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Thermally stable, barium stabilized α-$CsPbI_3$ perovskite for optoelectronic devices

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Table S1. Lifetime measurement results of the perovskite thin films.

Condition	τ_1 (ns)	f_1 (%)	τ_2 (ns)	f_2 (%)	τ_{avg} (ns)	χ^2
CSA-1	3.066	79.46	5.905	20.54	**3.649**	1.02
CSA-2	5.973	56.28	14.942	43.72	**9.894**	1.09
CSA-3	2.473	27.01	4.809	72.99	**4.178**	1.01

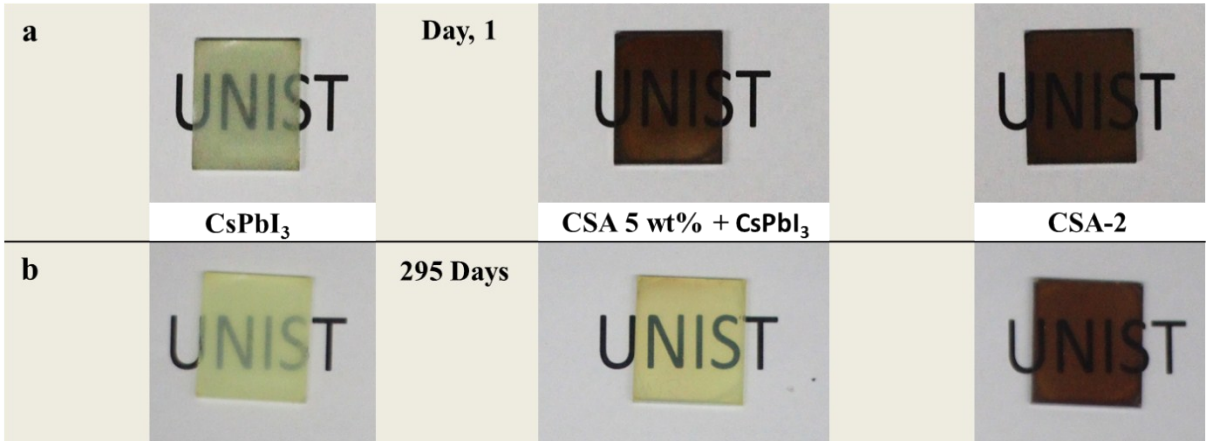

Fig. S1. The photographs of inorganic perovskite processed at low temperature with a composition of pristine $CsPbI_3$, (CSA 5 wt% +$CsPbI_3$), and (CSA 5 wt% + $CsPb_{1-x}Ba_xI_3$). a) Day-1 photograph of the thin films stored inside the nitrogen glove box. b) Day-295 photograph of the thin films stored.

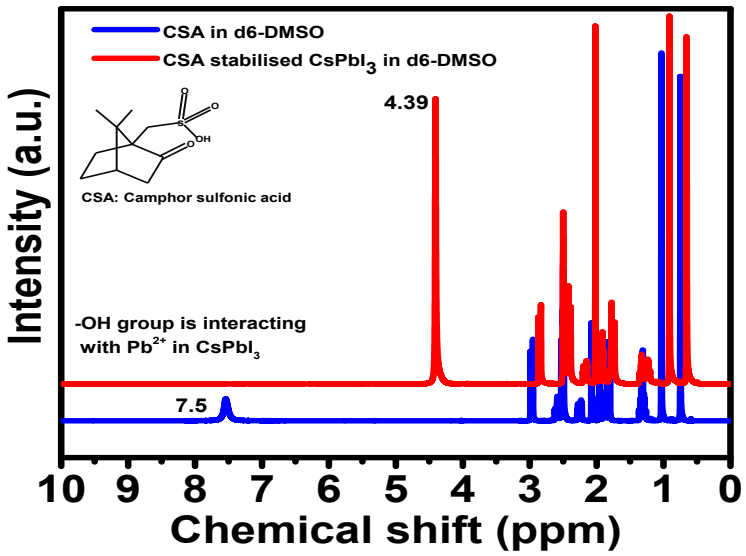

Fig. S2. The NMR data representing the interaction of CSA with $CsPbI_3$, the characterization was done by dissolving the precursor solution in d-6 DMSO solution.

