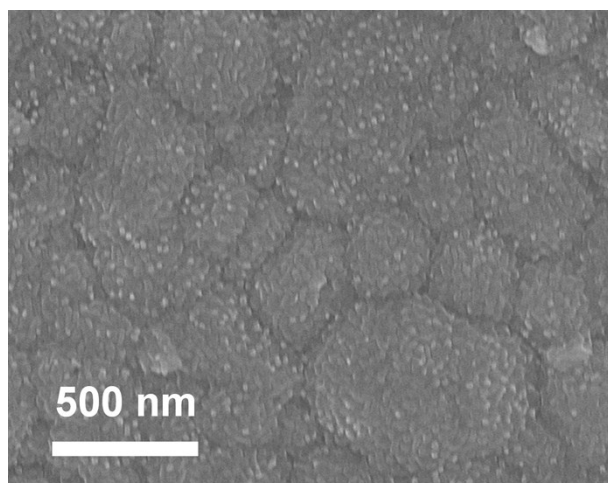
**Figure S1.** a,b,c) The photographs of various precursor formulations with different concentration. d) The solubility test of CsAc in pure DMSO. **Control group:** equimolar ratio of CsBr and PbBr<sub>2</sub> dissolved in pure DMSO; **MAAc group:** equimolar ratio of CsBr and PbBr<sub>2</sub> dissolved in a mixture solution of MAAc and DMSO (1:7, vol/vol); **CsAc/MAAc group:** equimolar ratio of CsAc, MABr and PbBr<sub>2</sub> dissolved in a mixture solution of MAAc and DMSO (1:7, vol/vol).



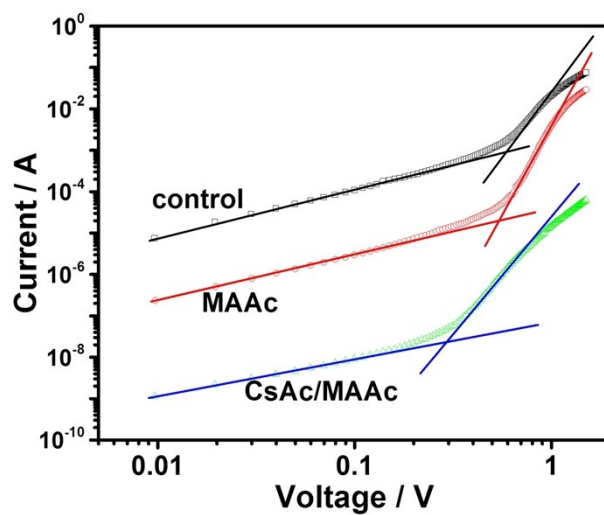
**Figure S2.** XRD patterns (a) and absorption spectra (b) of the CsPbBr<sub>3</sub> films prepared with different precursors.



**Figure S3.** Top-view SEM images of perovskite film prepared with CaAc/MAAc-based precursor after the first stage annealing of low temperature (45 °C).



**Figure S4.** (a) Top-view of the CsPbBr<sub>3</sub> film deposited with 5 nm-thick CuPc.



**Figure S5.** Dark *I-V* characteristics for FTO/TiO<sub>2</sub>/CsPbBr<sub>3</sub>/PCBM/Au devices.

**Table S1.** The peak parameters extracted from XRD patterns in Figure 2b.

| Sample              | (100) | (110) | (210) | (200) <sub>FTO</sub> |
|---------------------|-------|-------|-------|----------------------|
| 160 °C              | 15.29 | 21.23 | 30.77 | 37.97                |
| 45 °C               | 15.19 | 21.55 | 30.63 | 37.97                |
| MAPbBr <sub>3</sub> | 15.11 | 21.69 | 30.21 | 37.97                |

**Table S2.** The parameters extracted from the time-resolved PL spectra based on the CsPbBr<sub>3</sub> films prepared with different precursors.

| Sample    | $\tau_{\text{avg}}$ [ns] | $\tau_1$ [ns] | $\tau_2$ [ns] | A <sub>1</sub> [%] | A <sub>2</sub> [%] |
|-----------|--------------------------|---------------|---------------|--------------------|--------------------|
| control   | 1.5                      | 0.27          | 1.94          | 68.9               | 31.1               |
| MAAc      | 2.5                      | 0.97          | 2.72          | 32.1               | 67.9               |
| CsAc/MAAc | 6.2                      | 2.68          | 7.62          | 53.3               | 46.7               |

**Table S3.** The average values of photovoltaic parameters and maximum PCE, which are extracted from measured  $J$ - $V$  curves at one sun illumination (100 mW cm<sup>-2</sup>, AM 1.5G).

| Device    | $J_{\text{sc}}$<br>[mA cm <sup>-2</sup> ] | $V_{\text{oc}}$<br>[V] | FF    | PCE<br>[%] | Maximum<br>PCE [%] |
|-----------|---|------------------------|-------|------------|--------------------|
| control   | 4.59                                      | 0.86                   | 0.645 | 2.53       | 2.81               |
| MAAc      | 5.63                                      | 1.09                   | 0.665 | 4.07       | 4.79               |
| CsAc/MAAc | 7.19                                      | 1.23                   | 0.731 | 6.48       | 7.37               |

**Table S4.** The photovoltaic parameters extracted from  $J$ - $V$  curves, which were recorded under forward/reverse voltage scanning directions at one sun illumination (100 mW cm<sup>-2</sup>, AM 1.5G).

| Device  | $J_{sc}$<br>[mA cm <sup>-2</sup> ] | $V_{oc}$<br>[V] | FF    | PCE<br>[%] |
|---------|------------------------------------|-----------------|-------|------------|
| Reverse | 7.40                               | 1.22            | 0.814 | 7.37       |
| Foward  | 7.42                               | 1.21            | 0.754 | 6.79       |

### SCLC measurement

The space charge limited current (SCLC) measurements use the devices of FTO/TiO<sub>2</sub>/CsPbBr<sub>3</sub>/PCBM/Au. The PCBM and Au layer were prepared by spin-coating PCBM chlorobenzene solution (10.0 mg/mL) and by thermal evaporation, respectively.  $I$ - $V$  characteristics of those devices were measured by Keithley 2401 under dark and vacuum. The trap density ( $n_{trap}$ ) of samples were calculated by the equation:<sup>1,2</sup>

$$V_{TEF} = \frac{en_{trap}L^2}{2\varepsilon_0\varepsilon} \quad (1)$$

where  $e$  is the elementary charge,  $L$  is the thickness of CsPbBr<sub>3</sub> film,  $\varepsilon_0$  is permittivity of vacuum and  $\varepsilon$  (16.46) is dielectric constant of CsPbBr<sub>3</sub>.<sup>3</sup> The trap-filled limit voltage ( $V_{TFL}$ ) was obtained from  $I$ - $V$  curve.

### References

- 1 A. Rose, *Phys. Rev.*, 1955, **97**, 1538.
- 2 Q. Dong, Y. Fang, Y. Shao, P. Mulligan, J. Qiu, L. Cao and J. Huang, *Science*, 2015, **347**, 967–970.
- 3 J. Song, Q. Cui, J. Li, J. Xu, Y. Wang, L. Xu, J. Xue, Y. Dong, T. Tian and H. Sun, *Adv. Opt. Mater.*, 2017, **5**, 1700157.