Supporting Information

Impact of Potassium Doping in the Optoelectronic Properties over Inorganic and Hybrid Bismuth Bromide Perovskite Thin Films (A$_3$Bi$_2$Br$_9$, A= Cs$^+$, MA)

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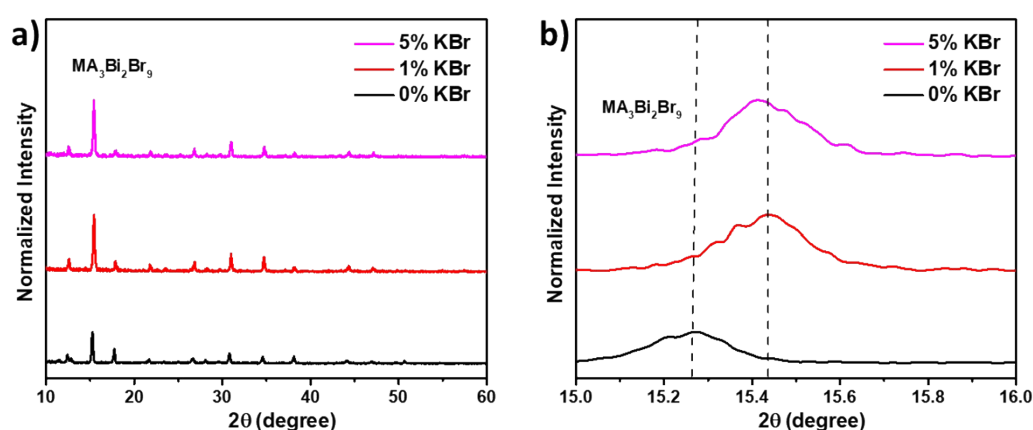Fig. S1: a) Stacked XRD plot of KBr incorporated MA$_3$Bi$_2$Br$_9$ perovskite thin film compositions b) XRD peak shift of MA$_3$Bi$_2$Br$_9$ perovskite towards higher angle with KBr incorporation.

Table S1: Average grain size of KBr incorporated Cs$_3$Bi$_2$Br$_9$ perovskite thin film compositions.

Perovskite	Average Grain size (μm)
0% KBr	1±0.2
1% KBr	2.37±0.6

5% KBr	2.59±0.5

Table S2: The Electron Dispersive Spectroscopic (EDS) elemental composition of KBr incorporated $Cs_3Bi_2Br_9$ perovskite thin film compositions.

Atomic percentage	0% KBr	1% KBr	5% KBr	Error %
K^+	nil	0.8	0.6	17.4-19.1
Cs^+	19.8	19.8	19.5	7.7-8.4
Bi^{3+}	15.8	15.2	16.1	6
Br^-	64.4	64.1	63.9	6.7

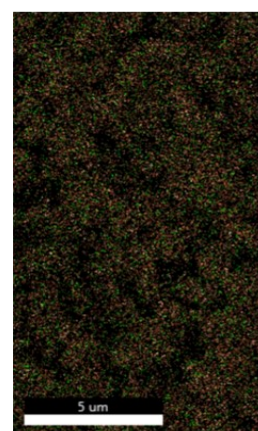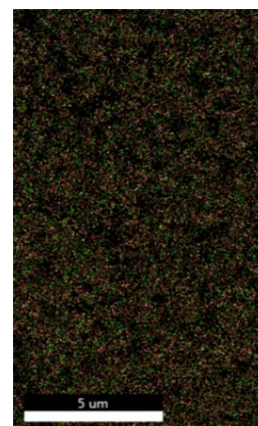| Composition	Element	Wavelength (nm)	Concentration (ppm)
0% KBr	K	766.491	nil
1% KBr	K	766.491	5.34
5% KBr	K	766.491	16.81

Fig. S2: The Electron Dispersive Spectroscopic (EDS) mapping of KBr incorporated $Cs_3Bi_2Br_9$ perovskite thin film compositions.

