Supporting Information

In-situ gas/solid reaction formation of luminescent quantum confined CH$_3$NH$_3$PbBr$_3$ perovskite planar film

Taiyang Zhang, a Ge Li, a Feng Xu, a Yipeng Wang, a Nanjie Guo, a Xufang Qian, a and Yixin Zhao, a*

a School of Environmental Science and Engineering, Shanghai Jiao Tong University, 800 Dongchuan Road, Shanghai 200240 (China)

Experimental:

Materials. MABr was synthesized according to reported method.\textsuperscript{1} PbBr$_2$, 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 PbBr$_2$ (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\textsubscript{$\alpha$} 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 Al 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 MAPbBr$_3$+MA (g) and PbBr$_2$+MA (g) film.

Figure S4. AFM images of PbBr$_2$+ MA(g) perovskite films. The scalebar is 100 nm.
Figure S5. Photos of PbBr₂ DMF solution (left) and PbBr₂ DMF solution exposed at MA atmosphere (right) (a); XRD patterns of perovskite films from PbBr₂ film (noted as PbBr₂ (S)) and PbBr₂ solution (noted as PbBr₂ (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.