Electronic Supplementary Material (ESI) for Materials Advances.


# Supporting Information

# for

# Nanometer-Thick [$(FPEA)_2PbX_4$; X=I, Br] 2D Halide Perovskite Based Thin Films for Pollutant Detection and Nonconventional Photocatalytic Degradation

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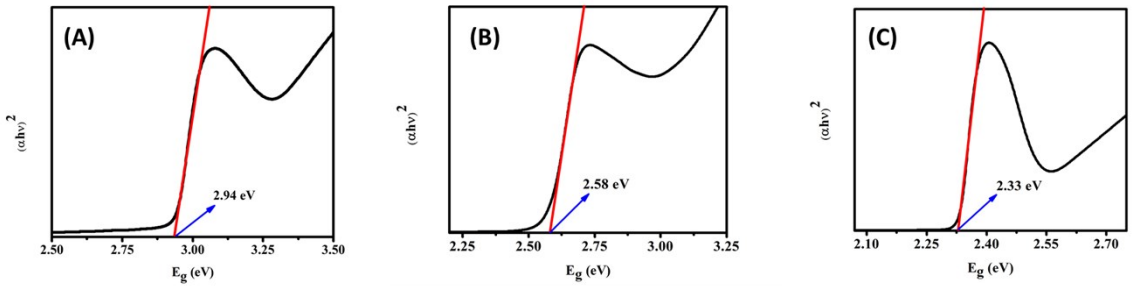


**Fig. S1.** Band gap analysis of (A) $(FPEA)_2PbBr_4$, (B) $(FPEA)_2PbI_2Br_2$ and (C) $(FPEA)_2PbI_4$ using Tauc Plot.

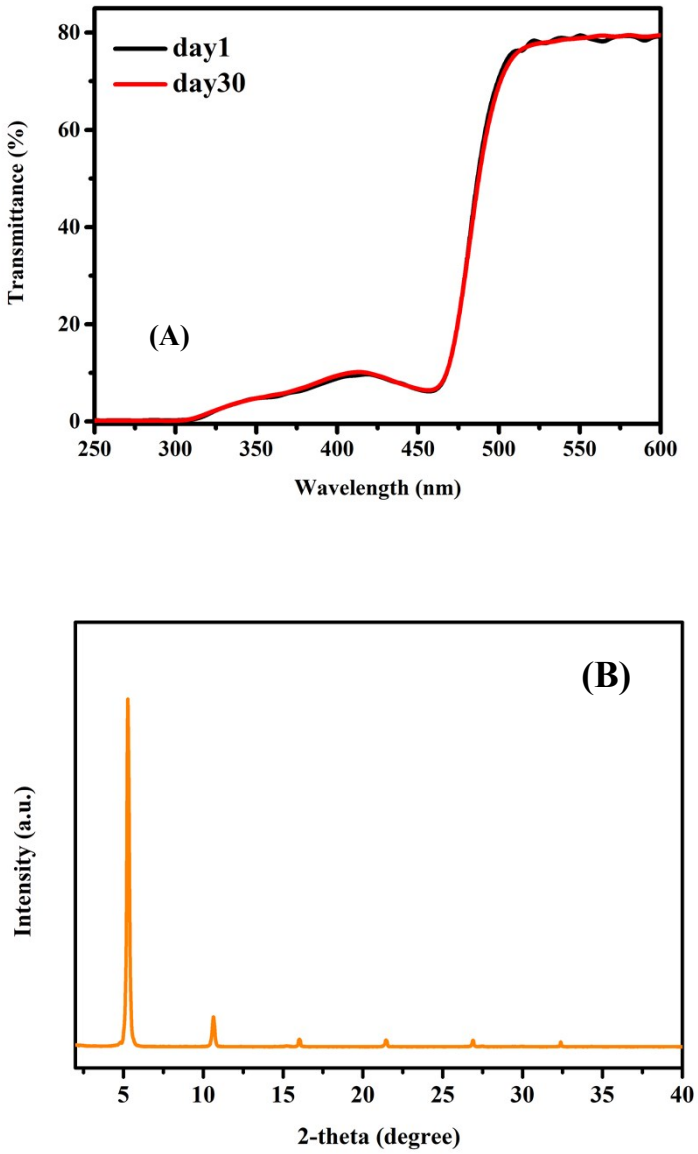


**Fig. S2. (A)** Transmittance (%) as a function of wavelength for $(FPEA)_2PbI_2Br_2$ for day 1 and day30 **(B)** XRD diffraction pattern of $(FPEA)_2PbI_2Br_2$ for >1 months, indicating excellent stability of the material.

