Supporting Information

Stabilizing black-phase $CsPbI_3$ under over 70% humidity

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Experimental

Materials

Unless stated otherwise, all materials and solvents were purchased from Sigma-Aldrich. Lead iodide (PbI_2, 99.999%) and Cesium iodide (CsI) purchased from Xi'an Polymer Light Technology Corp. 4-N, N-dimethylamino-4′-N′-methyl-stilbazolium tosylate (DAST) was purchased from Sekisui Medical Co. Ltd. All chemicals were used as received without further purification.

Perovskite ink preparation and film fabrication

Firstly, an equal molar ratio of CsI and PbI_2 was dissolved in a DMSO/DMF mixed solvent (1:4 in volume ratio). Then, it was quickly injected into the methanol antisolvent under vigorous stirring, which enabled the precipitation of $CsPbI_3$ crystals immediately. Due to the poor solubility of $CsPbI_3$ in methanol, the $CsPbI_3$ crystals precipitated immediately. After centrifuging, the $CsPbI_3$ powders were dried at 90 ^oC for 4 hours and then redissolved in the above-mentioned DMF/DMSO mixed solvent for preparing $CsPbI_3$ perovskite ink. For the DAST-modified sample, 0.24 mM DAST was incorporated into the above-mentioned perovskite ink. The $CsPbI_3$ perovskite films were fabricated by spin-coating the 70 ^oC pre-heated perovskite ink onto the 70 ^oC pre-heated substrate at a spin rate of 4000 rpm for 50 s in ambient air, and no antisolvent and subsequent annealing process were required.

Characterization

The UV-vis absorption spectra of the $CsPbI_3$ films were obtained from the UV-3600 spectrophotometer (Shimadzu). The morphologies and surface coverage of the samples were characterized using a field emission scanning electron microscope (SEM, Hitachi-SU8010). The XRD patterns of the samples were measured on an X-ray diffractometer (Bruker D8 ADVANCE). Fourier-transform-infrared (FTIR) characterization was conducted by using an infrared spectrometer (Frontier, 16A01828).

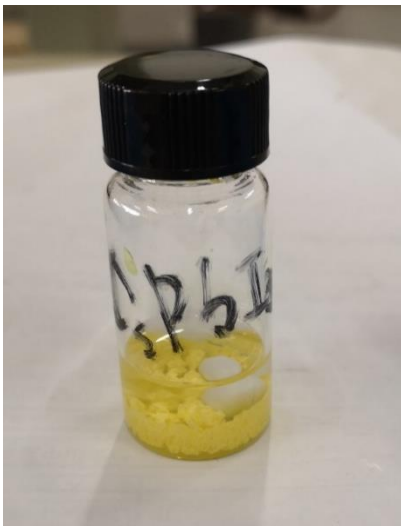

Figure S1. The photo of the $CsPbI_3$ crystals obtained via antisolvent-assisted precipitation strategy.

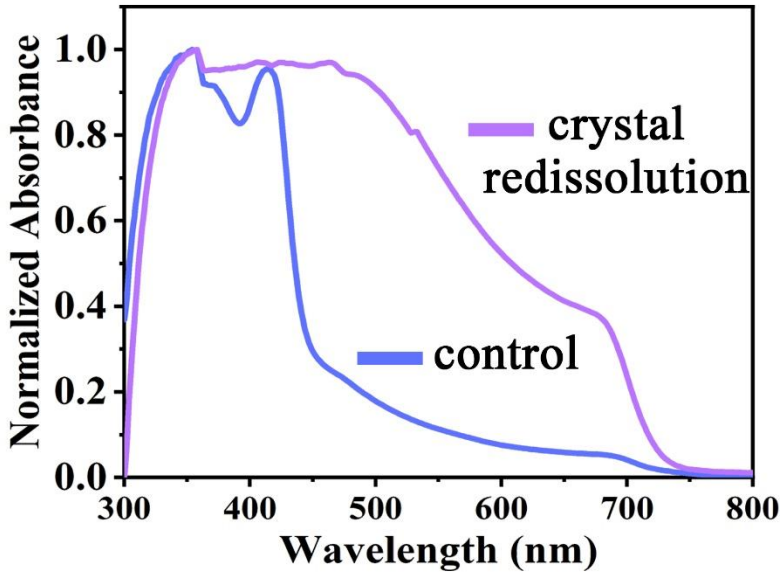

Figure S2. The absorbance spectra of the resultant $CsPbI_3$ films and as indicated.