Table S3: ICP-OES data showing the amount of K in all compositions of KBr incorporated $Cs_3Bi_2Br_9$ perovskites
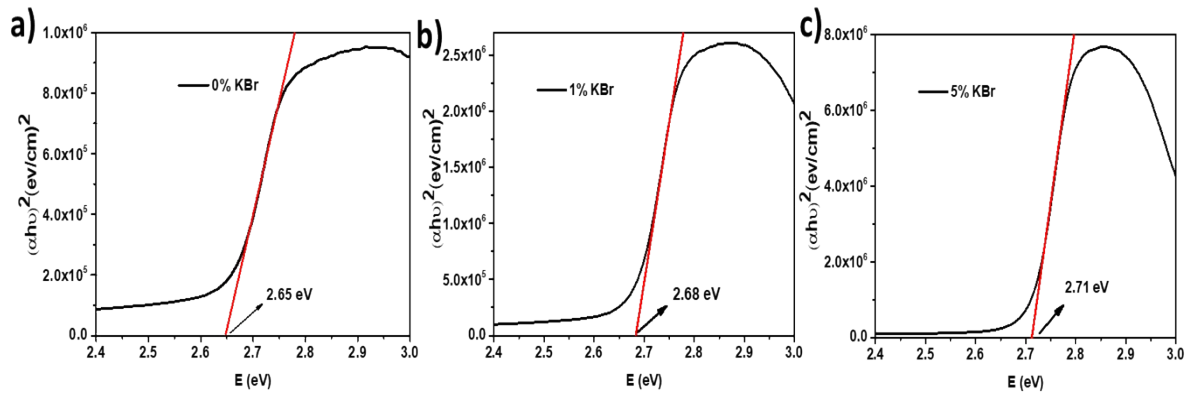
Fig. S3: Tauc plot depicting the direct bandgap of a) 0% KBr, b) 1% KBr, and c) 5% KBr compositions of $Cs_3Bi_2Br_9$ perovskite.
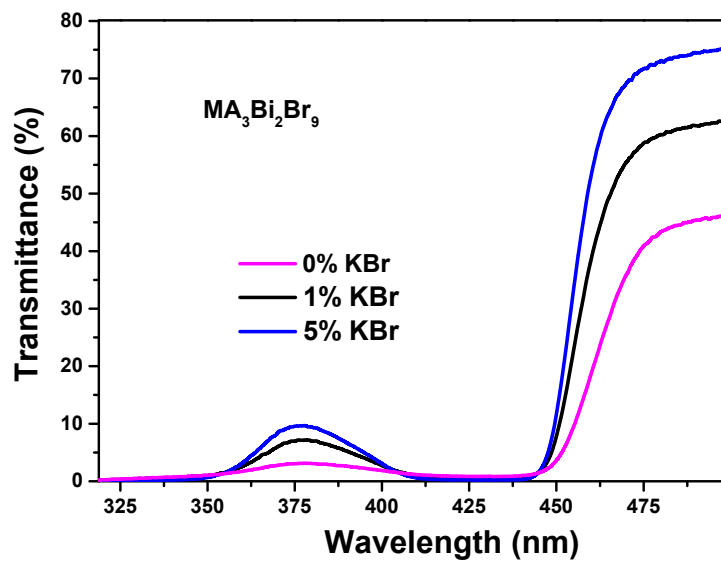

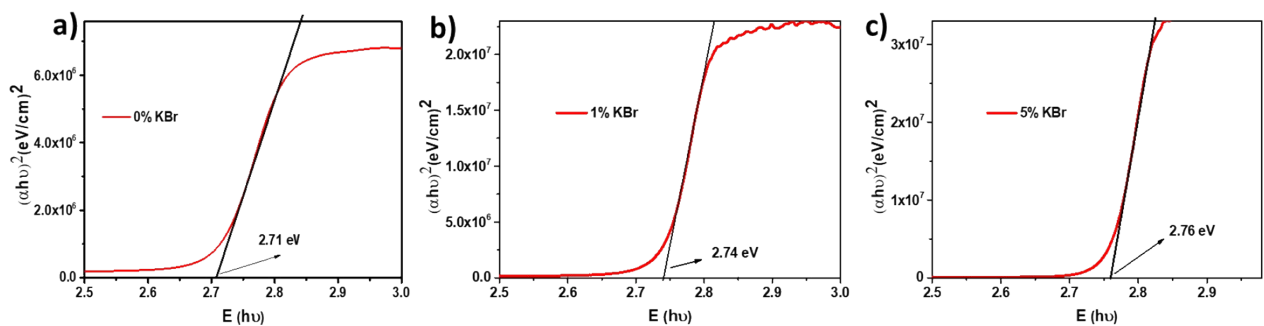Fig. S4: Transmittance curve of KBr incorporated $MA_3Bi_2Br_9$ perovskite compositions.