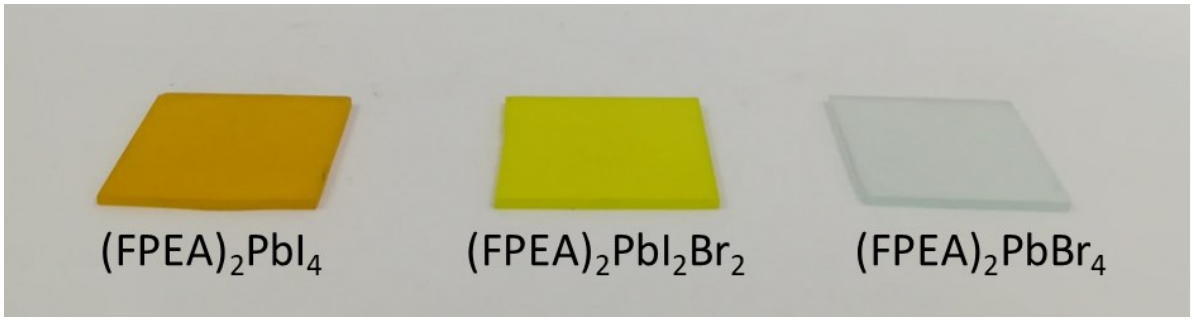


**Fig. S3.** Optical Images of $(FPEA)_2PbI_4$, $(FPEA)_2PbI_2Br_2$, and $(FPEA)_2PbBr_4$ films over glass, deposited via anti-solvent assisted one-step spin coating method.

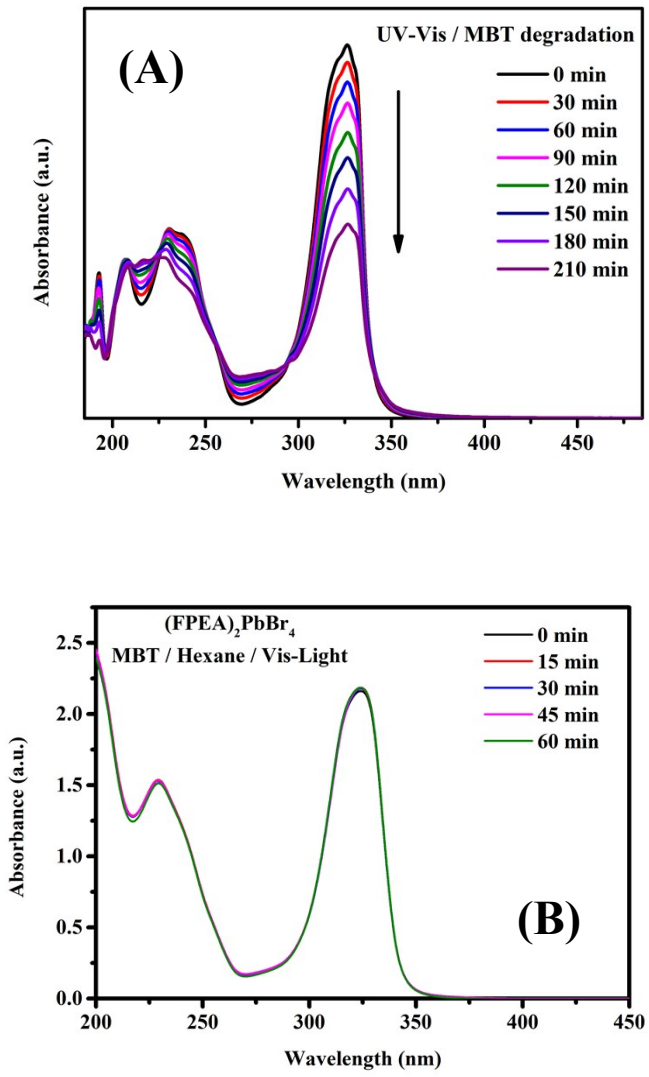


**Fig. S4. (A)** Absorbance spectra of MBT showing photolysis in presence of UV-Vis light (without 2D-HaP). **(B)** UV-Vis absorbance spectra of MBT as a function of time Under Visible light of showing no photocatalytic degradation in presence of $(FPEA)_2PbBr_4$ thin-film.

