Electronic Supplementary Material (ESI) for Journal of Materials Chemistry A.

Supporting Information

Liquid Metal Acetate Assisting Preparation of High-efficiency and Stable Inverted Perovskite Solar Cells

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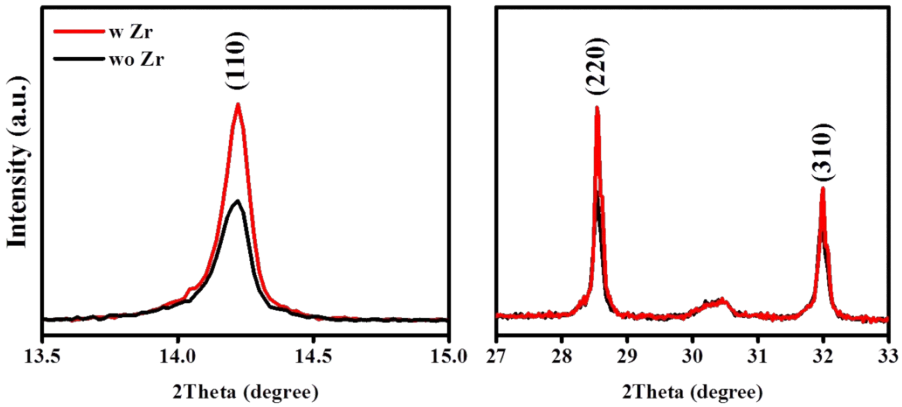

Fig. S1 XRD peaks of $MAPbI_3$ films with (w) and without (wo) $Zr(Ac)_4$ doping.

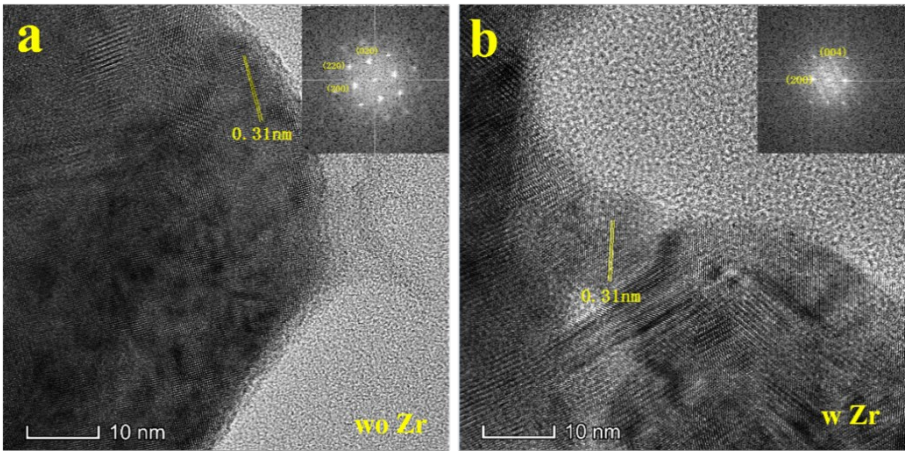

Fig. S2 HR-TEM images of perovksite doping a) without (wo) Zr, b) with (w) Zr. The inserts are the selected area diffraction pattern corresponding to the tetragonal crystal structure.