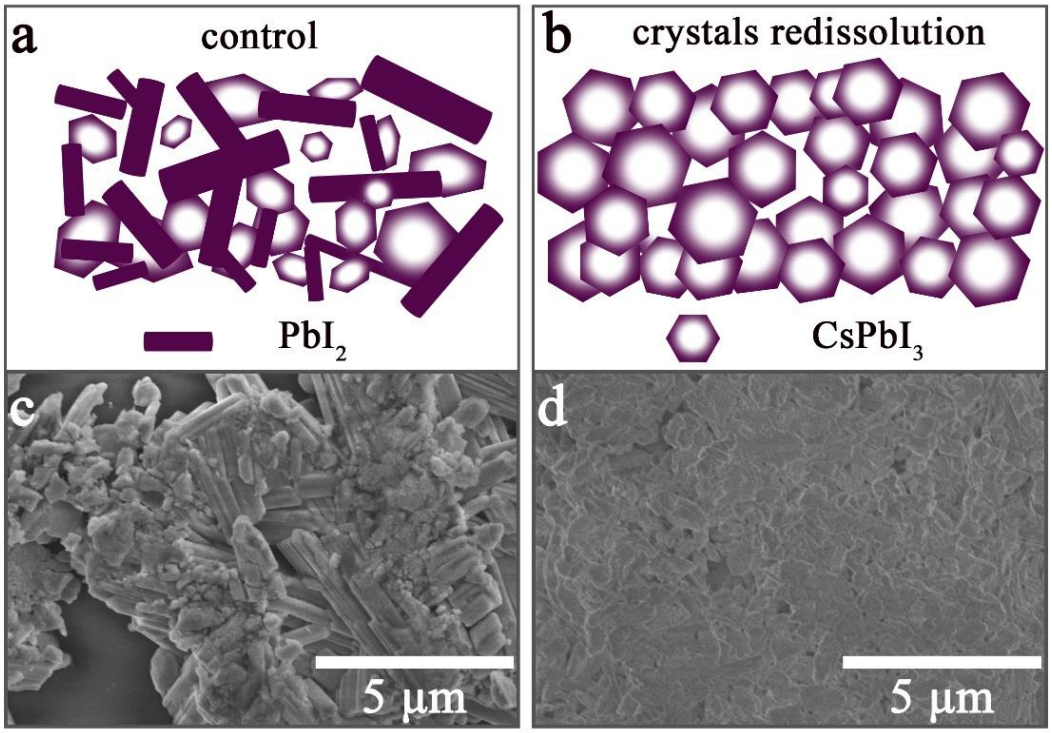

Figure S3. Sketch and SEM images of (a, c) control $CsPbI_3$ film and (b, d) crystal redissolution-derived $CsPbI_3$ film.

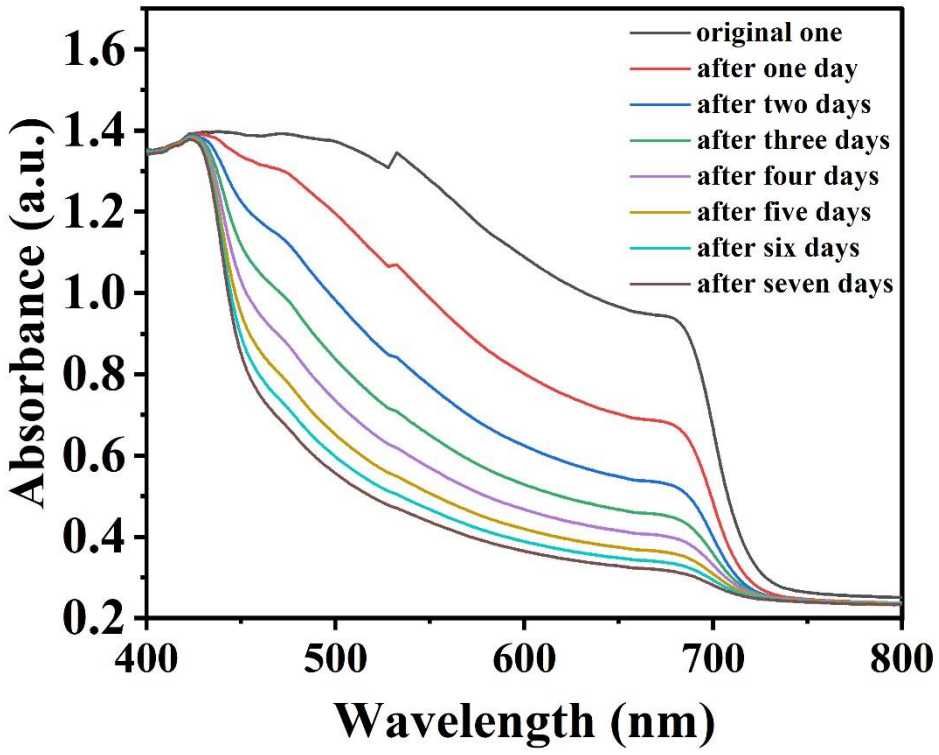

Figure S4. The absorbance spectra of the crystal redissolution-derived $CsPbI_3$ film, which has been stored in air for one week.