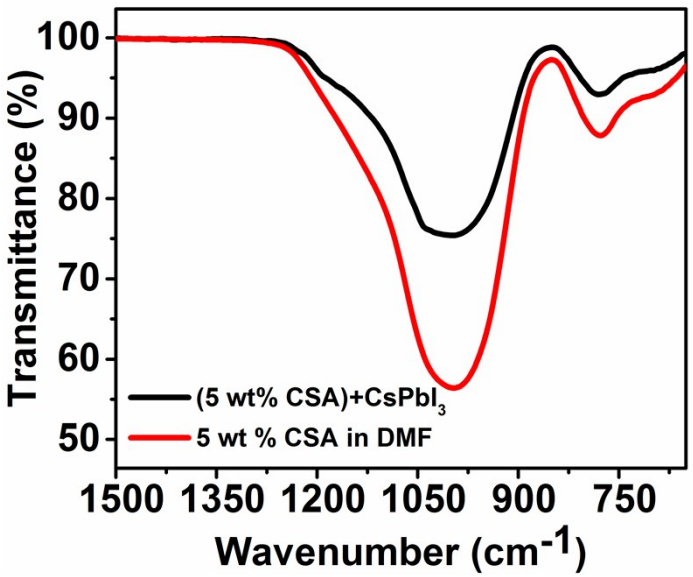

Fig. S3. FTIR measurement of 5 wt % CSA and CSA-2 thin films.

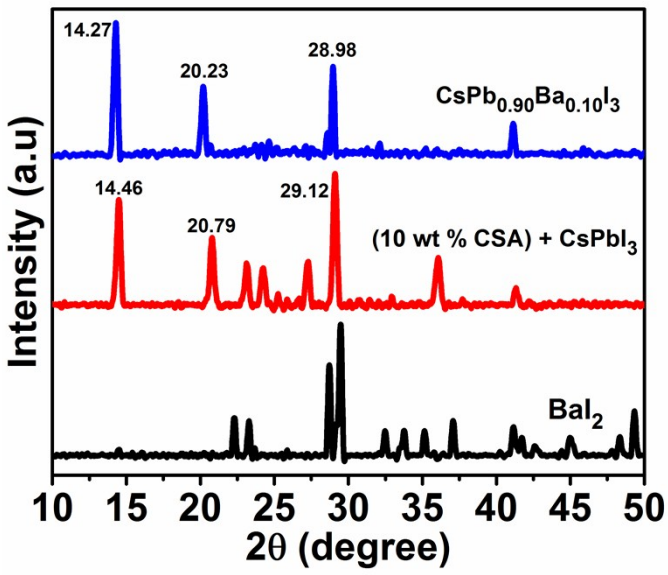

Fig. S4. XRD pattern of the BaI_2, CSA stabilized $CsPbI_3$, and Ba doped $CsPbI_3$ thin films.

