Electronic supplementary information

Highly Efficient and Ultra-Stable $CsPbBr_3$ Composites for LCD Device and X-ray Imaging

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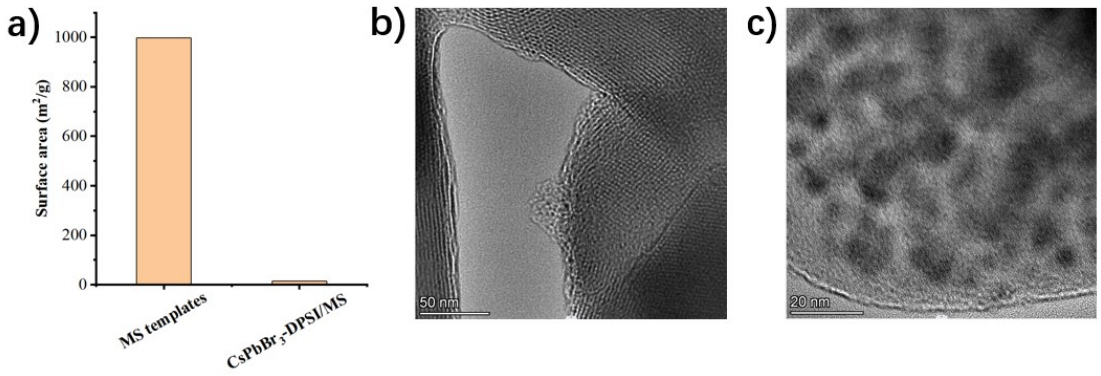

Fig. S1 a) BET result of MS templates and $CsPbBr_3$-DPSI/MS composites. b) TEM image of the original MS templates, showing the mesoporous structure. c) TEM image of $CsPbBr_3$-DPSI/MS composites.

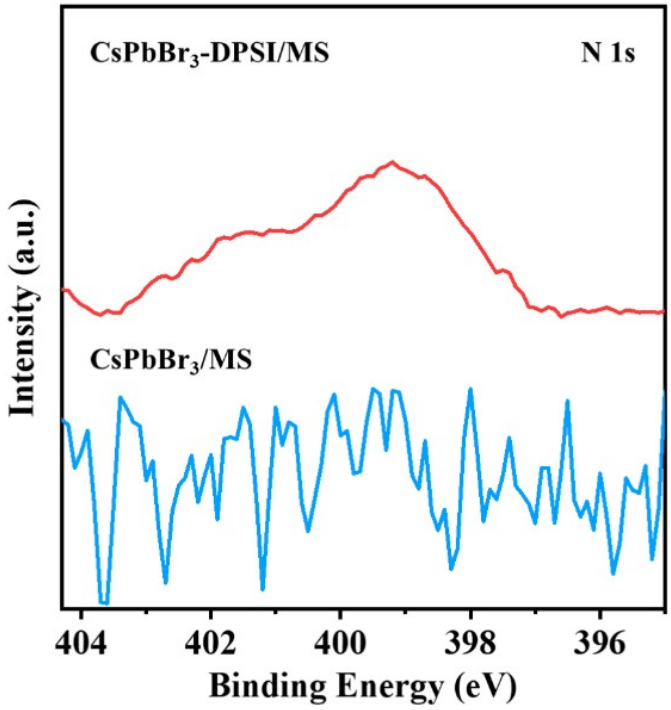

Fig. S2 The N1s XPS spectra of $CsPbBr_3$/MS and $CsPbBr_3$-DPSI/MS.

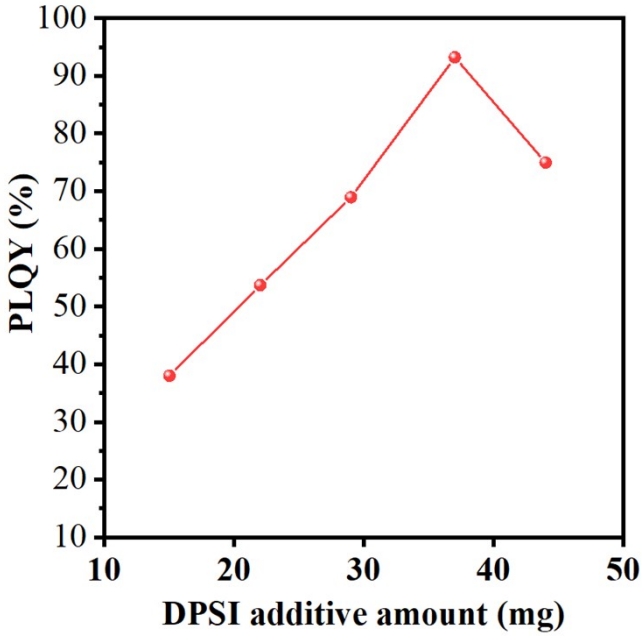

Fig.S3 The PLQY of obtained samples as a function of the DPSI additive amount in precursors

