Electronic Supplementary Material (ESI) for Materials Chemistry Frontiers.

Supplementary Information

Triethyl phosphate in antisolvent: A novel approach to fabricate high efficiency and stable perovskite solar cells under ambient air

Pengyun Zhang[a], Ningxia Gu[a], Xiang Chen[a], Lixin Song[a], Pingfan Du[a], Wei-Hsiang Chen[b], Jie Xiong[a*]*

[a] College of Textile Science and Engineering, Zhejiang Sci–Tech University, Hangzhou, 310018, China

[b] School of Science, Huzhou University, Huzhou, 313000, Zhejiang, China

*** Corresponding Authors: lxsong12@zstu.edu.cn (LX Song); jxiong@zstu.edu.cn (J Xiong).**

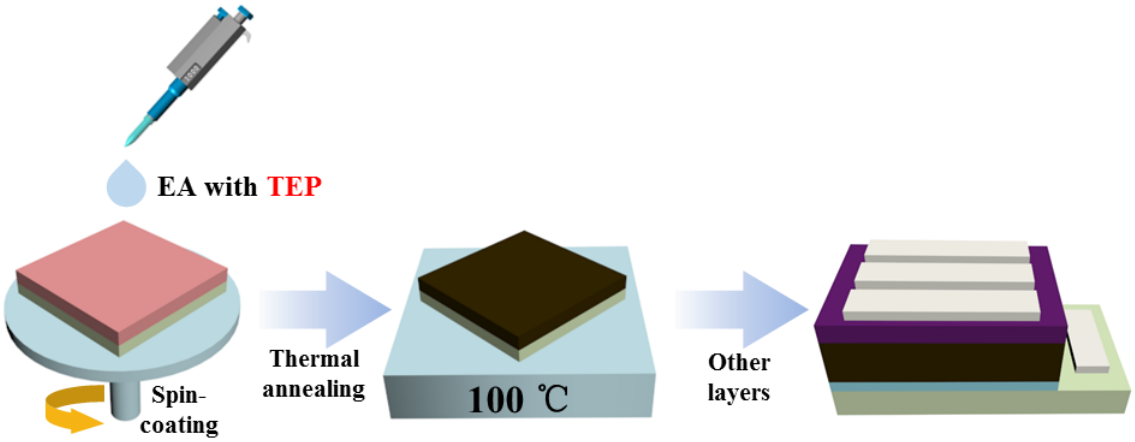

Fig. S1. The schematic diagram of fabricate high-efficiency and stable perovskite ($MAPbI_3$) solar cells under ambient environment. The complete structure of device is FTO-etched glass/TiO_2/$MAPbI_3$ (with or without TEP)/Spiro-OMeTAD/Ag.

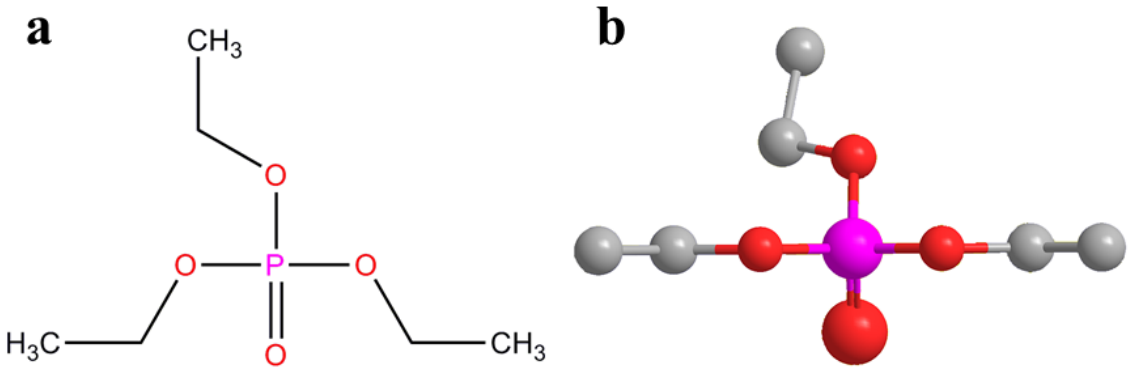

Fig. S2. The chemical structure (a) and the corresponding 3D model (b) of triethyl phosphate (TEP).