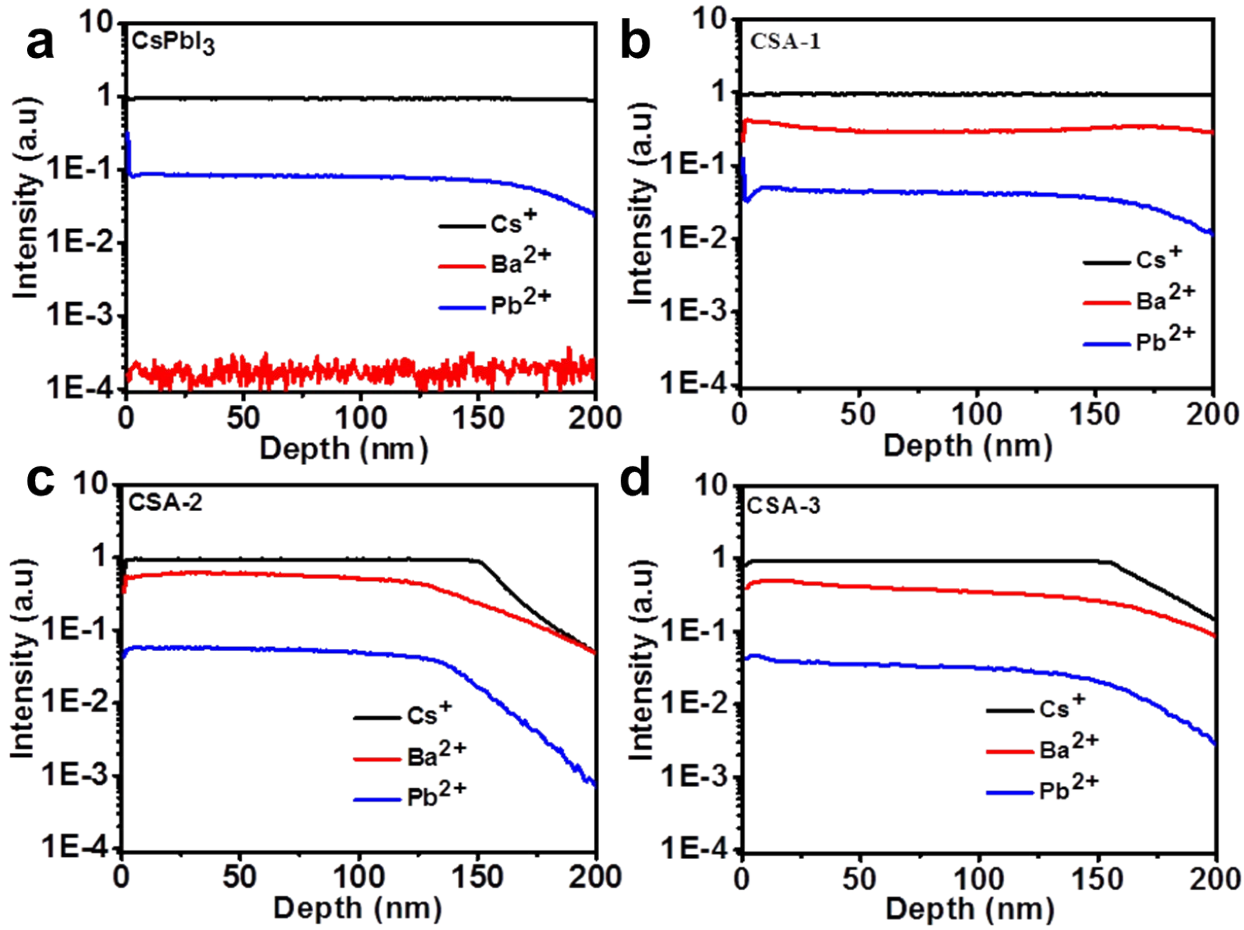

Fig. S5. a) Depth profile of a $CsPbI_3$ perovskite films processed at room temperature, the Cs, Pb, and Ba curves represents the chemical composition and their uniformity inside the film. b) The variation in intensity of Cs, Pb, and Ba depth profiles, which indicates the uniformity of CSA-1 components in scheme. c) Depth profiling of CSA-2. d) Depth profiling of CSA-2. Film thickness: (~200±50 nm).

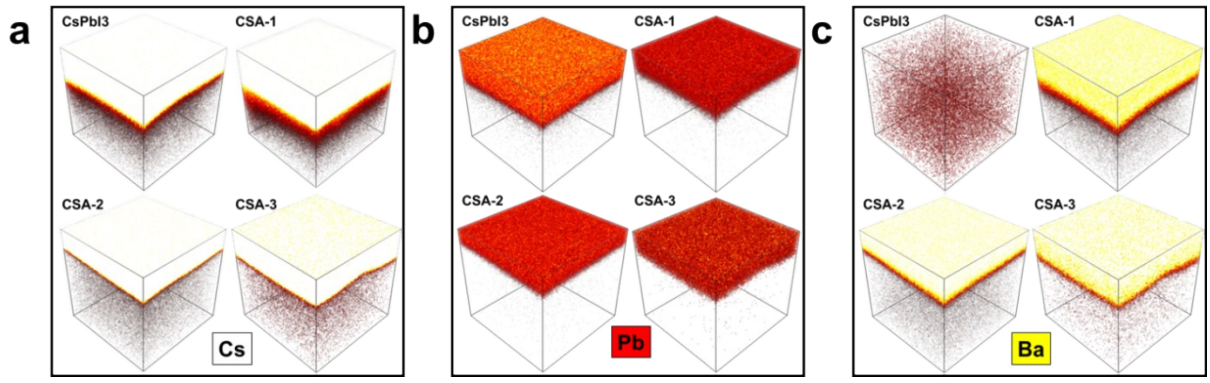

Fig. S6. TOF-SIMS 3D tomography results for inorganic perovskite processed at low temperature. 3D image of four films with $CsPbI_3$, CSA-1, CSA-2, and CSA-3 schemes showing a) Cs (white color) element depth profiling with film thickness (~200±50 nm), b) Pb in red color, and c) Ba in color yellow. 3D reconstruction dimension is 50 × 50 × 0.5 μm^3.