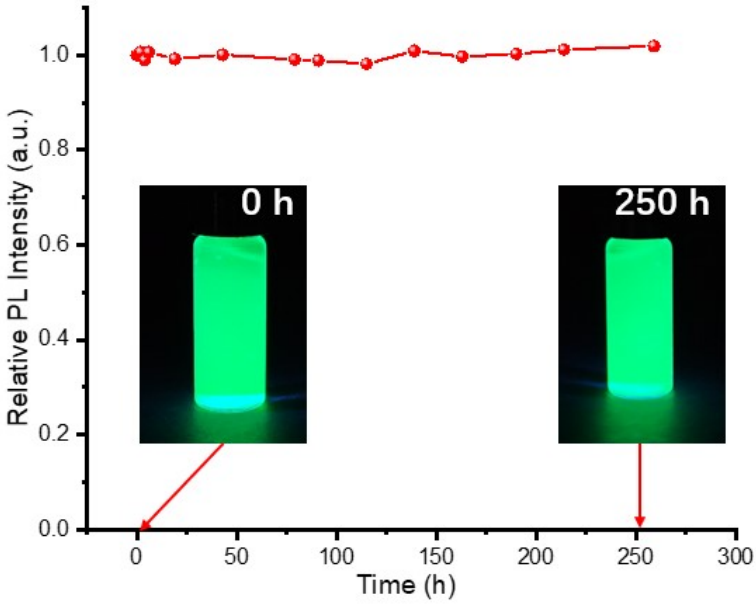

Fig. S4 Relative PL intensity curve of $CsPbBr_3$-DPSI/MS composites in water for 250 hours.

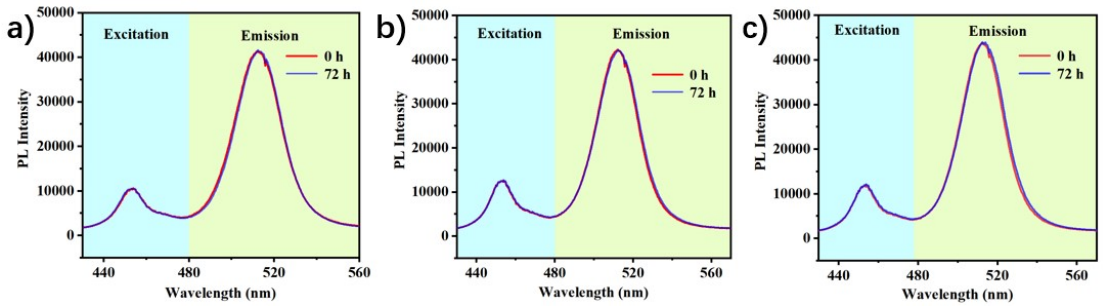

Fig.S5 PL spectra of $CsPbBr_3$-DPSI/MS composites in a) 1 mol/L KI, b) 1 mol/L KCl, and c) 1 mol/L HCl aqueous solutions for 0 and 72 h. 450 nm laser is used as the excitation light source.

