Supplementary Information

Low temperature green synthesis of red emitting Pb-free $CsMnBr_3$ perovskite films

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1. EDS analysis

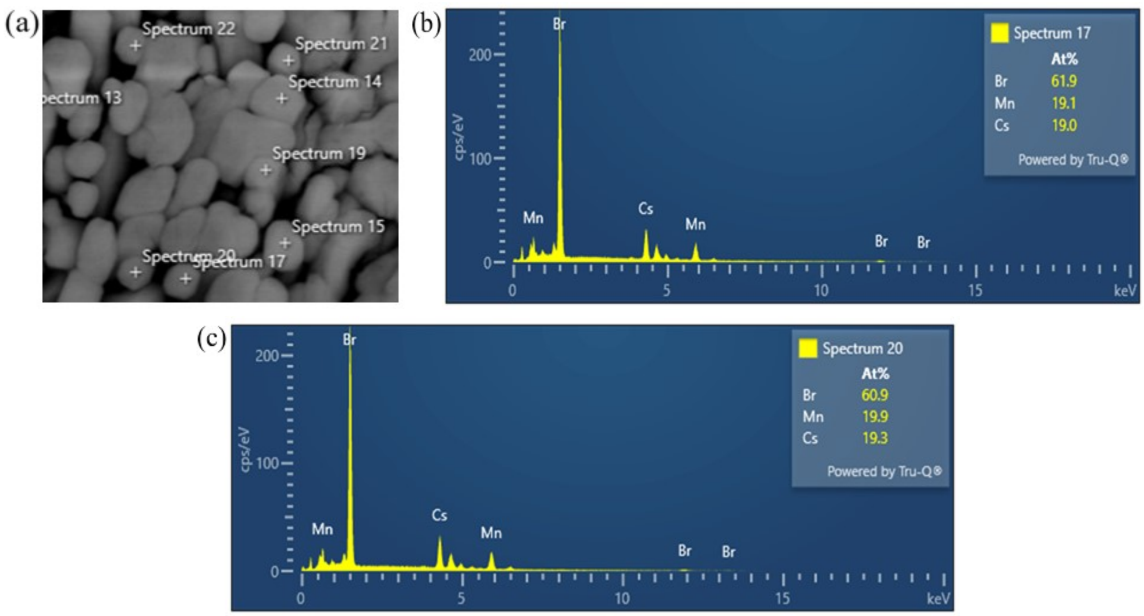

Fig. S1. (a-c) EDS analysis depicting 1:1:3 molar ratios of Cs:Mn:Br in as-prepared $CsMnBr_3$ films.

2. Mathematical equations

Bragg's law is used to calculate the interplanar spacing 'd' from the diffraction peaks of $CsMnBr_3$ peaks and given below:

$$n\lambda = 2dSin\theta \tag{S1}$$

where 'n' is the order of diffraction, 'λ' is the incident wavelength, 'd' is the interplanar spacing and 'θ' is the diffraction angle.

The following d-spacing equation is used to calculate lattice parameters for hexagonal systems:

$$\frac{1}{d_{hkl}^2} = \frac{4\,(h^2 + hk + k^2)}{3\,(a^2)} + \frac{l^2}{c^2} \tag{S2}$$

where 'd_{hkl}' is the interplanar spacing for (hkl) crystallographic plane, and 'a' and 'c' are corresponding lattice constants for respective hexagonal structure.

The temperature dependence of PL peak wavelength is given as:

$$\lambda\,(T) = \lambda(T_0) + \beta_T \Delta T \tag{S3}$$

for $|\Delta T/T_0| << 1$. Here, '$\lambda(T)$' and '$\lambda(T_0)$' are the PL peak wavelengths at temperature T and a reference temperature 'T_0', and 'β_T' is a factor determining the thermal shift of PL peak wavelength, respectively.

The conductance (G) of the $CsMnBr_3$ films is determined from corresponding I-V curves via the following equation:

$$G = \frac{dI}{dV} \tag{S4}$$

where 'G' represents the conductance, and 'dI/dV' represents the slope of I-V curves.