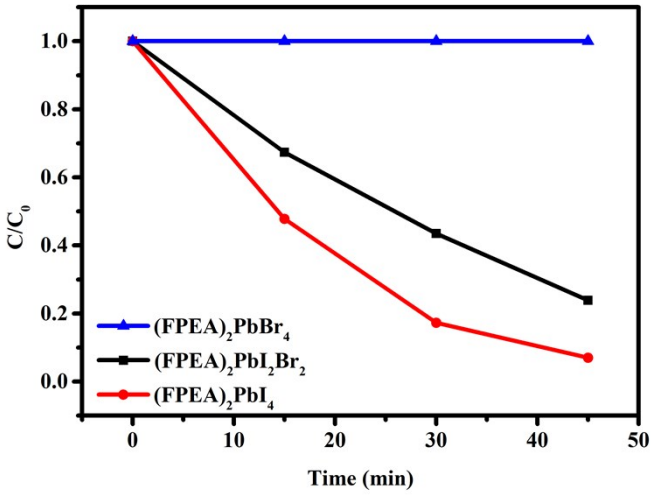


**Fig S5.** ($C/C_0$) as a function of time for various 2D-HaP.

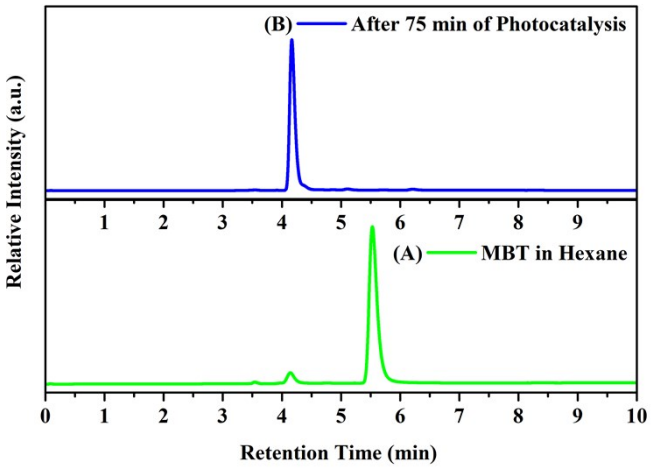


**Fig S6.** HPLC analysis of MBT in hexane (A) before photocatalyst and (B) after 75 minutes of photocatalysis.

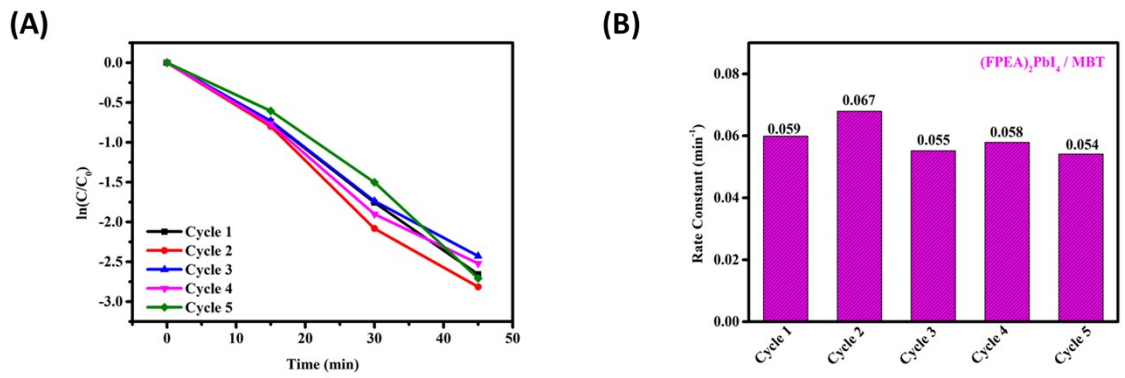


**Fig. S7.** (A) $\ln(C/C_0)$ as a function of time for $(FPEA)_2PbI_4$ for consecutive 5 cycles, and (B) rate constants of $(FPEA)_2PbI_4$ for 5 consecutive cycles.

