Supporting Information

Impact of Cesium in Methylammonium Lead Bromide Perovskites: Insights from the Microstructures, Stability and Photophysical Properties

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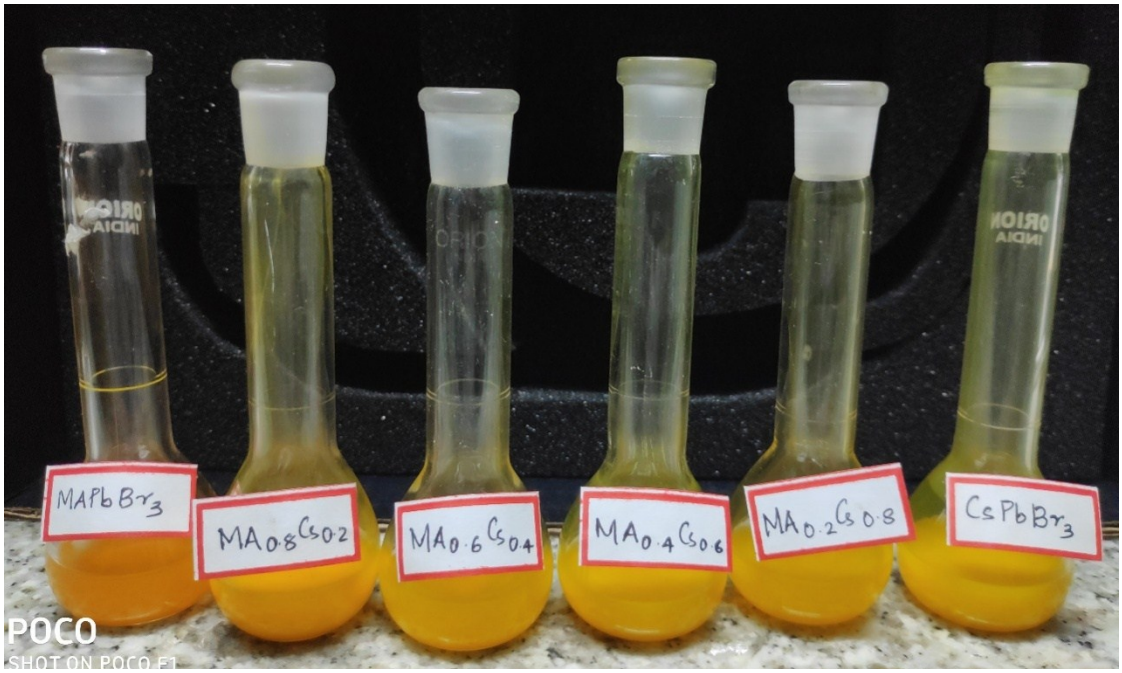

Fig. S1. Photograph of colloidal dispersions of $MA_{1-x}Cs_xPbBr_3$ ($0 \leq x \leq 1$) perovskites in cyclohexane under room light.

