Electronic supplementary Information (ESI)

Preparation of Bismuth-doped $CsPbBr_3$ Perovskite Single Crystal for X-ray and Gamma-ray sensing Application

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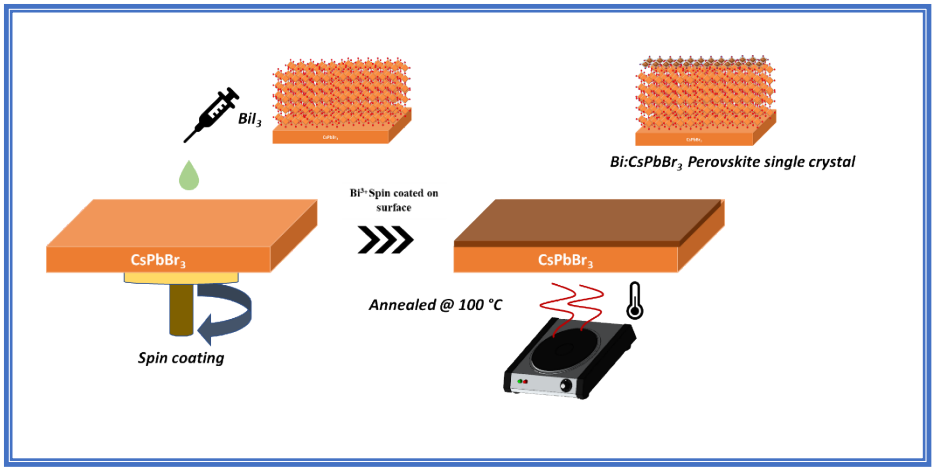

Figure. S1. Schematic representation of Bismuth doped on the surface of the $CsPbBr_3$ single crystal by spin coating process.

In this work, based on precursor engineering, we developed a two-step solution process to prepare the bismuth-doped $CspbBr_3$ single crystal. The top of the BiI_3 layer was coated on top of the $CsPbBr_3$ single crystals surface by spin coating (0.2mM BiI_3 solution was prepared by dissolving in 1ml of DMF) solution was used to by spin coating, 800 rpm @ 10 sec, repeated two times after that, dried under a vacuum Oven at 100 °C for 6 hours. This allowed partial cation exchange on the single crystal surface. Also, I_3 has a weak field ligand compared to Br_3, which makes it difficult to replace the Br_3 atoms in the pure $CsPbBr_3$ single crystal.

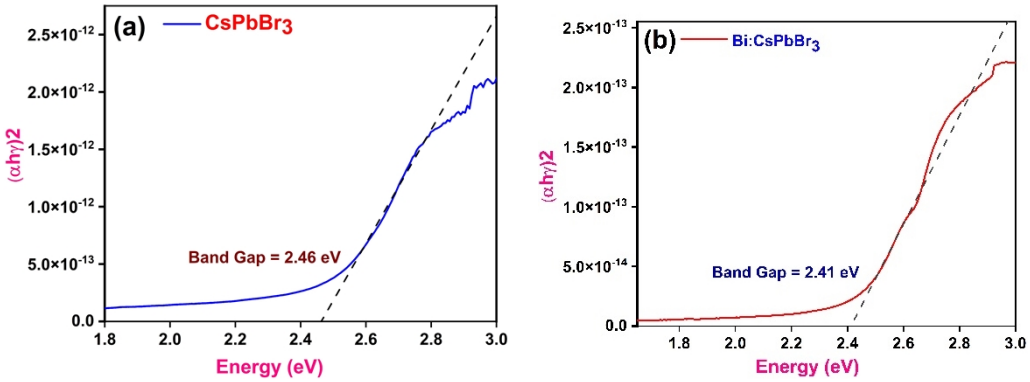
(a)
CsPbBr3
Band Gap = 2.46 eV
(αhγ)2
Energy (eV)
(b)
Bi:CsPbBr3
Band Gap = 2.41 eV
(αhγ)2
Energy (eV)

Figure.
S2

Bandgap energies obtained as a function of Tauc plot analysis from absorbance, the calculated band gap values are 2.46 and 2.41 eV for the pure $CsPbBr_3$ and Bi-doped $CsPbBr_3$ single crystal samples, respectively.