3. Electrical response of $CsMnBr_3$ films

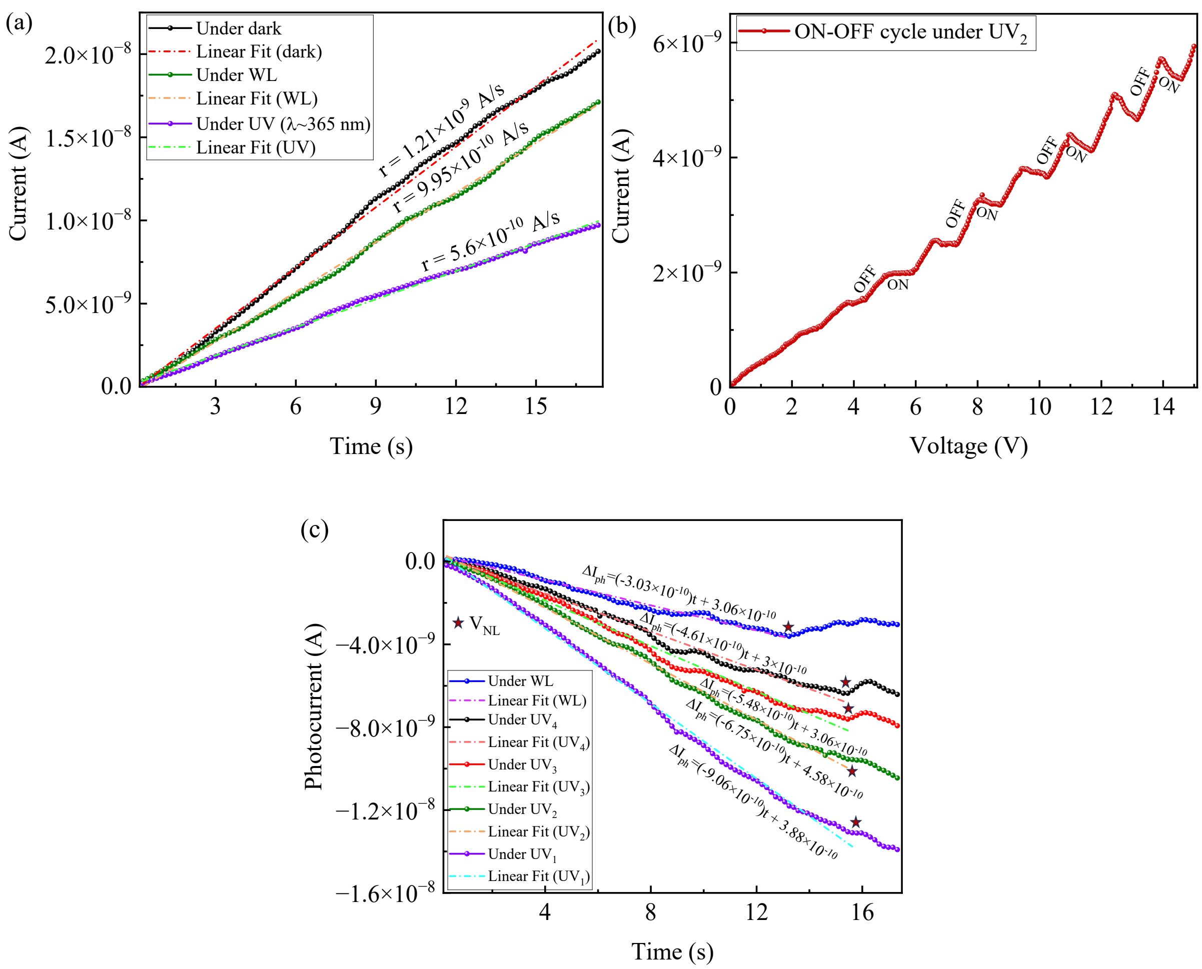

Fig. S2. (a) Current-time (I-t) characteristics of as-prepared $CsMnBr_3$ films under dark, white light, and UV light (λ: ~365 nm) at a scan rate of 0.55 $V \cdot s^{-1}$, and (b) I-V curve of as-prepared $CsMnBr_3$ films under UV light (λ: ~365 nm) with ON-OFF cycles at a scan rate of 0.25 $V \cdot s^{-1}$, and (c) photocurrent-time (ΔI_{ph}-t) curves of as-prepared $CsMnBr_3$ films under UV irradiations of varying intensities.