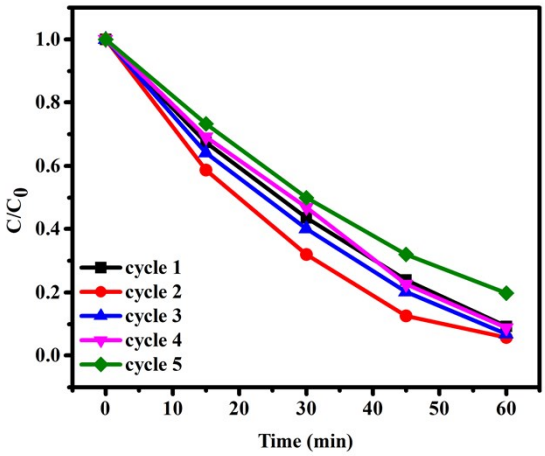


**Fig. S8.** $(C/C_0)$ as a function of time of $(FPEA)_2PbI_2Br_2$ for 5 consecutive cycles during MBT photocatalysis.

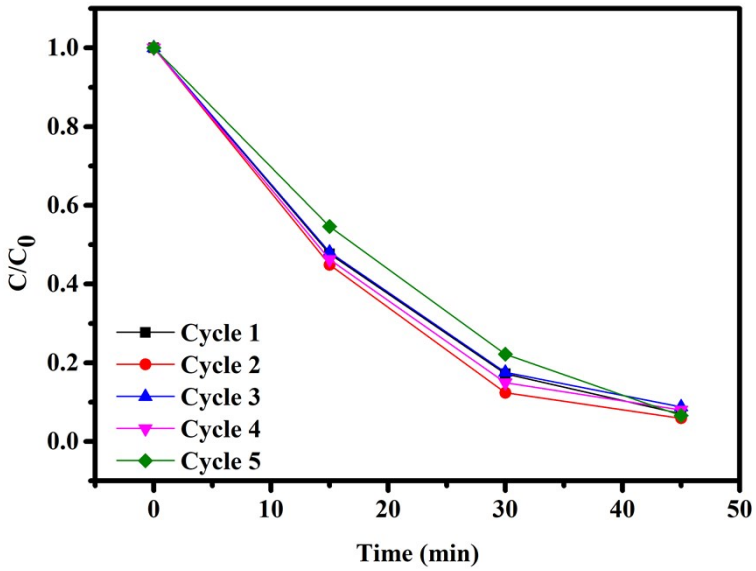


**Fig. S9.** ($C/C_0$) as a function of time of $(FPEA)_2PbI_4$ for 5 consecutive cycles during MBT photocatalysis.

| $R_2PbI_2Br_2$ | Rate constant(/K/) $min^{-1}$ |
|---|---|
| 1st Cycle | 0.034 |
| 2nd Cycle | 0.051 |
| 3rd Cycle | 0.038 |
| 4th Cycle | 0.037 |
| 5th Cycle | 0.027 |

**Table S1.** Values of rate constants of $(FPEA)_2PbI_2Br_2$ for 5 consecutive cycles.

| $R_2PbI_4$ | Rate constant(/K/) $min^{-1}$ |
|---|---|
| 1st Cycle | 0.059 |
| 2nd Cycle | 0.067 |
| 3rd Cycle | 0.055 |
| 4th Cycle | 0.058 |
| 5th Cycle | 0.054 |

