

Supplemental information

Table S1 Photovoltaic parameters of the carbon-based PSCs with different Br content.

Device	V_{oc} (mV)	J_{sc} (mA cm^{-2})	FF (%)	PCE (%)
5%Br	942	20.69	0.552	10.75
10%Br	958	20.29	0.593	11.53
15%Br	937	19.85	0.523	9.73

Table S2 Photovoltaic parameters of the carbon-based PSCs with different Cs content.

Device	V_{oc} (mV)	J_{sc} (mA cm^{-2})	FF (%)	PCE (%)
5%Cs	954	20.12	0.576	11.05
10%Cs	970	20.91	0.578	11.72
15%Cs	978	21.48	0.53	11.14

Table S3 The detailed fitting parameters of the FAPbI₃-based perovskite.

Lifetime	pure	10%Br	10%Cs	10%Br-Cs
τ 1(ns)	31.67	42.74	46.79	17.87
τ 2(ns)	212.12	322.44	402.82	524.58

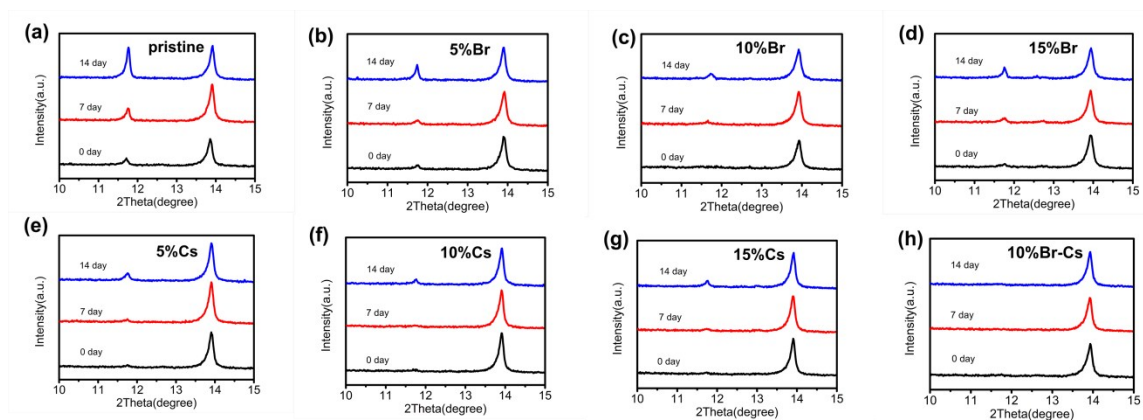


Fig. S1 The XRD patterns of the PSCs stored after 14 days.

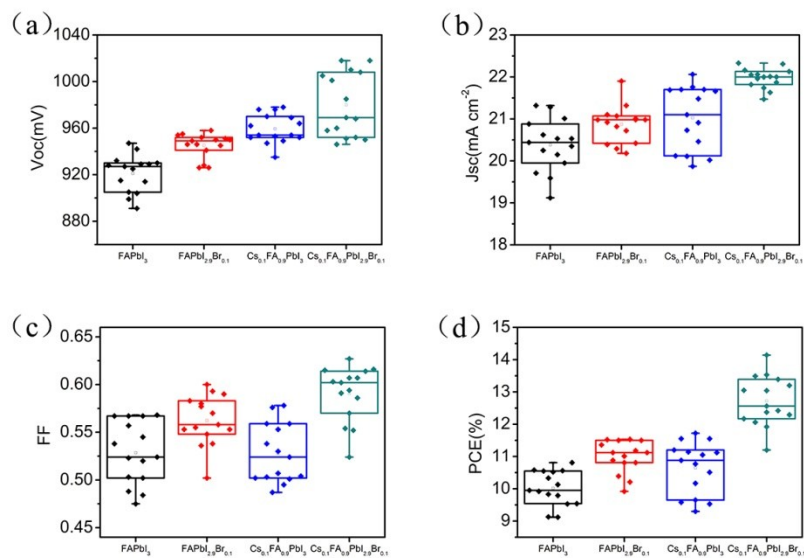


Figure S2 The statistic J-V parameters of the FAPbI₃-based PSCs.