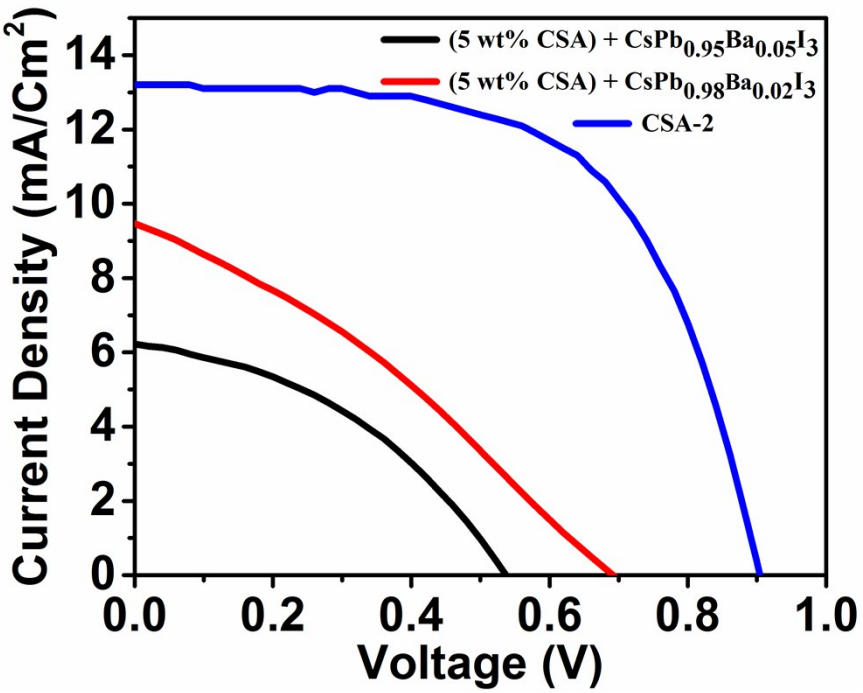

Fig. S7. PCE performance of the $CsPbI_3$ perovskite device with different doping concentration of Ba having 5 wt% CSA as additive.