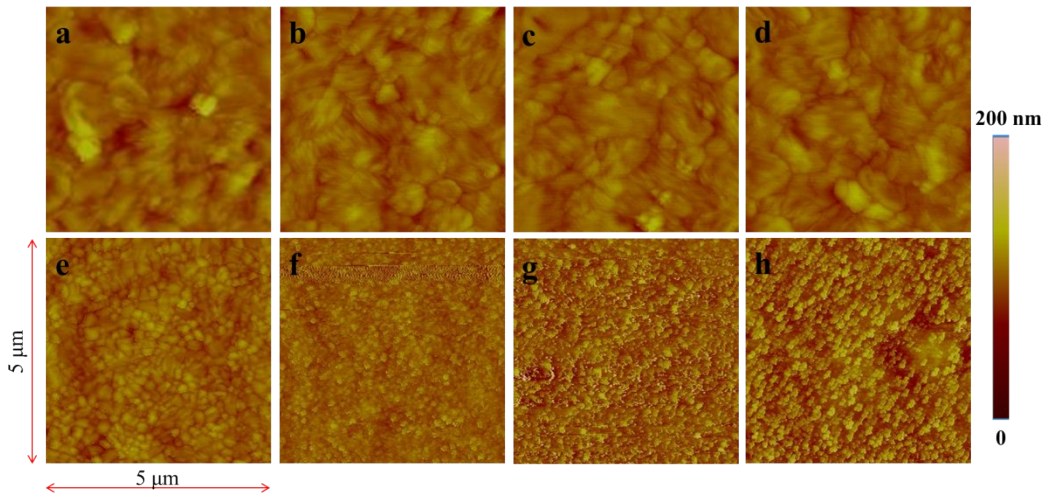

Fig. S3 AFM images of Perovskite films with different concentration of $Zr(Ac)_4$: a) 0 mol%, Ra = 7.50 nm, b) 0.075 mol%, Ra = 7.02 nm, c) 0.15 mol%, Ra = 6.97 nm, d) 0.3 mol%, Ra = 6.69 nm, e) 0.6 mol%, Ra = 7.05 nm, f) 1.2 mol%, Ra = 7.16 nm, g) 2.5 mol%, Ra = 13.00 nm, h) 5 mol%, Ra = 14.60 nm.

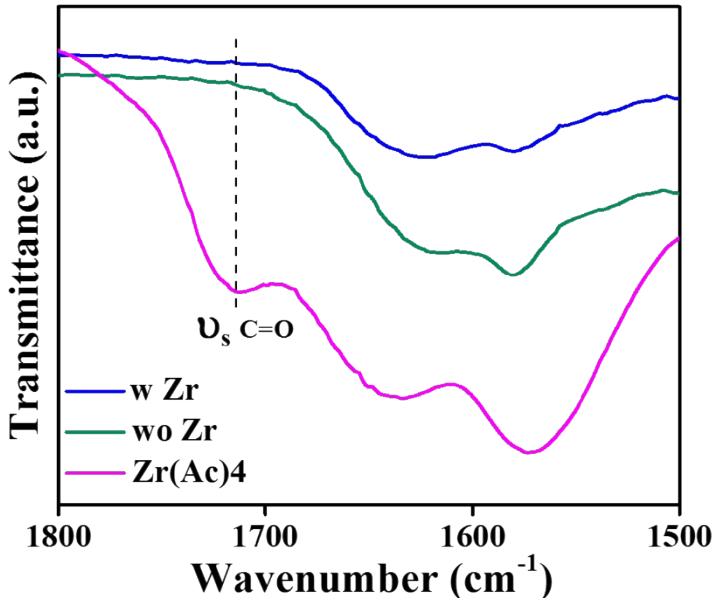

Fig. S4 FTIR curves of perovskites with (w) Zr, without (wo) Zr, and the pristine $Zr(Ac)_4$.

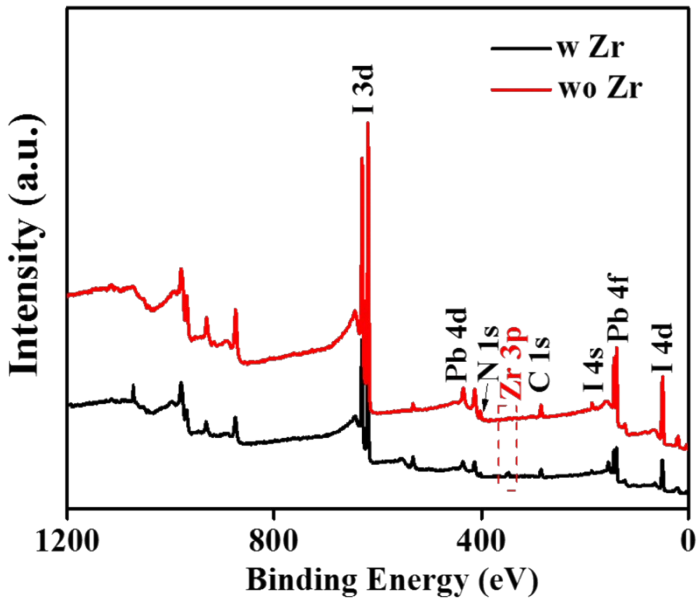

Fig. S5 XPS survey of perovskites with (w) Zr, without (wo) Zr.