Samples	τ_1 **(Sec)**	τ_2 **(Sec)**	**Avg. Lifetime** τ **(ns)**
$CsPbBr_3$	6.98×10^{-10} [84.08 %]	4.342×10^{-9} [15.92 %]	2.67×10^{-9}
Bi-doped $CsPbBr_3$	7.11×10^{-10} [89.57 %]	4.14×10^{-9} [10.43 %]	2.25×10^{-9}

Table. 1 TCSPC lifetime values of the pure $CsPbBr_3$ and Bi-doped $CsPbBr_3$ single crystal samples respectively.

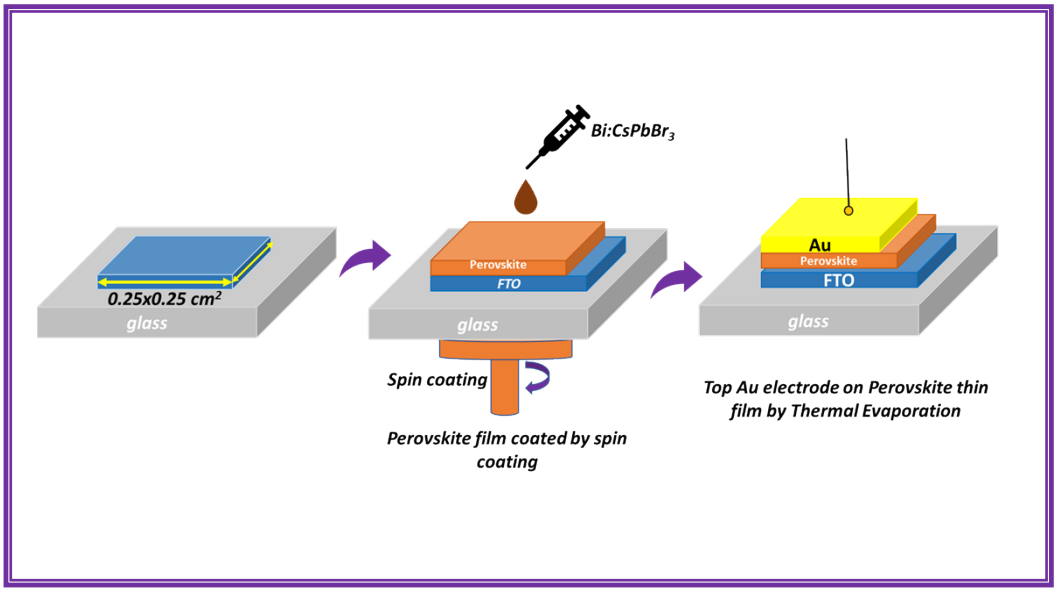

Figure S3. Schematic representation of Bi-doped $CsPbBr_3$ perovskite-based thin film photodetector fabrication.

We fabricated Bi-doped $CsPbBr_3$ thin films by using single crystals dispersed in DMSO and spin-coated on an FTO substrate. were used in photodetectors with FTO/Bi-doped $CsPbBr_3$ /Au device structure. Different layers of the device were deposited on the pre-cleaned FTO-coated glass slides. The Bi-doped $CsPbBr_3$ (photosensitizer) single crystals were dispersed in DMSO: DMF. After that, the solution was deposited by spin coating method over the FTO with 800 rpm at 20 seconds, repeated at two times, and dried at ambient temperature for 3 hrs. Au top electrodes was deposited (electrode area (0.25×0.25 cm_2) by using thermal evaporation method. The constructed devices were subjected to photocurrent measurements.