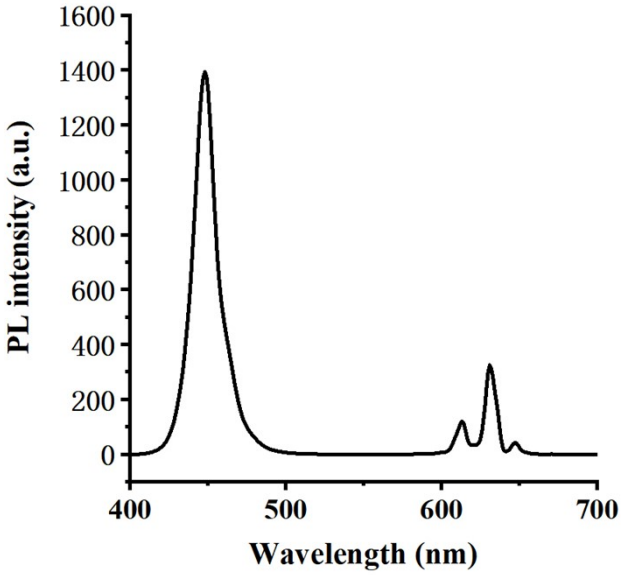

Fig. S6 PL spectrum of purple LED chips in the LCD device

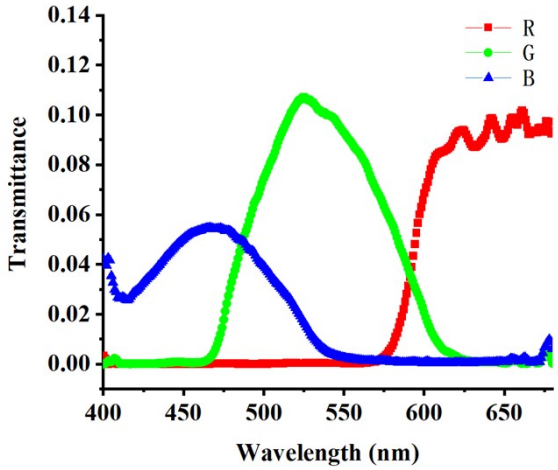

Fig. S7 The transmittance spectrum of three primary colors in the LCD module

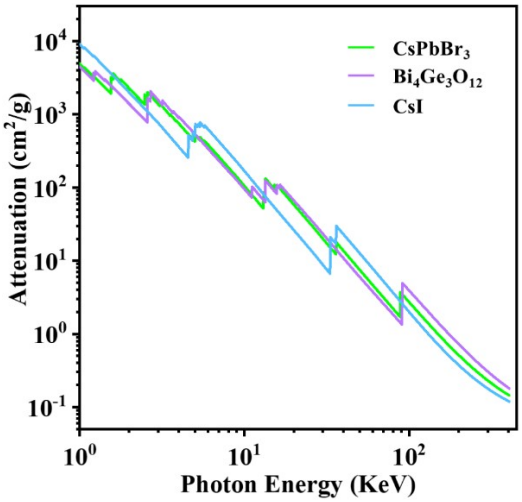

Fig. S8 Calculated attenuation spectra of $CsPbBr_3$, $Bi_4Ge_3O_{12}$, and CsI as a function of X-ray photon energy.

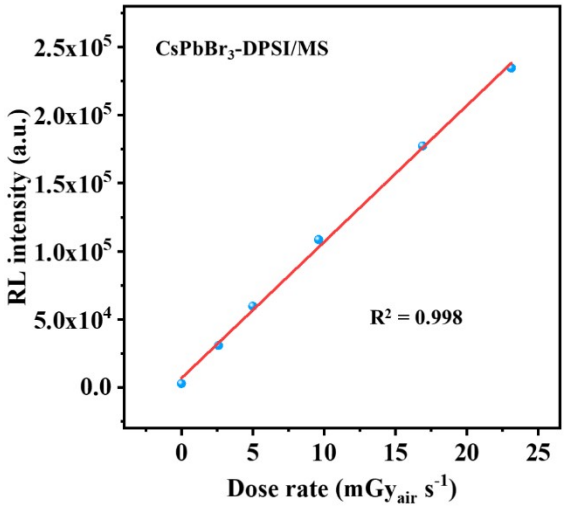

Fig. S9 RL intensity for the $CsPbBr_3$-DPSI/MS as a function of X-ray dose rate.

Table S1 The parameters of carrier lifetime by fitting the TRPL spectroscopy based on $CsPbBr_3$/MS and $CsPbBr_3$-DPSI/MS composites.
The TRPL decay curves are fitted by a biexponential equation:

$$I(t) = I_0 + a_1 \exp\left(-t/\tau_1\right) + a_2\, exp(-t/\tau_2) \quad \text{(S1)}$$

where a_1 and a_2 are amplitudes; τ_1 and τ_2 are lifetimes for fast and long PL decay processes.
A_1 and A_2 are relative amplitudes, which can be calculated using the following formula:

$$A_i = {}^{a_i\tau_i}\Big/\sum_{n=1}^{2} a_n\tau_n \quad \text{(S2)}$$

$\tau_{average}$ is the average lifetime, which can be calculated using the following formula:

$$\tau_{average} = \tau_1 A_1 + \tau_2 A_2 \quad \text{(S3)}$$

Sample	τ_1 [ns]	A_1 [%]	τ_2 [ns]	A_2 [%]	$\tau_{average}$ [ns]
$CsPbBr_3$/MS	11.97	54.65	96.88	45.35	50.48
$CsPbBr_3$-DPSI/MS	8.32	78.91	43.59	21.09	15.76