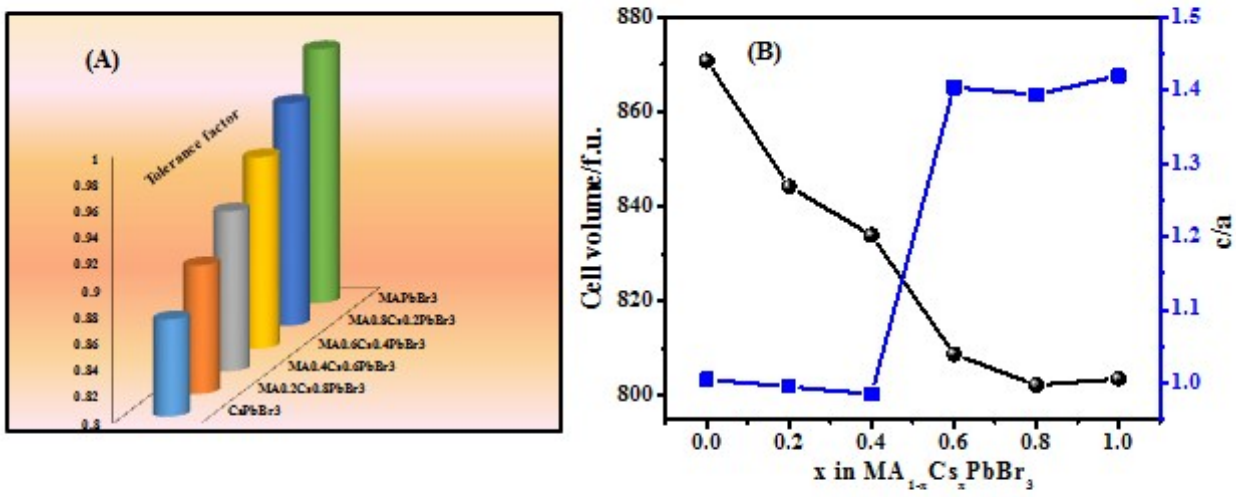

Fig. S2. (A) Calculated effective tolerance factors and **(B) s**tructural distortion in $MA_{1-x}Cs_xPbBr_3$ ($0 \leq x \leq 1$) perovskites with cell volume per formula unit and the c/a ratio as a function of composition.

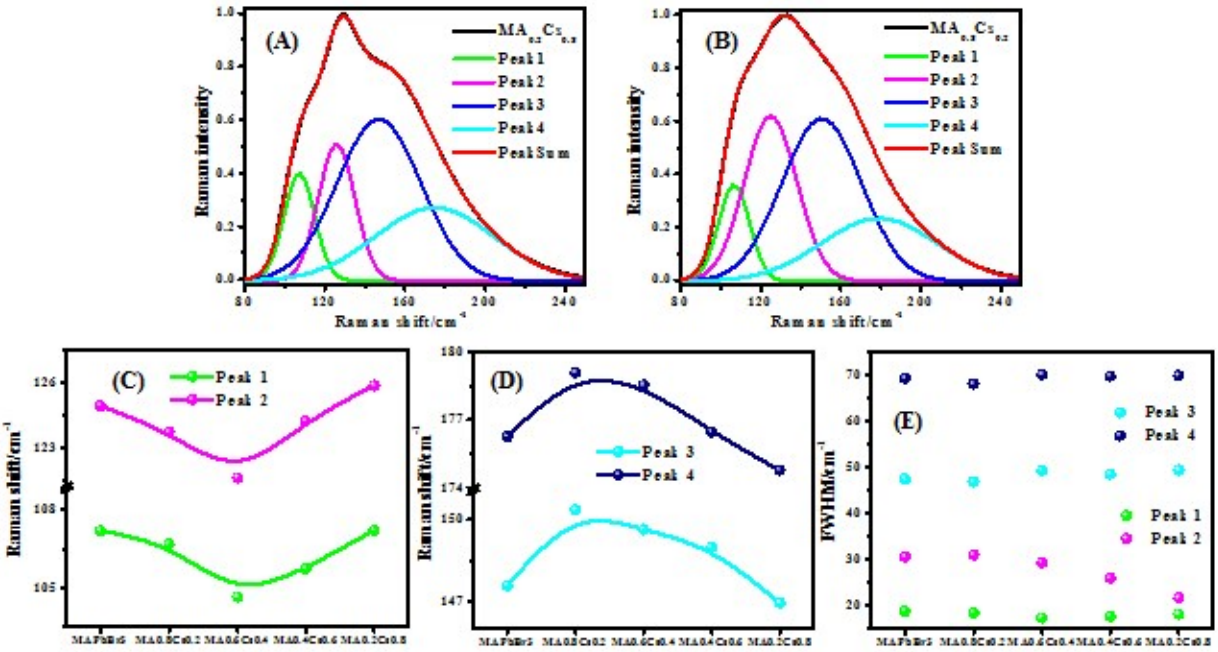

Fig. S3. Gaussian deconvolution of low-frequency Raman spectra of the synthesized **(A)** $MA_{0.2}Cs_{0.8}PbBr_3$, and **(B)** $MA_{0.8}Cs_{0.2}PbBr_3$ perovskites. **(C and D panels)** Raman frequency shift of the individual deconvoluted peaks as a function of composition along with the **(D)** FWHM of $MA_{1-x}Cs_xPbBr_3$ ($0 \leq x \leq 1$) perovskites.