**Table S2.** Values of rate constants of $(FPEA)_2PbI_4$ for 5 consecutive cycles.

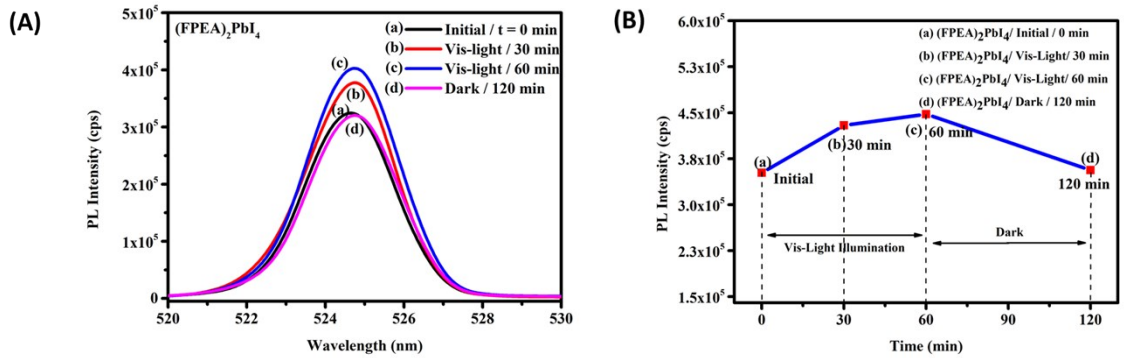


**Fig. S10.** (A) Increase in PL emission intensity for $(FPEA)_2PbI_4$ after constant visible light irradiation (b, c) compared to initial PL emission intensity and then decrease in PL emission intensity (d) under dark. (B) The increase in the corresponding magnitude of PL emission intensity values, followed by decrease in the PL emission intensity value under dark.

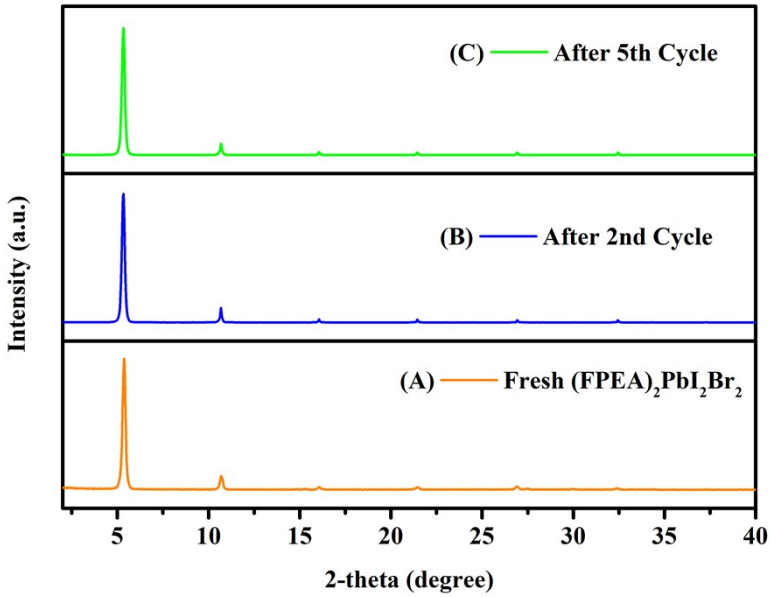


**Fig. S11.** XRD pattern of the fresh $(FPEA)_2PbI_2Br_2$ (A), after 2nd cycle of photocatalysis (B), and after 5th cycle of photocatalysis (C).