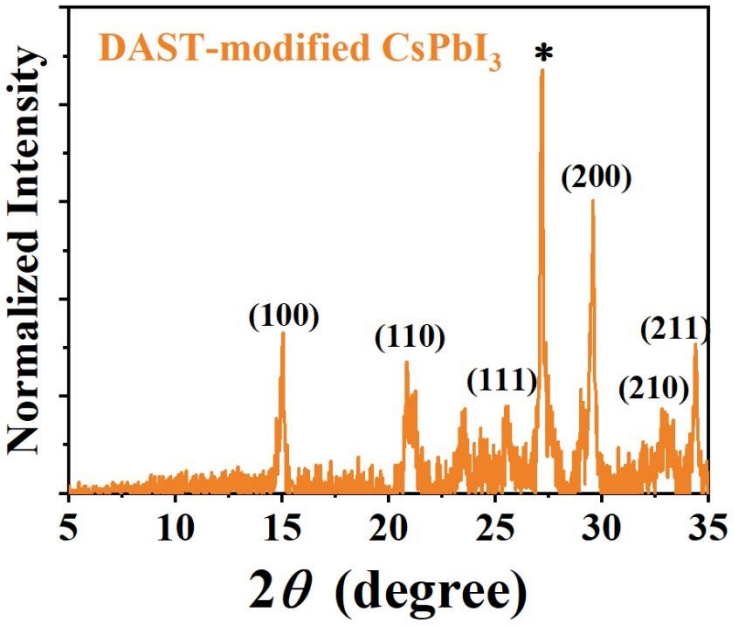

Figure S5. The XRD pattern of the DAST-modified $CsPbI_3$.

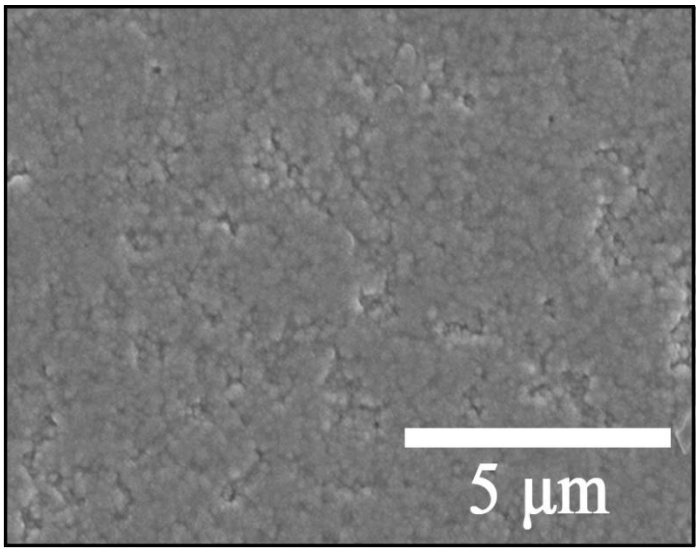

Figure S6. SEM image of the DAST-modified $CsPbI_3$ film.

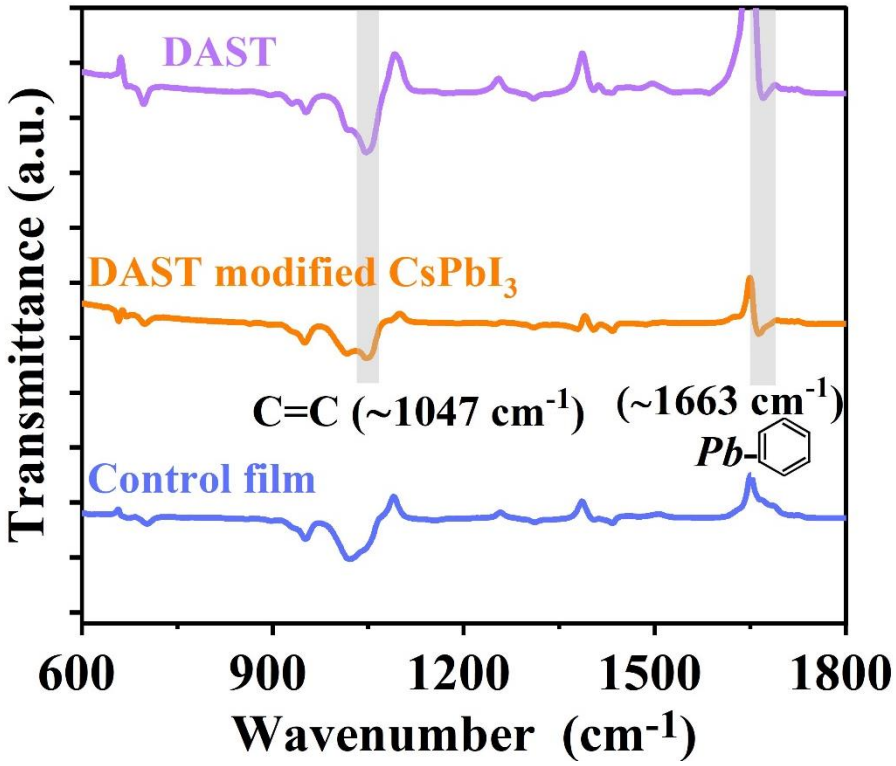

Figure S7. FTIR spectra of DAST powder, DAST-modified $CsPbI_3$ film and pristine $CsPbI_3$ film.