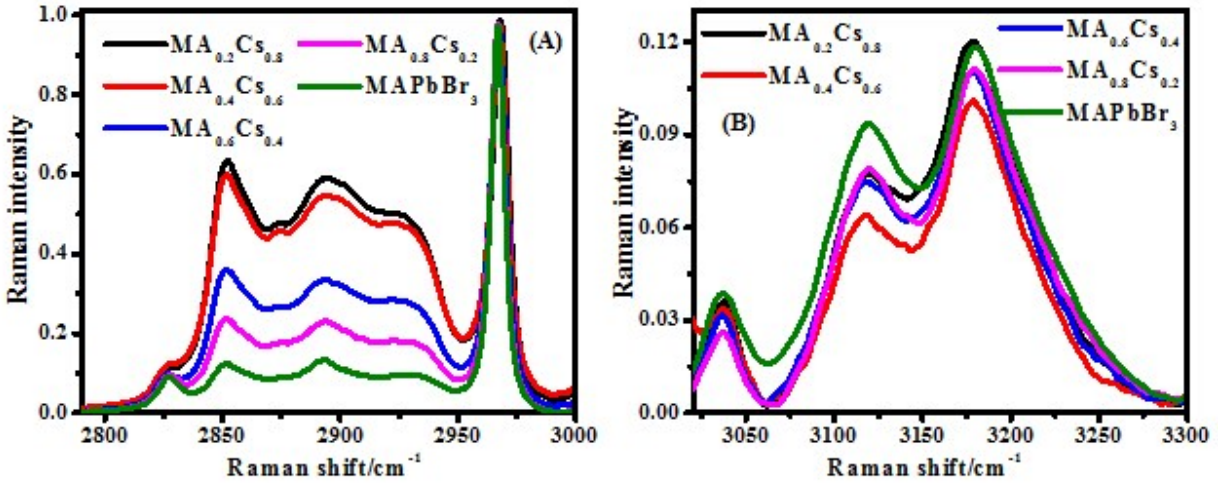

Fig. S4. (A and B panels). Raman spectra of the synthesized $MA_{1-x}Cs_xPbBr_3$ ($0 \leq x \leq 1$) perovskites over the high-frequency region (2700-3300 cm^{-1}), i.e., where the C-H and N-H vibrations of methylammonium appear.

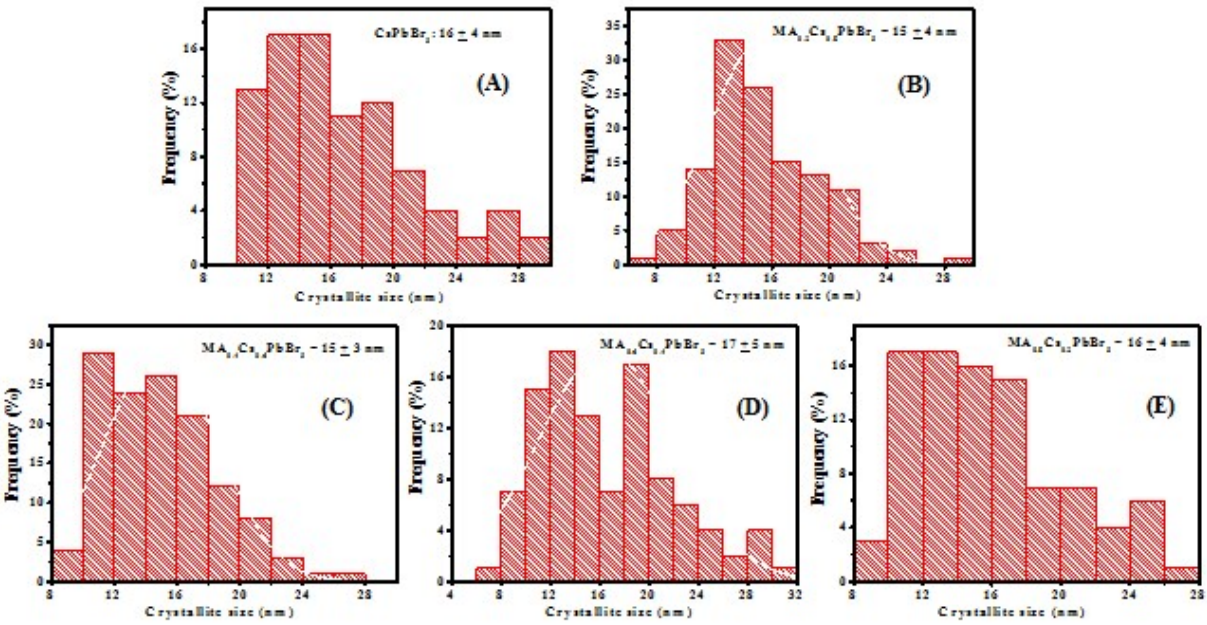

Fig. S5. The size distribution histogram of the $MA_{1-x}Cs_xPbBr_3$ ($0 \leq x \leq 1$) perovskites.