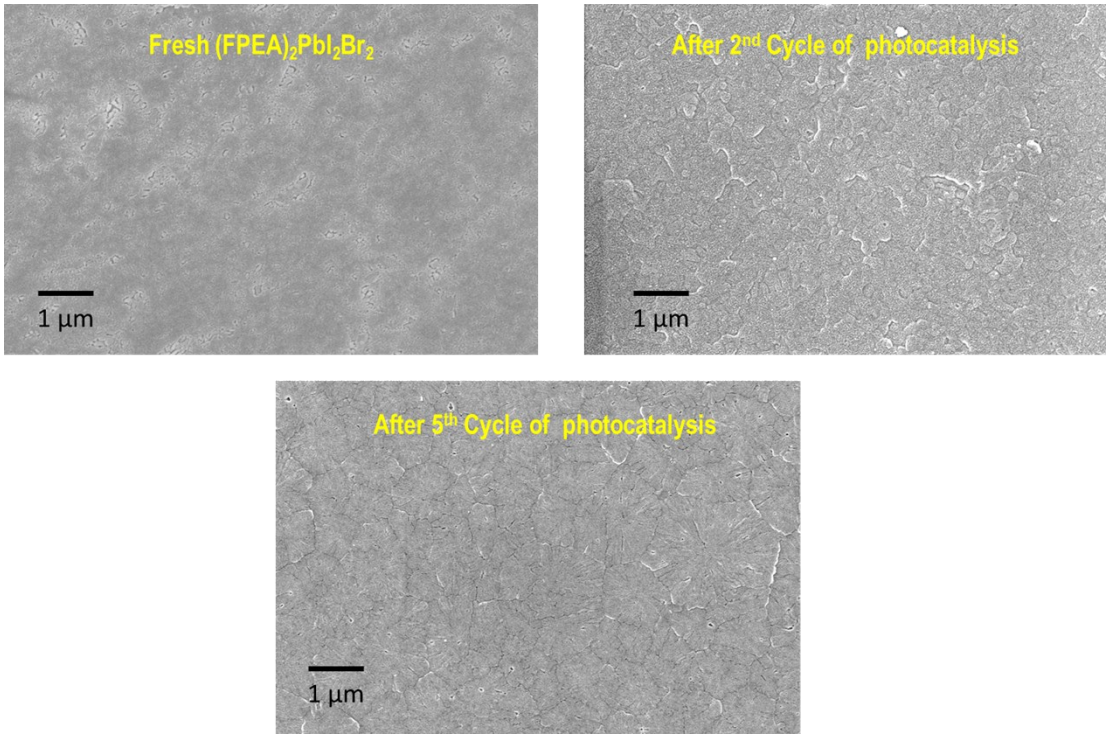


**Fig. S12.** SEM images of the surface of fresh $(FPEA)_2PbI_2Br_2$, and $(FPEA)_2PbI_2Br_2$ after 2nd and 5th cycle of photocatalysis.