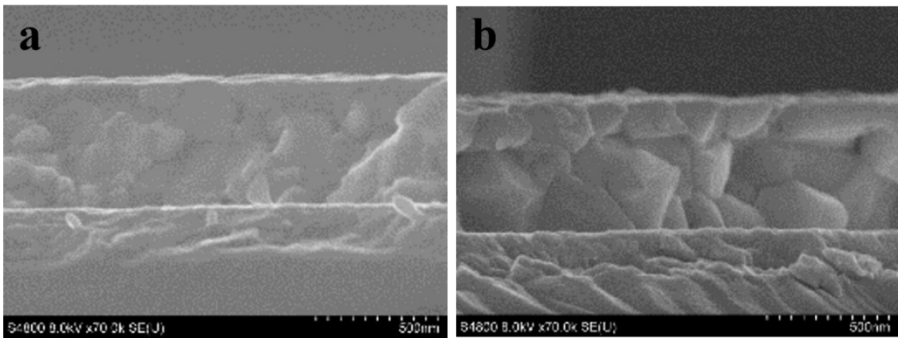

Fig. S6 Cross-sectional SEM images of a) without and b) with $Zr(Ac)_4$.

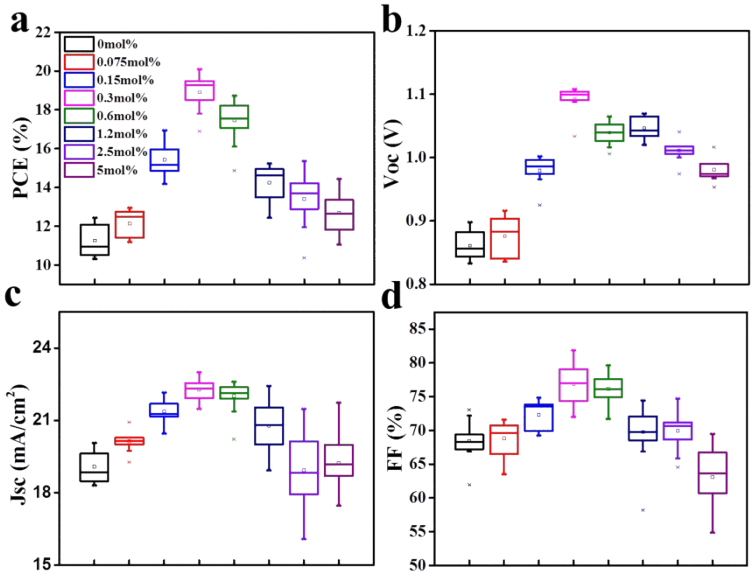

Fig. S7 Parameters distribution box charts of devices with different concentration of dopant $Zr(Ac)_4$.

Table S1. Parameters of perovksite solar cells with different concentration of $Zr(Ac)_4$.

Concentration	V_{oc} (V)	J_{sc} (mA/cm^2)	FF (%)	PCE (%)	Max PCE (%)
0 mol%	0.86±0.02	19.09±0.6	68.4±2.53	11.25±0.81	12.43
0.075 mol%	0.88±0.03	20.14±0.39	68.82±2.49	12.14±0.66	12.94
0.15 mol%	0.98±0.02	21.38±0.43	72.31±2.02	15.43±0.79	16.94
0.3 mol%	1.09±0.02	22.28±0.41	76.87±3.09	18.91±0.85	20.10
0.6 mol%	1.04±0.02	22.02±0.55	76.15±2.07	17.44±0.96	18.73
1.2 mol%	1.05±0.02	20.79±1.02	69.76±3.37	14.25±0.83	15.24
2.5 mol%	1.01±0.02	18.94±1.53	69.96±2.54	13.4±1.24	15.36
5 mol%	0.98±0.02	19.24±1.25	63.1±4.17	12.69±0.97	14.44