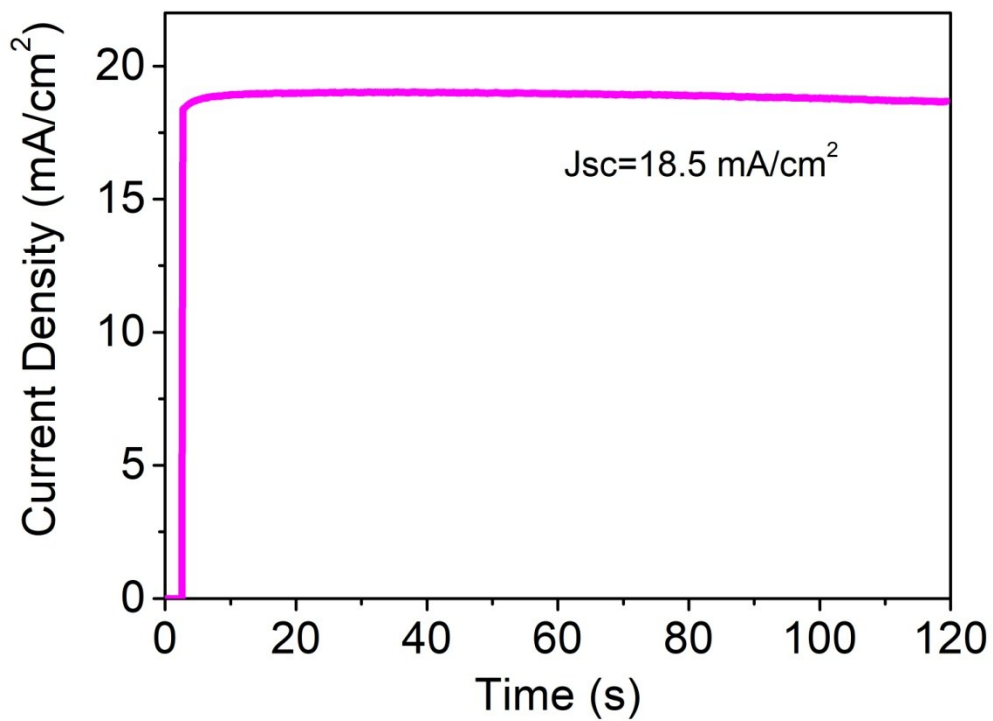


Fig. S3 The steady current output of the champion cell at V_{max} of 0.75 V.

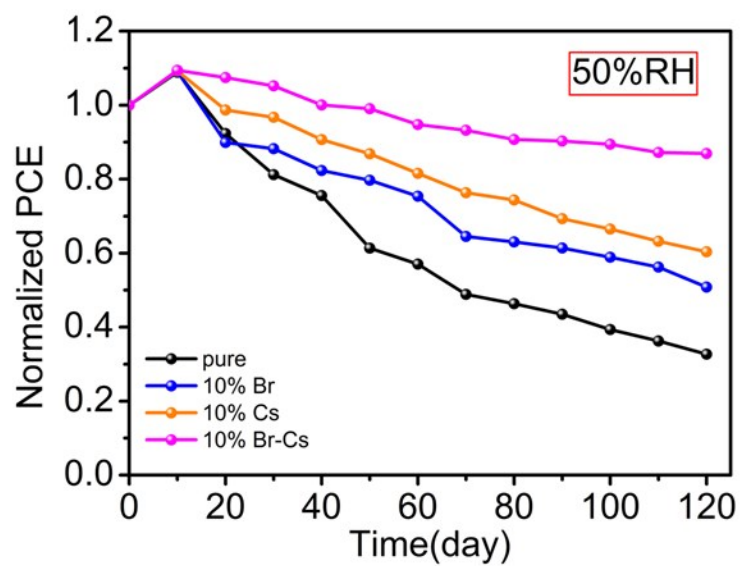


Fig. S4 Long-term stability of the FAPbI₃-based PSCs devices under RH 50% condition.