Fig. S5: Tauc plot depicting the direct bandgap of a) 0% KBr, b) 1% KBr, c) 3% KBr and d) 5% KBr compositions of $MA_3Bi_2Br_9$ perovskite
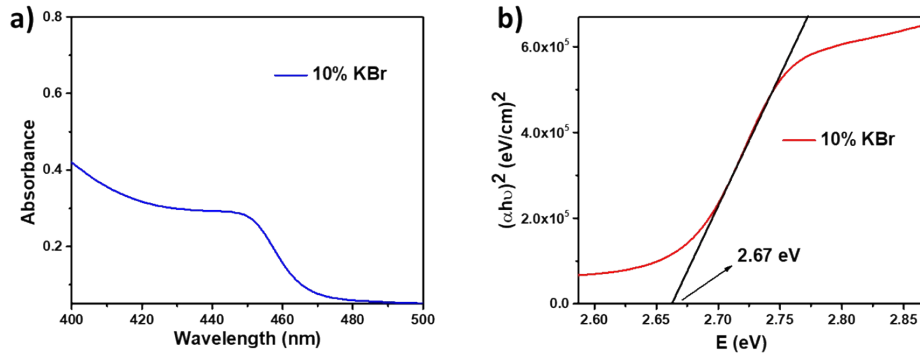
Fig. S6: a) Absorbance and b) Tauc plot showing the bandgap of 10% KBr in incorporated $Cs_3Bi_2Br_9$ perovskite
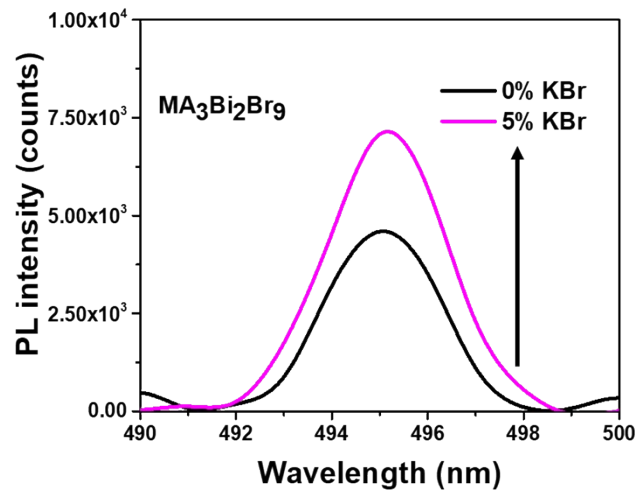

Fig. S7: SSPL curve of 5% KBr incorporated of $MA_3Bi_2Br_9$ perovskite compositions.

The TRPL curves are fitted using the triexponential decay function

i.e., $I(t) = A + B1\, e^{\left(-\frac{t}{T1}\right)} + B2 * e^{\left(-\frac{t}{T2}\right)} + B3 * e^{(-t/T3)}$

where 'I(t)' is the Intensity at Time ' t,'

'A' Background Intensity,

[B1, B2, B3] is the amplitudes of the decay component,

[T1, T2, T3] is the lifetimes of the decay components,

'$e^{-\frac{t}{Ti}}$' Exponential Decay Function

The lifetime obtained for different decay components is shown in the table below.

Table S4: Parameters of TRPL decay curve fitting equation.