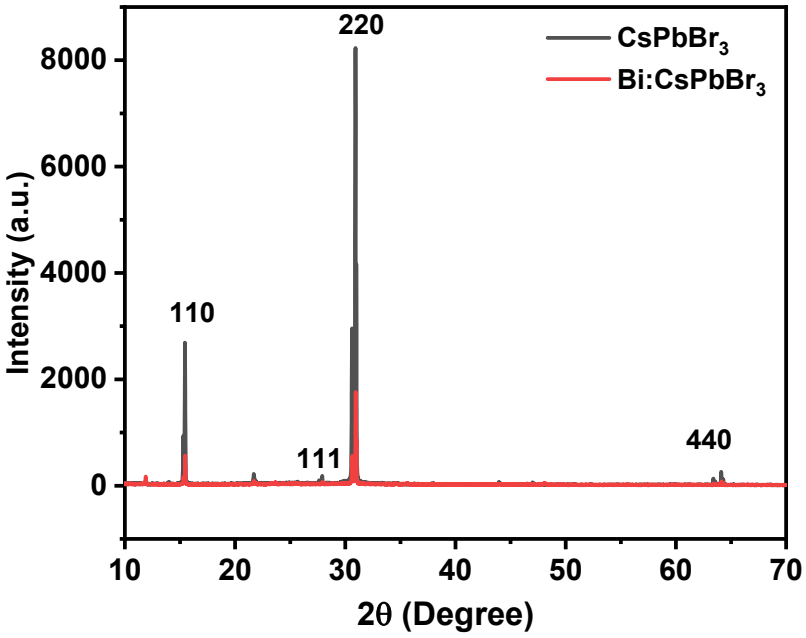

Figure. S4. (a) Room-temperature X-ray diffraction pattern of $CsPbBr_3$ and Bi-doped $CsPbBr_3$ single crystal thinfilm samples coated on FTO substrate.

The XRD characterization explores the structural authentication of thinfilm, crystallographic planes, and crystallinity. The powder XRD patterns of synthesised pure $CsPbBr_3$ and Bi-doped $CsPbBr_3$ perovskite thin film coated on FTO substrate are shown in **Fig. S4**. As a result, the 2θ peaks were found to be 15.46°, 27.31°, 30.93°, and 64.11° and corresponding planes of (110), (111), (220), and (440) for both $CsPbBr_3$ and Bi-doped $CsPbBr_3$ single crystal thin films samples, which are in good agreement with a single crystal. The $CsPbBr_3$ perovskite thin films exhibit an orthorhombic structure (ICSD 97851) with the Pnma space group, and there is no phase change occurring in the thin film formation.

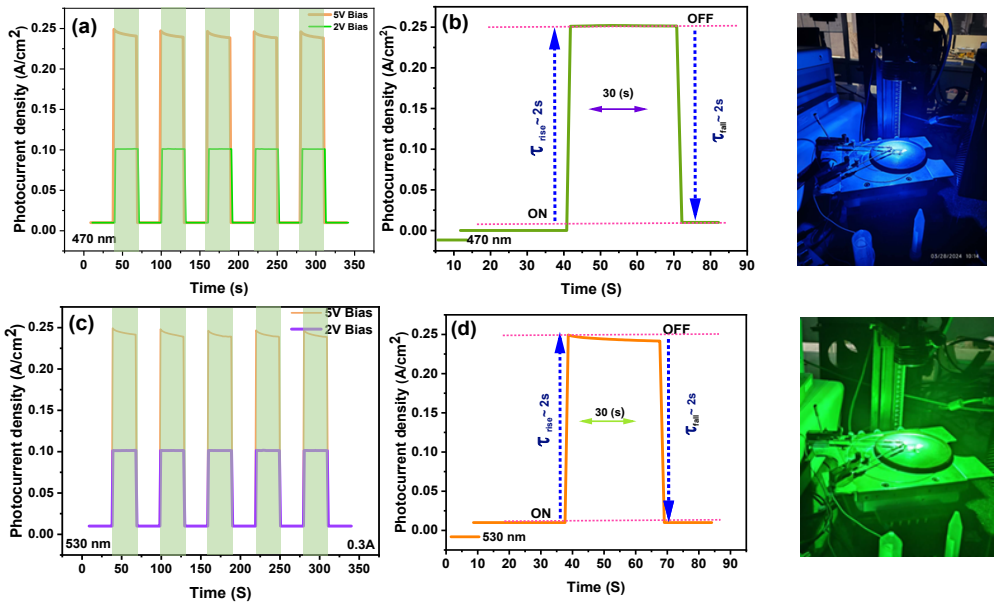

Figure S5. Time-dependent photocurrent spectra of Bi-doped $CsPbBr_3$ thin-film photodetectors at bias 5V and 2V under different wavelength LED source 470 nm and 530 nm (The LED source intensity with 0.3 A input power).

The photoresponsivity (R) is the ratio of the photogenerated current density to that incident light (at given (wavelength) λ~470 nm and 530 nm.

$$R = \frac{\Delta I}{PA}$$

Where ΔI is the corresponding change in dark and illuminated current and P is the light's power density (or illumination intensity). The value of the responsivity is calculated for the photodetector at two different wavelength and tabulated in Table.1

S.No	Wavelength (nm)	I_{ON}/I_{OFF} ratio	Responsivity (mA/W)
1.	**470**	**596**	**0.35**
2.	**530**	**24**	**0.25**

Table. 2 Calculated value of the responsivity of the Bi-doped $CsPbBr_3$ thin film sample at 5v bias.