

Electronic Supplementary Information (ESI)

Cadmium doping for improving the efficiency and stability of carbon-based CsPbIBr₂ all-inorganic perovskite solar cells

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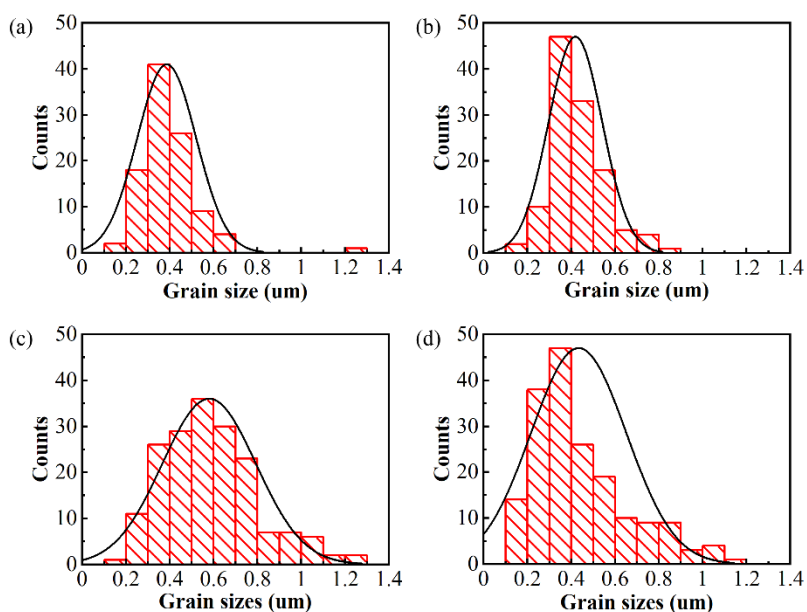


Fig. S1. Statistical chart of grain sizes corresponding to SEM images of the CsPbIBr₂ perovskite film with 0%-Cd, 0.25%-Cd, 0.5%-Cd and 1%-Cd, respectively.

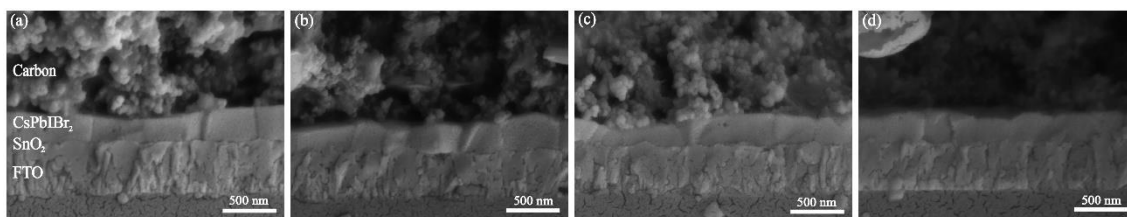


Fig. S2. The cross-sectional SEM images of the CsPbIBr₂ PSCs based on (a) 0%-Cd; (b) 0.25%-Cd; (c) 0.5%-Cd and (d) 1%-Cd.

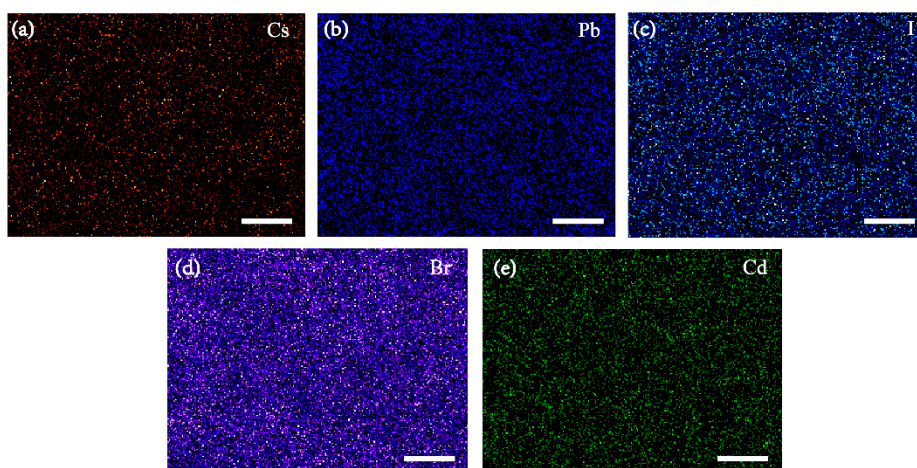


Fig. S3. Energy dispersive X-ray (EDX) mapping images of the CsPbIBr₂ film with 0.5%-Cd. The scale bar is 1 μm.

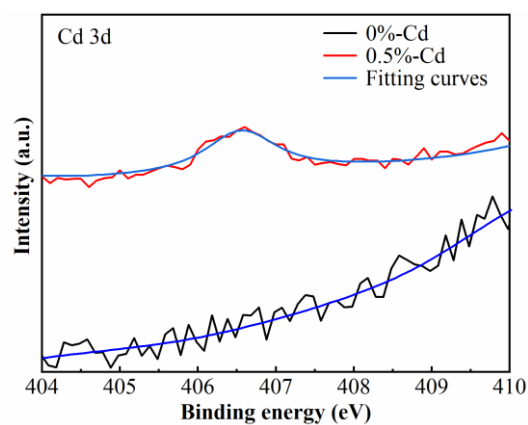


Fig. S4. XPS spectra of the CsPbIBr₂ film (0.5%-Cd) for Cd 3d.