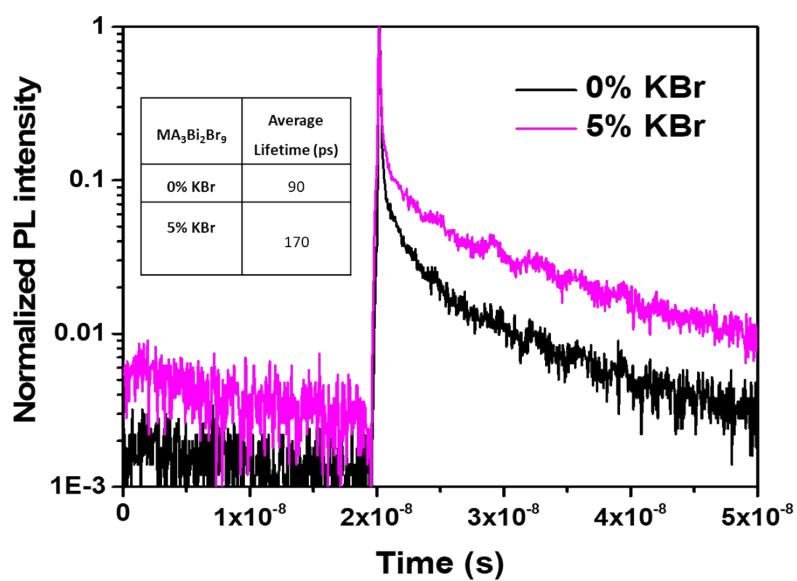| $Cs_3Bi_2Br_9$	A	B1	B2	B3	T1 (ns)	T2 (ns)	T3 (ns)	Chi-square	Average Lifetime (ps)
0% KBr	13.89	9.48	26.54	63.98	1.37	9.13	0.05	1.76	76
1% KBr	30.99	7.83	55.59	36.58	1.05	11.91	0.03	1.35	90
5% KBr	22.63	8.03	51.04	40.92	1.18	11.5	0.04	1.33	105

Fig. S8: TRPL curve of 5% KBr incorporated $MA_3Bi_2Br_9$ perovskite thin films (Average TRPL lifetime of KBr incorporated $MA_3Bi_2Br_9$ perovskite thin film is shown in the inset).
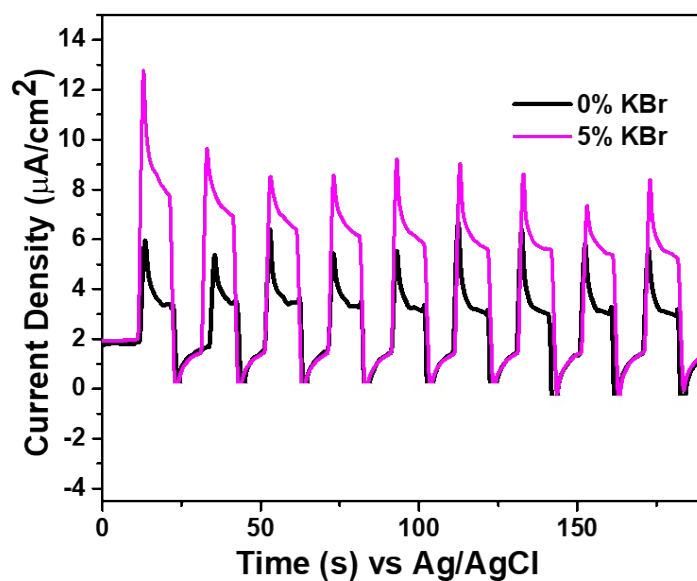
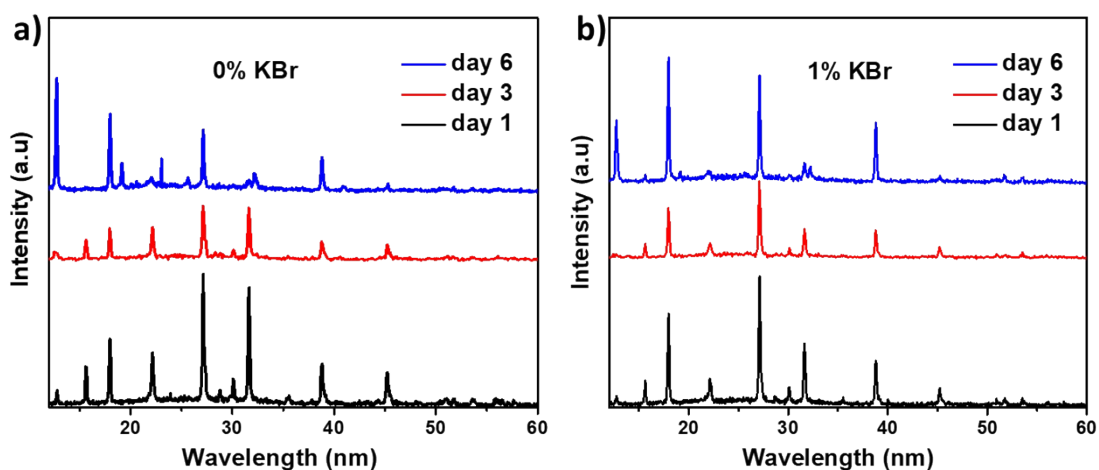Fig. S9: Chronoamperometry curve of KBr incorporated $MA_3Bi_2Br_9$ perovskite thin films.