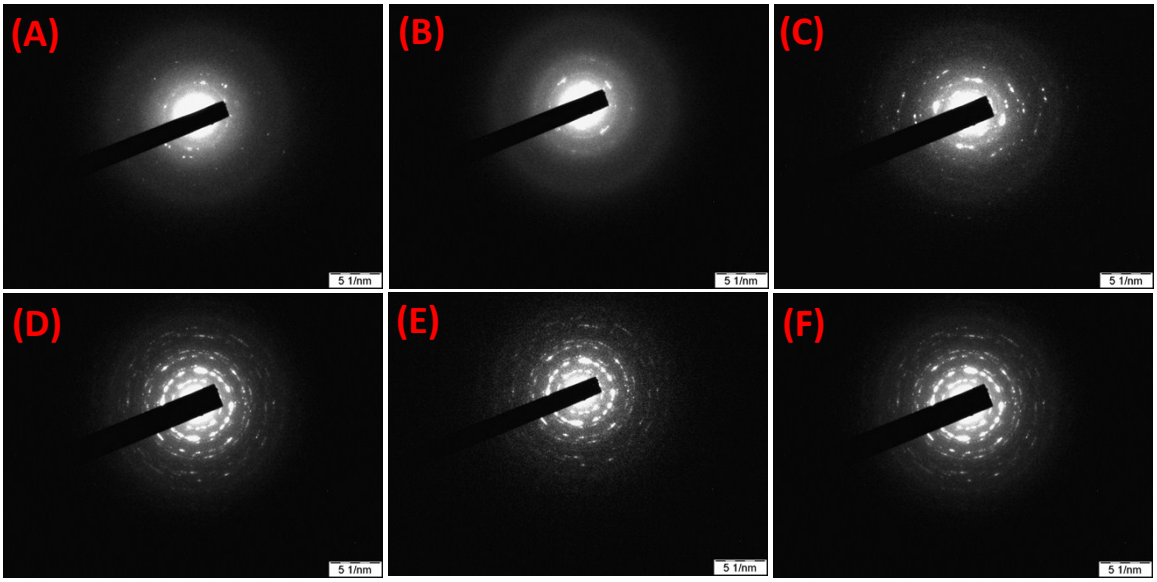

Fig. S6. SAED patterns of the synthesized **(A)** $MAPbBr_3$, **(B)** $MA_{0.8}Cs_{0.2}PbBr_3$, **(C)** $MA_{0.6}Cs_{0.4}PbBr_3$, **(D)** $MA_{0.4}Cs_{0.6}PbBr_3$, **(E)** $MA_{0.2}Cs_{0.8}PbBr_3$ and **(F)** $CsPbBr_3$ perovskites.