The slopes of I-t curves are calculated using the following equation:

$$r = \frac{dI}{dt} \tag{S5}$$

where '*r*' denotes the change rate of current, and 'd*I*/d*t*' is the slope of I-t curves.

The current-time (I-t) curves for the $CsMnBr_3$ films under cyclic ON-OFF UV irradiation can be approximately described by the following exponential equation:

$$I = I_0 + A_1 e^{-t/\tau} \tag{S6}$$

where 'I_0' denotes the baseline current at 'dark' state, 'A_1' represents steady state current under UV irradiation, and 'τ' represents the characteristic rise/decay time constants, respectively.

4. PL spectra of $CsMnBr_3$ films on different substrates

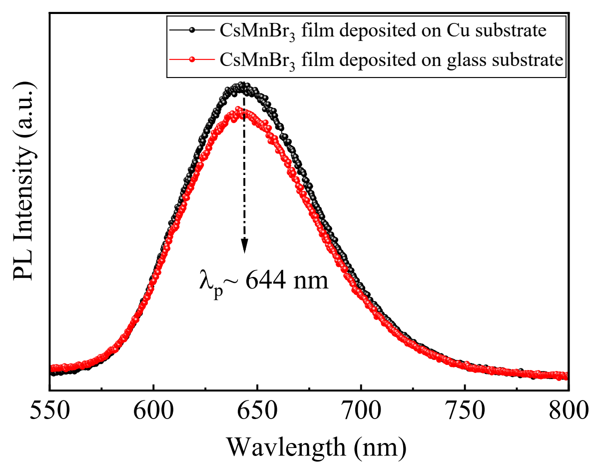

Fig. S3. Photoluminescence spectra of $CsMnBr_3$ films deposited on copper (Cu) and glass substrates, under UV excitation of ~ 365nm wavelength.

5. White LCD backlight structures

5.1 Schematic illustration of the fabrication procedure

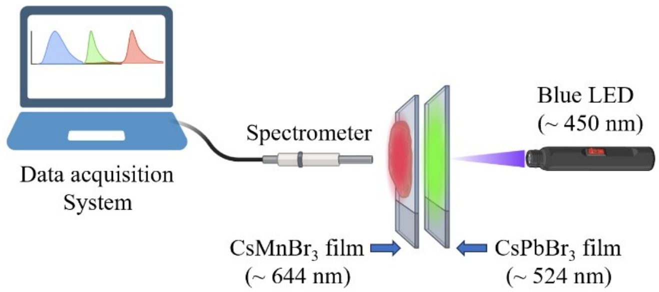

Fig. S4. Schematic of a white-emitting RGB LCD backlight structures fabricated via red-emitting $CsMnBr_3$ and green-emitting $CsPbbr_3$ films, excited with blue LED (λ~450 nm).

5.2 Color gamut coverage area calculations

Table S1. CIE coordinates of NTSC 1953 standard, sRGB standard and present work

Standards	$(X_R, Y_R)^*$	$(X_G, Y_G)^*$	$(X_B, Y_B)^*$	Gamut Coverage Area (GCA)	Relative Area Ratio (RAR) (%)
sRGB	(0.64,0.33)	(0.3, 0.6)	(0.15, 0.06)	0.1120	186.88
NTSC 1953	(0.67, 0.33)	(0.21, 0.71)	(0.14, 0.08)	0.1582	132.36
Present work	(0.71, 0.289)	(0.16, 0.79)	(0.15, 0.03)	0.2094	100

*Here, the subscripts 'R', 'G', and 'B' correspond to red, green, and blue emissions, respectively.

The color Gamut Coverage Area (GCA) spanned by RGB triangle in Fig. 11 (manuscript) is calculated via:

$$GCA = (X_R \times Y_G + X_G \times Y_B + X_B \times Y_R - X_R \times Y_B - X_G \times Y_R - X_B \times Y_G)/2 \tag{S7}$$

Further, the Relative Area Ratio (RAR) is calculated via:

$$RAR = \frac{(GCA)_{Present\ work}}{(GCA)_{Standard})} \times 100 \tag{S8}$$