Supporting Information

In-situ gas/solid reaction formation of luminescent quantum confined CH₃NH₃PbBr₃ perovskite planar film

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Experimental:

Materials. MABr was synthesized according to reported method.¹ PbBr₂, DMF and methylamine ethanol solution (33% wt.) were purchased from Sigma-Aldrich Co. LLC and used as received.

Perovskites film deposition. A solution of 288.8 mg PbBr₂ (0.8 mM) in 1 mL DMF was firstly spin coated onto the cleaned FTO substrate at 4000 rpm for 20 sec then dried on a 80° hotplate for 2 minutes. After the substrate cooled down to room temperature, it was placed upside-down over a beaker (100 ml) contain 10 ml methylamine ethanol solution for 3 s and the colourless film then turned to light yellow rapidly followed by annealing at 80° for 1 minute to remove the residual gas. All the process was done in ambient condition with 60% humidity.

Characterization. The crystal structures of the films were measured on Shimadzu XRD-6100 diffractometer with Cu K_{α} radiation. The morphologies of the precursor and perovskite films were characterized by a FEI sirion 200 scanning electron microscope (SEM). The absorption spectra of the perovskite films were taken on a Cary-60 UV-vis spectrophotometer. AFM images were observed by a Bruker fastscan scanning probe microscope; Steady fluorescence spectra and PLQY were acquired on a PTI QM/TM/IM spectrofluorometer. X-ray photoelectron spectroscopy (XPS) spectra were acquired with a Kratos Axis UltraDLD spectrometer (Kratos Analytical-A Shimadzu group company) using a monochromatic A1 K source

(1486.6 eV).



Figure S1. XRD patterns of perovskite films formed by $MAPbBr_3 + MA(g)$ and $PbBr_2 + MA(g)$ film.



Figure S2. UV-vis (a) and XRD patterns (b) of $PbBr_2$ and $PbBr_2 + MA(g)$ films, the diamond is indexed to the XRD peak of FTO substrate.



Figure S3. XPS analysis of MAPbBr₃+MA (g) and PbBr₂+MA (g) film.



Figure S4. AFM images of PbBr₂+ MA(g) perovskite films. The scalebar is 100 nm



Figure S5. Photos of $PbBr_2 DMF$ solution (left) and $PbBr_2 DMF$ solution exposed at MA atmosphere (right) (a); XRD patterns of perovskite films from $PbBr_2$ film (noted as $PbBr_2$ (S)) and $PbBr_2$ solution (noted as $PbBr_2$ (L)), the diamond is indexed to the XRD peak of FTO substrate. (b), the insert image is photo of "PbBr₂ (L)" based film under UV irradiation.

Reference.

1. Y. Zhao and K. Zhu, J. Am. Chem. Soc., 2014, **136**, 12241-12244.