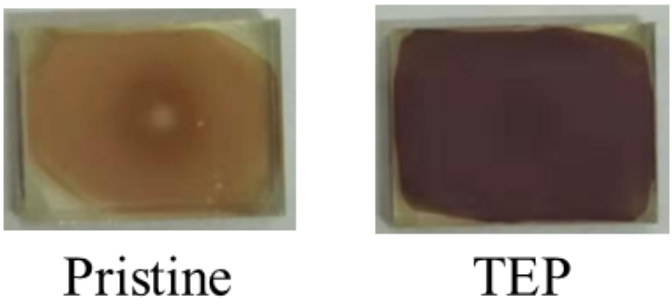

Fig. S3. The optical images of both perovskite films without and with the top perovskite seeds.

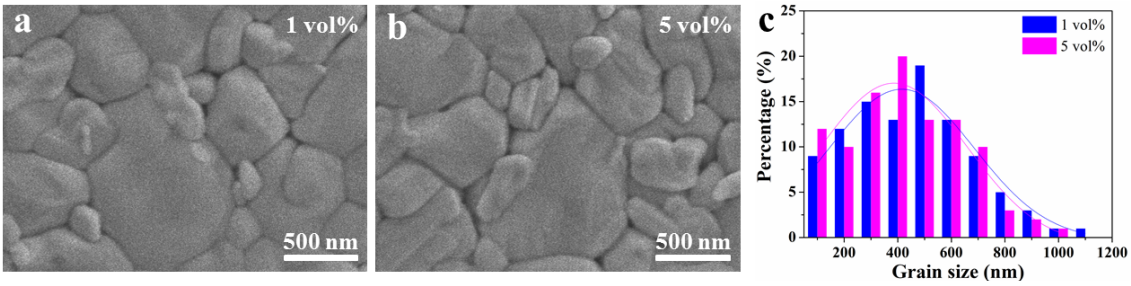

Fig. S4. (a and b) Top-view SEM images of perovskite films doping with different concentration (1 vol% and 5 vol%) of TEP.

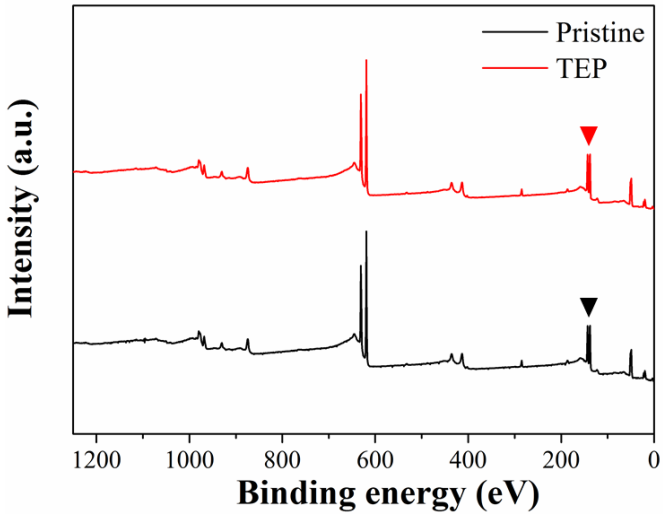

Fig. S5. The XPS spectra of survey the pristine and TEP modified perovskite films. The triangle marks are Pb 4f core level.

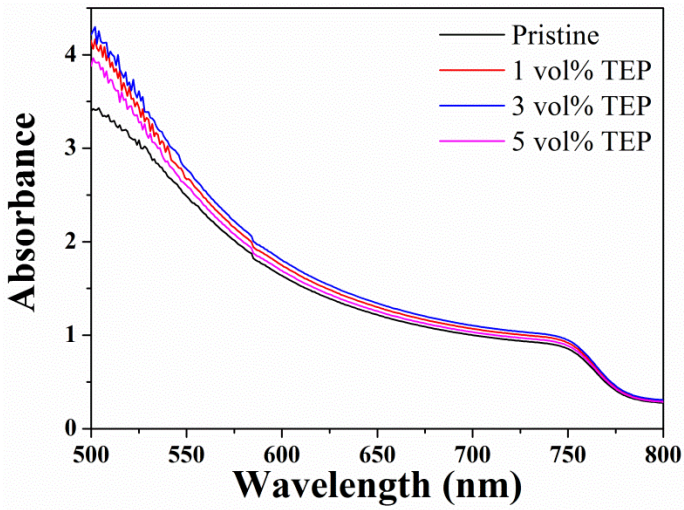

Fig. S6. The UV-Vis absorbance spectra of perovskite films which added different concentration (0 vol%, 1 vol%, 3 vol% and 5 vol%) of TEP.