Fig. S10: XRD analysis of a) 0% KBr b) 1% KBr incorporated $Cs_3Bi_2Br_9$ compositions for 6 days within a temperature range of 20ºC to 25ºC and 75% humidity. (the occurrence of additional peaks on the 6th day indicates the degradation of the film)
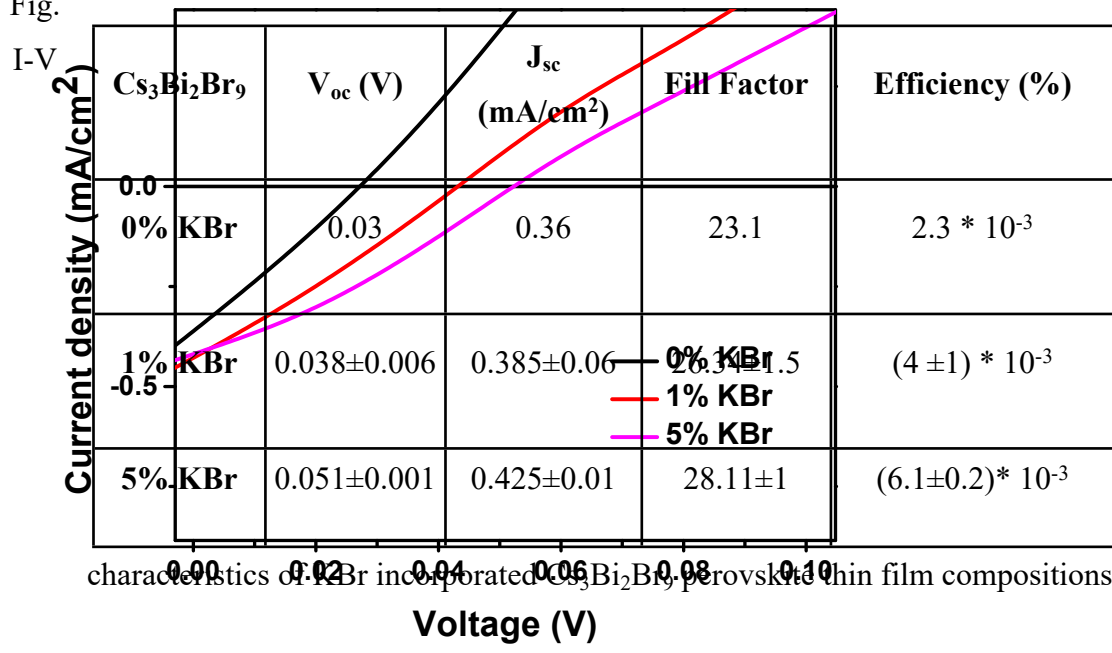
I-V

$Cs_3Bi_2Br_9$	V_{oc} (V)	J_{sc} (mA/cm^2)	Fill Factor	Efficiency (%)
0% KBr	0.03	0.36	23.1	$2.3 * 10^{-3}$
1% KBr	0.038±0.006	0.385±0.06	26.3±1.5	$(4 \pm1) * 10^{-3}$
5% KBr	0.051±0.001	0.425±0.01	28.11±1	$(6.1\pm0.2)* 10^{-3}$

Current density (mA/cm^2)

Voltage (V)

— 0% KBr
— 1% KBr
— 5% KBr

characteristics of KBr incorporated $Cs_3Bi_2Br_9$ perovskite thin film compositions.

Table S5: Device characteristics of KBr incorporated $Cs_3Bi_2Br_9$ perovskite solar cell