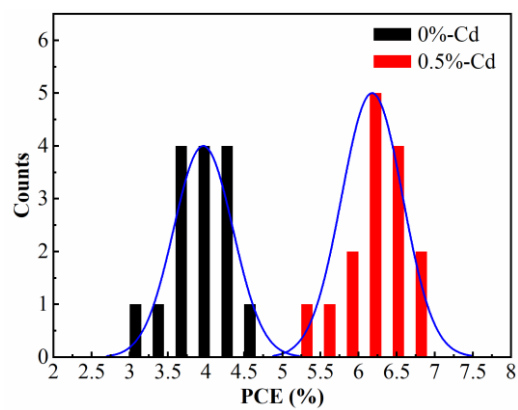


Fig. S5 PCE distribution histograms of CsPbIBr₂ PSCs and CsPbIBr₂ PSCs with 0.5%-Cd (15 devices).

Table S1. TRPL fitting results of the CsPbIBr₂ films with x%-Cd (x=0, 0.25, 0.5, 1).

samples	A ₁	τ ₁ (ns)	A ₂	τ ₂ (ns)	τ _{avg} (ns)
0%-Cd	0.96669	0.60398	0.11544	3.01125	1.50
0.25%-Cd	1.05582	0.59783	0.00983	12.66085	2.58
0.5%-Cd	1.00580	0.5382	0.05315	11.33478	6.22
1%-Cd	1.07784	0.64465	0.01074	8.58474	1.57

Table S2. Band energies of CsPbIBr₂ films with x%-Cd determined by the UV-visible absorption spectra and UPS analysis.

Samples	E _{cutoff} (eV)	E _{onset} (eV)	VB maximum (eV)	Band gap (eV)	CB minimum (eV)
0%-Cd	16.90	1.75	-6.07	2.05	-4.02
0.25%-Cd	16.91	1.62	-5.93	2.05	-3.88
0.5%-Cd	16.95	1.47	-5.74	2.05	-3.69
1%-Cd	16.92	1.67	-5.96	2.05	-3.91

Table S3. Summary of the photovoltaic performance parameters for CsPbIBr₂-based PSCs via different provskite preparation techniques.

Cell configuration ^{a)}	Perovskite fabrication method	V _{oc} [V]	J _{sc} [mA/cm ²]	FF	PCE [%]	Ref
FTO/SnO ₂ /CsPbIBr ₂ /Carbon	Cd ²⁺ doping	1.19	9.76	0.56	6.79	This work
FTO/c-TiO ₂ /CsPbIBr ₂ /Au	Dual-source evaporation	0.959	8.70	0.56	4.70	32
FTO/c-TiO ₂ /CsPbIBr ₂ /Carbon	Precursor aging	1.142	9.11	0.63	6.55	21
FTO/SnO ₂ /CsPbIBr ₂ /Carbon	Mn ²⁺ doping	0.99	13.15	0.57	7.36	30
FTO/TiO ₂ /CsPbIBr ₂ /Carbon	Zn ²⁺ doping	1.26	10.87	0.66	9.04	S1
FTO/c-TiO ₂ /CsPbIBr ₂ /Carbon	Light processing	1.283	11.17	0.60	8.60	S2
FTO/c-TiO ₂ /CsPbIBr ₂ /Carbon	Intermolecular exchange	1.245	10.66	0.69	9.16	20
FTO/c-TiO ₂ /CsPbIBr ₂ /CuPc/Carbon	Li ⁺ doping	1.213	10.27	0.74	9.25	28
ITO/ZnO/CsPbIBr ₂ /Spiro-OMeTAD/Ag	One-step spin coating	1.04	8.78	0.525	4.8	S3
FTO/NiO _x /CsPbIBr ₂ /MoO _x /Au	One-step spin coating	0.85	10.56	0.62	5.52	18
ITO/In ₂ S ₃ /CsPbIBr ₂ /Spiro-OMeTAD/Au	Two-step annealing	1.090	7.76	0.66	5.59	23
FTO/TiO ₂ /CsPbIBr ₂ /Spiro-OMeTAD/Ag	Cu ²⁺ doping	1.20	11.90	0.649	9.32	45
FTO/TiO ₂ /CsPbIBr ₂ /PCBM/Au	Ba ²⁺ doping	1.19	11.91	0.74	10.51	31
FTO/SnO ₂ /C ₆₀ /CsPb _{0.75} Sn _{0.25} IBr ₂ /Spiro-OMeTAD/Au	Sn ²⁺ doping	1.21	12.57	0.758	11.53	29

a) spiro-OMeTAD = 2,2',7,7'-tetrakis-(N,N-di-4-methoxyphenylamino)-9,9'-spirobifluorene.

References:

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