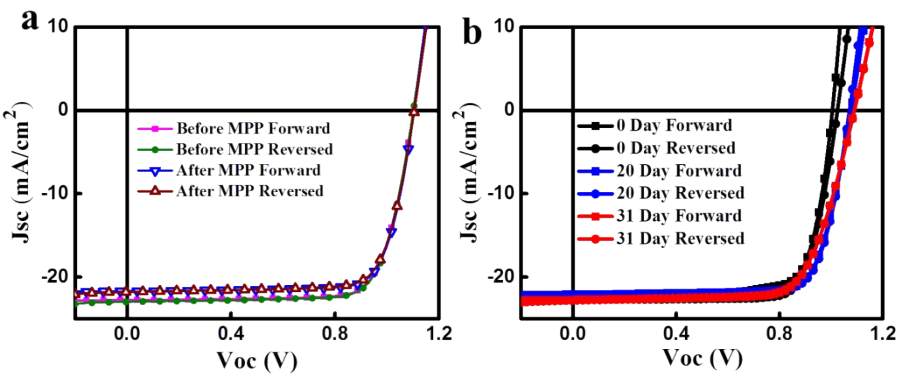

Fig. S8 (a) *J-V* curves of device with $Zr(Ac)_4$ before and after MPP test. (b) Different directions of *J-V* curves of devices with $Zr(Ac)_4$ after thermal heating for 0, 20, 31 days.

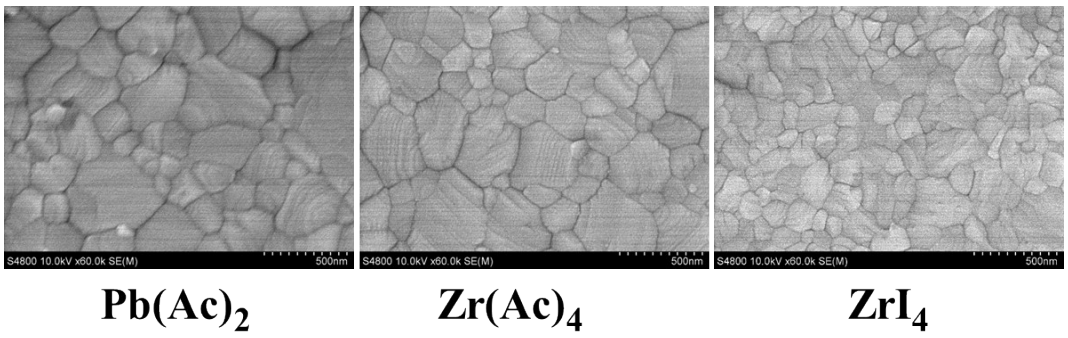

Fig. S9 SEM images of perovskites doped with $Pb(Ac)_2$, $Zr(Ac)_4$, ZrI_4, respectively.

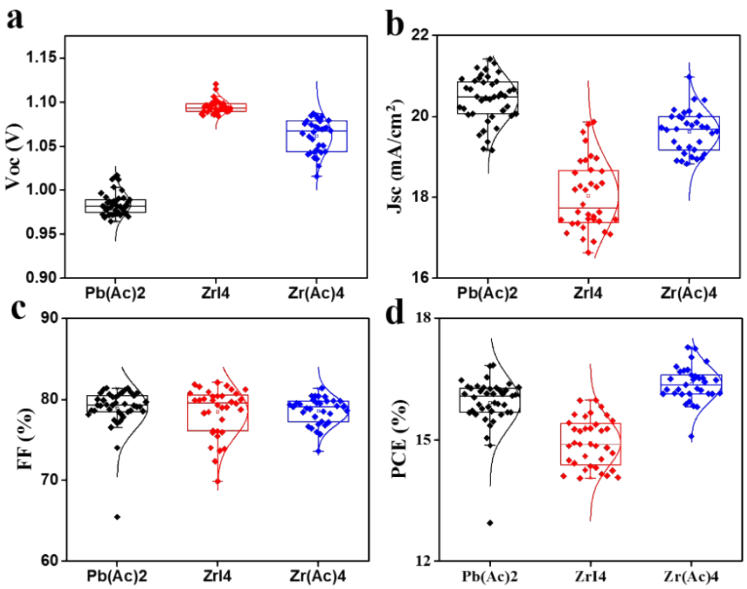

Fig. S10 Parameters of devices doped with $Pb(Ac)_2$, $Zr(Ac)_4$, ZrI_4, respectively.