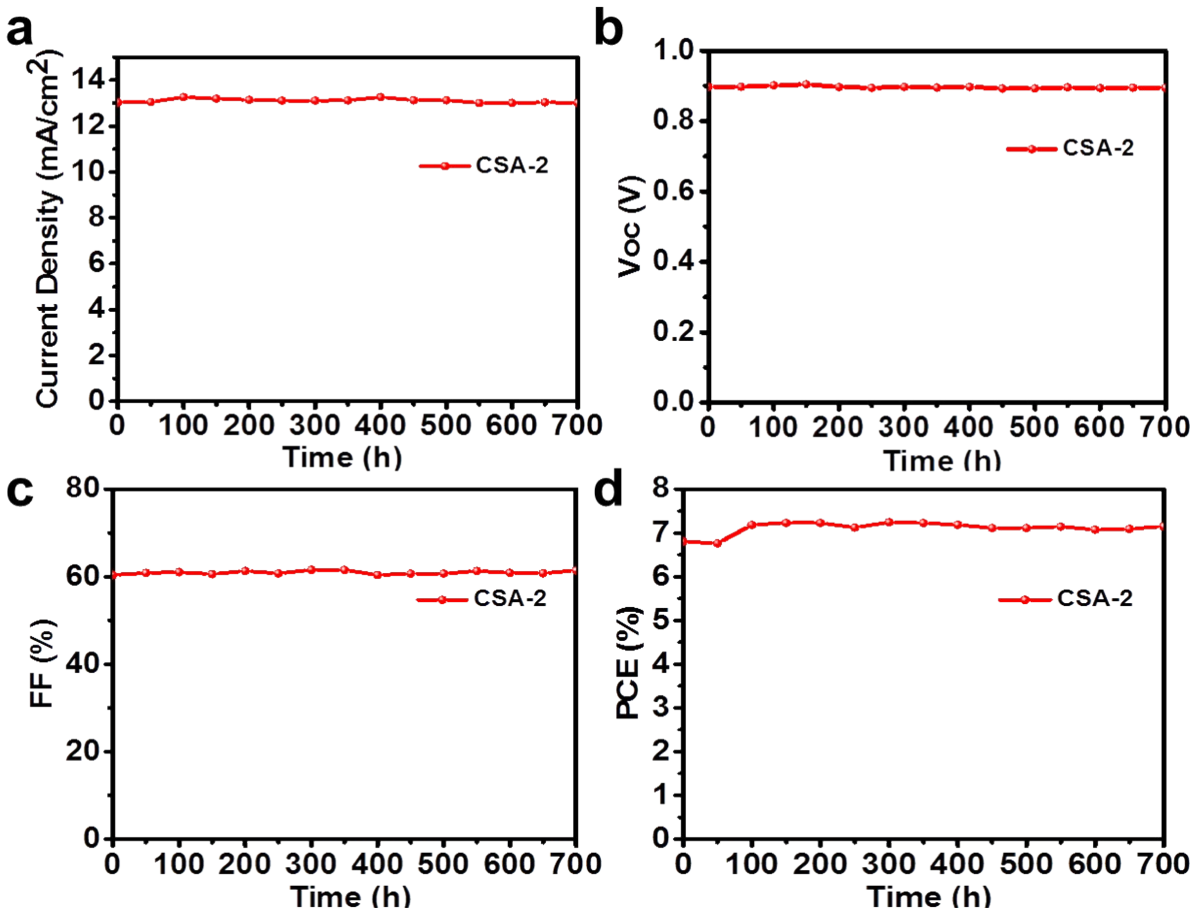

Fig. S8. Photostability and moisture stability investigation of the best performing perovskite solar cells device (CSA-2) without any encapsulation under nitrogen atmosphere. a) Short Circuit Current Density (Jsc) recorded at AM 1.5 G condition. b) Open Circuit Voltage (Voc). c) Fill factor (FF). d) Power conversion efficiency. Slight increase, in particular, in PCE was observed after aging for 100 h.

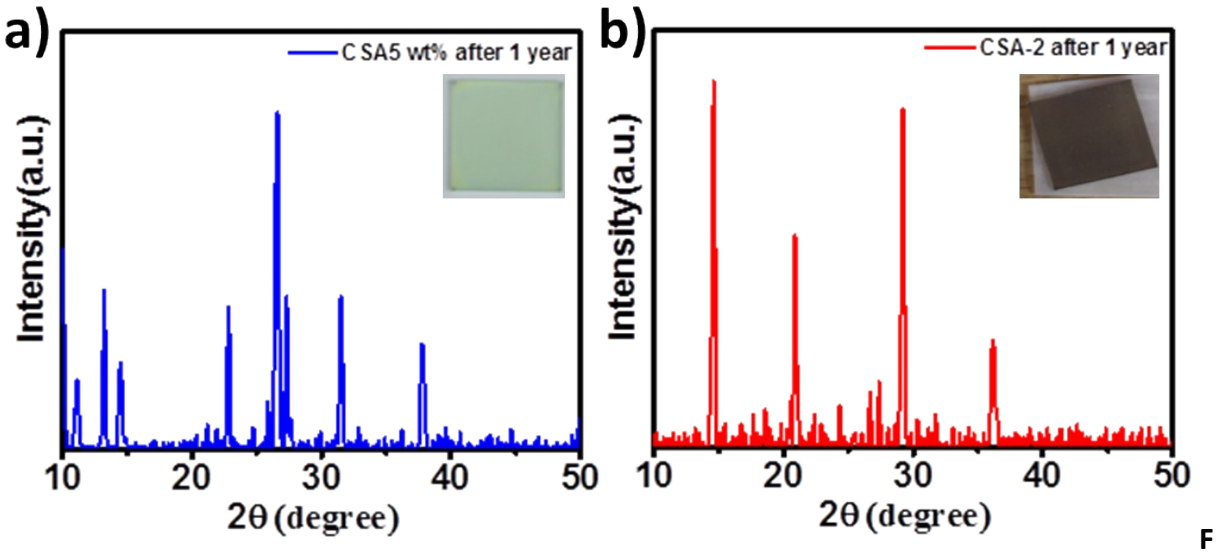

Fig. S9 X-ray diffraction (XRD) patterns. a) CSA 5wt % additive with $CsPbI_3$ and b) CSA-2 samples, after 1 year of storage under ambient conditions (Inset: photographs of the thin films).