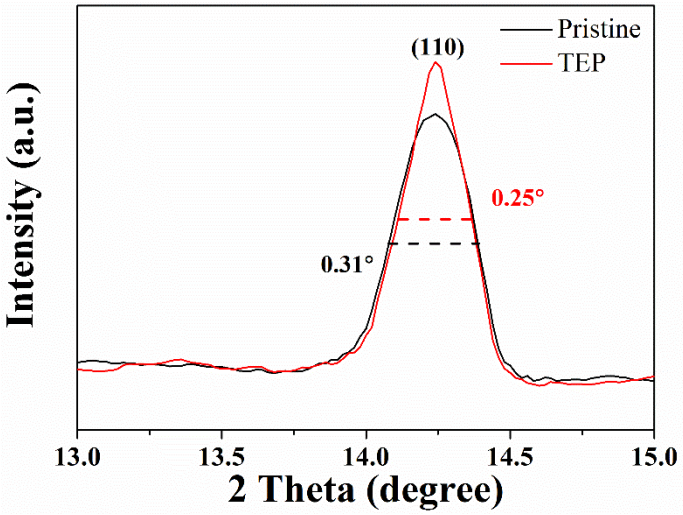

Fig. S7. The higher magnification patterns of XRD analysis around the (110) crystal plane.

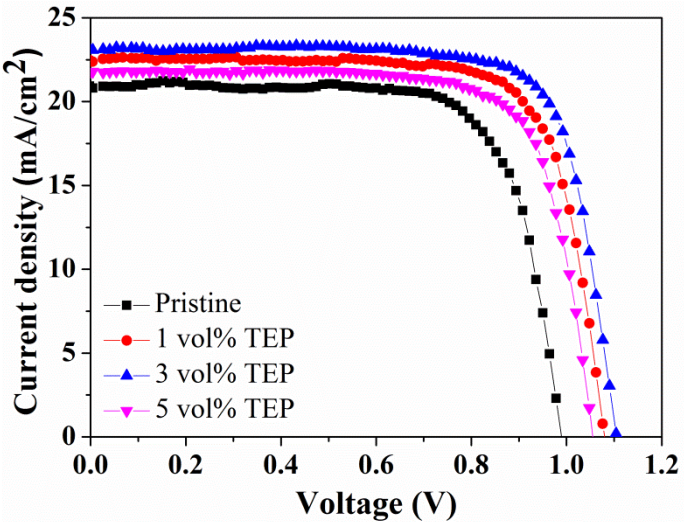

Fig. S8. The J-V curves of PSCs based on different concentration of TEP.

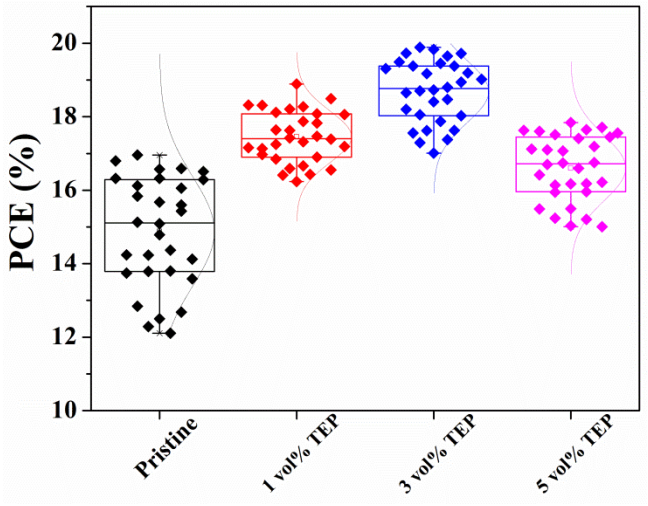

Fig. S9. Thirty individual cells' PCE of all kinds PSCs based on different concentration of

TEP.

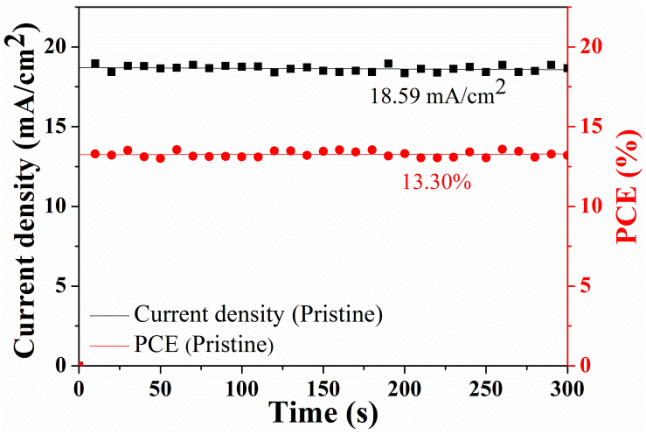

Fig. S10. Maximal steady-state photocurrent and stabilized PCE of pristine PSCs.