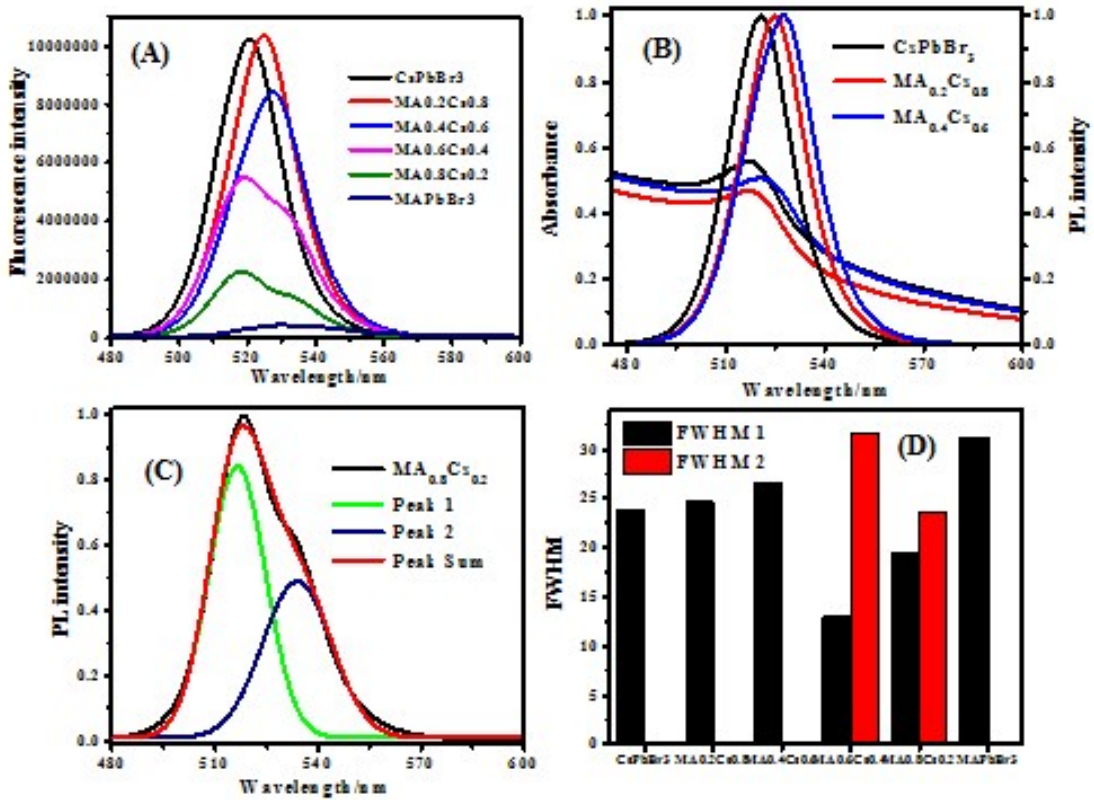

Fig. S7. (A) Photoluminescence (PL) spectra of the synthesized $MA_{1-x}Cs_xPbBr_3$ ($0 \leq x \leq 1$) perovskites. **(B)** UV-vis absorption and PL spectra of the synthesized $MA_{1-x}Cs_xPbBr_3$ ($0.6 \leq x \leq 1$) perovskites. **(C)** Gaussian deconvolution of PL spectra of the synthesized $MA_{0.8}Cs_{0.2}PbBr_3$ perovskite. **(D)** FWHM of the PL spectra of the synthesized $MA_{1-x}Cs_xPbBr_3$ ($0 \leq x \leq 1$) perovskites.

Table S1. Unit cell parameters of $MA_{1-x}Cs_xPbBr_3$ ($0 \leq x \leq 1$) perovskite samples.

Name/unit cell parameters	***a*/ Å**	***b*/ Å**	***c*/ Å**	**Volume/ Å^3**
$CsPbBr_3$	8.306058	8.203634	11.79377	803.6259
$MA_{0.2}Cs_{0.8}PbBr_3$	8.338306	8.276673	11.62543	802.3109
$MA_{0.4}Cs_{0.86}PbBr_3$	8.326415	8.326415	11.68876	808.8815
$MA_{0.6}Cs_{0.4}PbBr_3$	8.43999	11.88780	8.312142	833.9816
$MA_{0.8}Cs_{0.2}PbBr_3$	8.436164	11.91719	8.397279	844.2238
$MAPbBr_3$	8.493311	12.01103	8.536381	870.8253

Table S2. Fitted lifetime values using a bi-exponential decay model along with the respective % contribution of each component of $MA_{1-x}Cs_xPbBr_3$ ($0 \leq x \leq 1$) perovskite series.

Sample	τ_1 (ns)	τ_2 (ns)	A1	A2	τ_{avg} (ns)	χ^2
$CsPbBr_3$	**2.92**	**31.61**	**0.12**	**0.88**	**31.25309637**	**1.32**
$MA_{0.2}Cs_{0.8}PbBr_3$	**3.55**	**31.96**	**0.14**	**0.86**	**31.45540893**	**1.39**
$MA_{0.4}Cs_{0.6}PbBr_3$	**4.20**	**32.09**	**0.14**	**0.86**	**31.50816259**	**1.17**
$MA_{0.6}Cs_{0.4}PbBr_3$	**5.09**	**26.43**	**0.23**	**0.77**	**25.26918919**	**1.18**
$MA_{0.8}Cs_{0.2}PbBr_3$	**4.39**	**24.14**	**0.17**	**0.83**	**23.4307771**	**1.23**
$MAPbBr_3$	**1.06**	**39.82**	**0.63**	**0.37**	**38.13935641**	**1.22**