Table S2 FWHM comparisons of typical fluorescence materials.

materials	FWHM [nm]	Ref.
$CsPbBr_3$-Beta composites	25	1
$CsPbBr_3$@glass nanocomposites	25.8	2
$CsPbBrI_2$ glass	31	3
$CsPb(Br/I)_3$ NCs glass	36	4
$CsPb(Br/I)_3$-PMMA film	35	5
$CdSe/Zn_xCd_{1-x}S/ZnS$ quantum rods	25	6
InP/ZnSe/ZnS QDs	36	7
Cs_3MnBr_5 polycrystalline	42	8
Cs_3MnBr_5 NCs	43	9
Cs_3MnBr_5	42	10
Cs_3MnI_5 polycrystalline	48	11
$CsMn_{0.95}Zn_{0.05}Cl_3$ NCs	84	12
$Sr_2LiAl_{0.6}Ga_{0.4}O_4$: Eu^{2+}	40	13
$NaBaB_9O_{15}$: Eu^{2+}	61	14
β-Sialon: Eu^{2+}	55	15
$MgAl_2O_4$: Mn^{2+}	35	16
$CsPbBr_3$-DPSI/MS composites	**25**	**this work**

Table S3 Stability and PLQY of the typical $CsPbBr_3$ QDs reported to date.

materials	photostability	thermal stability	PLQY	Ref.
$CsPbBr_3$:Sr/PbBr(OH)/molecular sieve composites	retained 80% PLQY after being aged under blue light irradiation (1500 W m^{-2}) for 200h	retained 78% and 51% of their initial PL intensity at 60℃ and 100℃	75%	17
$CsPbBr_3$-HSZ ZSM-5 composites	/	retained 43% and 7% of their initial PL intensity at 60℃ and 100℃	62%	18
$CsPbBr_3$QDs@glass	retained 90% of their initial PL intensity after being irradiated with UV lamp (4 w) for 180 h	retained 66% and 27% of their initial PL intensity at 60℃ and 100℃	47%	19
$CsPbBr_3$@MSNs -PDMS film	retained 98.4% of their initial PL intensity after being irradiated with blue light (500 W m^{-2}) for 12 h	/ /	81%	20
$CsPbBr_3$/MS matrices	retained 100% of their initial PL intensities after being irradiated with 450 nm LED chip (20 mA, 2.7 V) for 1000 h	/	71%	21
BVA-$CsPbBr_3$ colloidal QDs	/	retained 4% and 3% of their initial PL intensity at 60℃ and 100℃	80%	22
$CsPbBr_3$-DPSI/MS Composites	**retained 100% of their initial PL intensity after being exposed to blue light (3500W m^{-2}) for 48 h**	**retained 84% and 41% of their initial PL intensity at 60℃ and 100℃**	**93%**	**this work**
	retained 90% of their initial PL intensities under harsh aging conditions (temperature: 60℃, humidity: RH 90%, blue light irradiation with a power density of 3500 W m^{-2}) for 1000 h			

Table S4 The three primary color coordinates of CPB-LCD and OC-LCD

		CIE x	CIE y
CPB-LCD	R	0.684	0.305
	G	0.142	0.728
	B	0.152	0.068
OC-LCD	R	0.681	0.310
	G	0.235	0.692
	B	0.155	0.068

Table S5 Spatial resolutions of X-ray imaging for the $CsPbBr_3$-DPSI/MS composites-based scintillator and other typical perovskite scintillators.

scintillators	spatial resolution [lp mm^{-1}]	Ref.
$CsPbBr_3$@PMMA polymer film	12.5	23
$CsPbBr_3$@Polymethyl methacrylate composite	8	24
$CsPbBr_3$:Eu^{3+} NCs glass-ceramic	15	25
$CsPbBr_3$ NCs +PPO scintillators	3.5	26
$Cs_2AgBiBr_6$	4.9	27
$Cs_3Cu_2I_5$@PMMA	12.5	28
$MAPbBr_3$ QDs	9	29
$CsPbBr_3$-DPSI/MS composites	**16**	**this work**

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