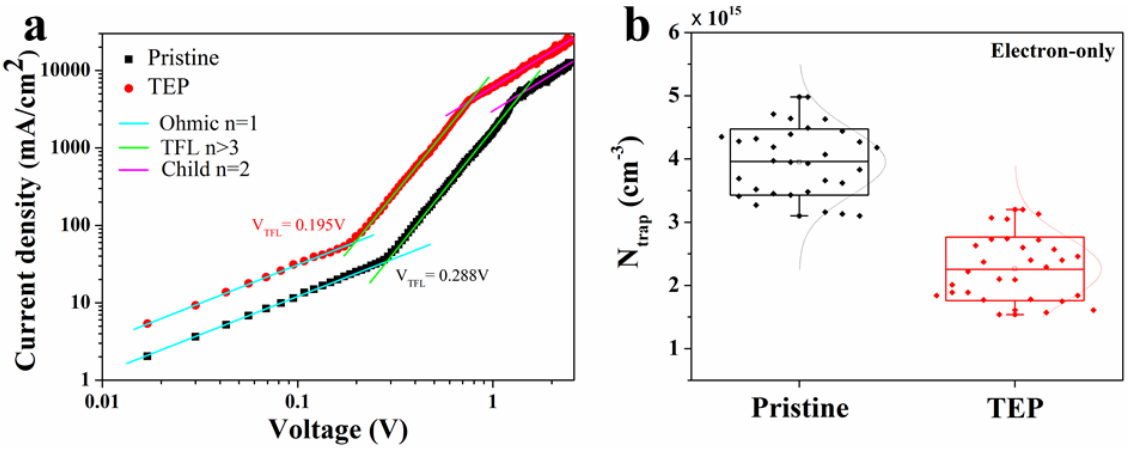

Fig. S11. (a) Dark J-V curves of electron-only PSCs with the structure of FTO/TiO_2/$MAPbI_3$/$PC_{61}BM$/Ag. (b) The statistical collection of data on 30 sets samples of electron-only devices.

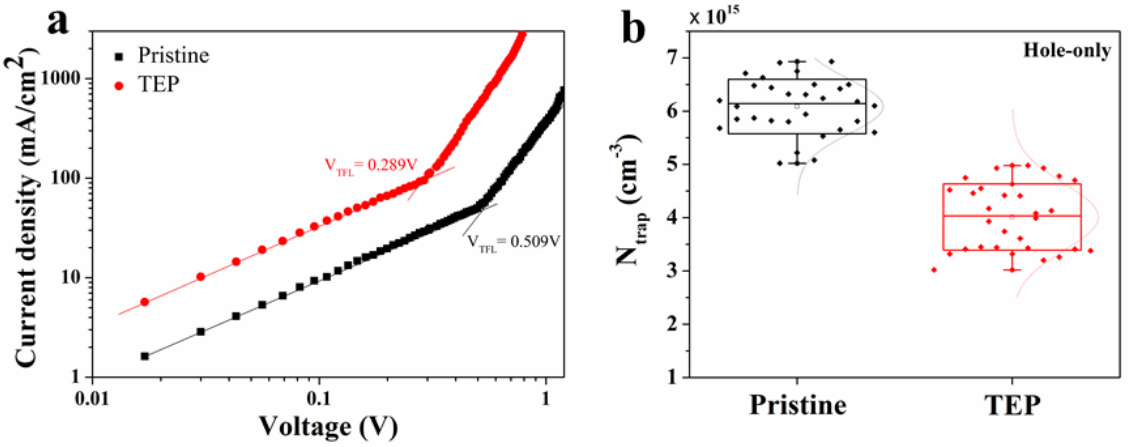

Fig. S12. The Dark J−V curves of (a) hole-only device (The complete structure of hole-only

device is FTO-etched glass/PEDOT:PSS/$MAPbI_3$ (with or without TEP)/Spiro-OMeTAD/Ag) and its statistical collection of 30 sets samples (b).

Table S1. Detailed photovoltaic parameters of PSCs with different concentrations of TEP.

Samples	J_{sc} (mA/cm^2)	V_{oc} (V)	FF (%)	PCE (%)
Pristine	20.81	0.98	74.53	15.20
1 vol% TEP	22.38	1.08	75.96	18.36
3 vol% TEP	23.08	1.10	77.20	19.60
5 vol% TEP	21.79	1.05	75.13	17.19