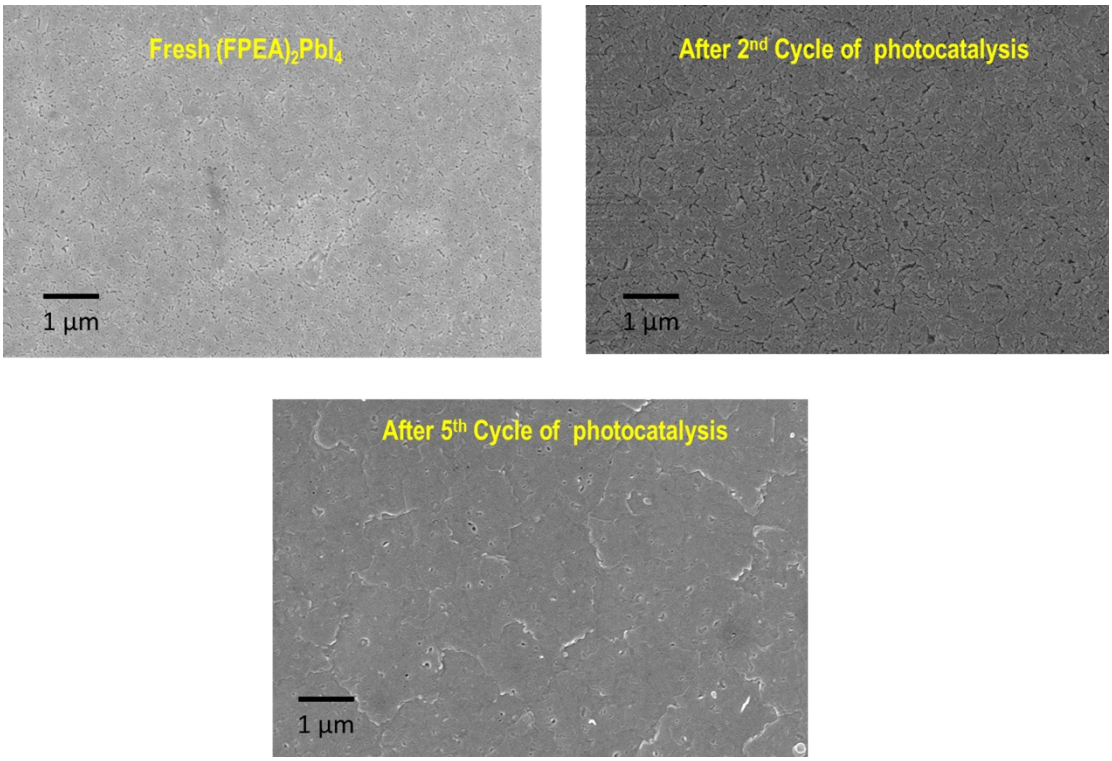


**Fig. S13.** SEM images of the surface of fresh $(FPEA)_2PbI_4$, and $(FPEA)_2PbI_4$ after 2nd and 5th cycle of photocatalysis.

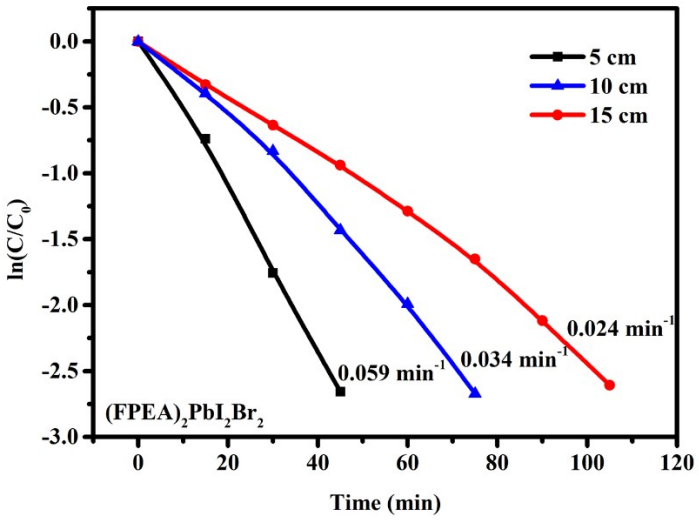


**Fig. S14.** $\ln(C/C_0)$ as a function of time for $(FPEA)_2PbI_2Br_2$ as a function of light source distance.

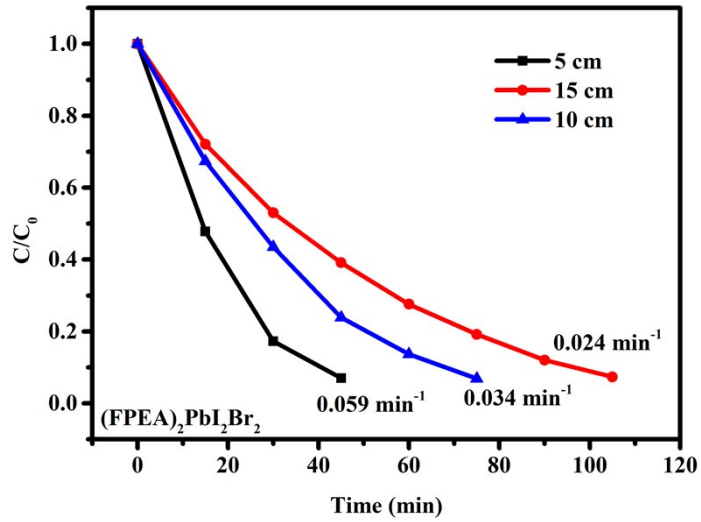


**Fig. S15.** $(C/C_0)$ as a function of time for $(FPEA)_2PbI_2Br_2$ as a function of light source distance.

| Distance of light source from the reactor | Equivalent Sun (100 mW $cm^{-2}$ irradiation = 1 Sun) | Rate Constants ($min^{-1}$) |
|---|---|---|
| 5 cm | 0.6 | 0.059 |
| 10 cm | 0.25 | 0.034 |
| 15 cm | 0.12 | 0.024 |

**Table S3.** Rate constant values as a function of distance between the source and the reaction mixture for photocatalytic dye degradation by $(FPEA)_2PbI_2Br_2$.

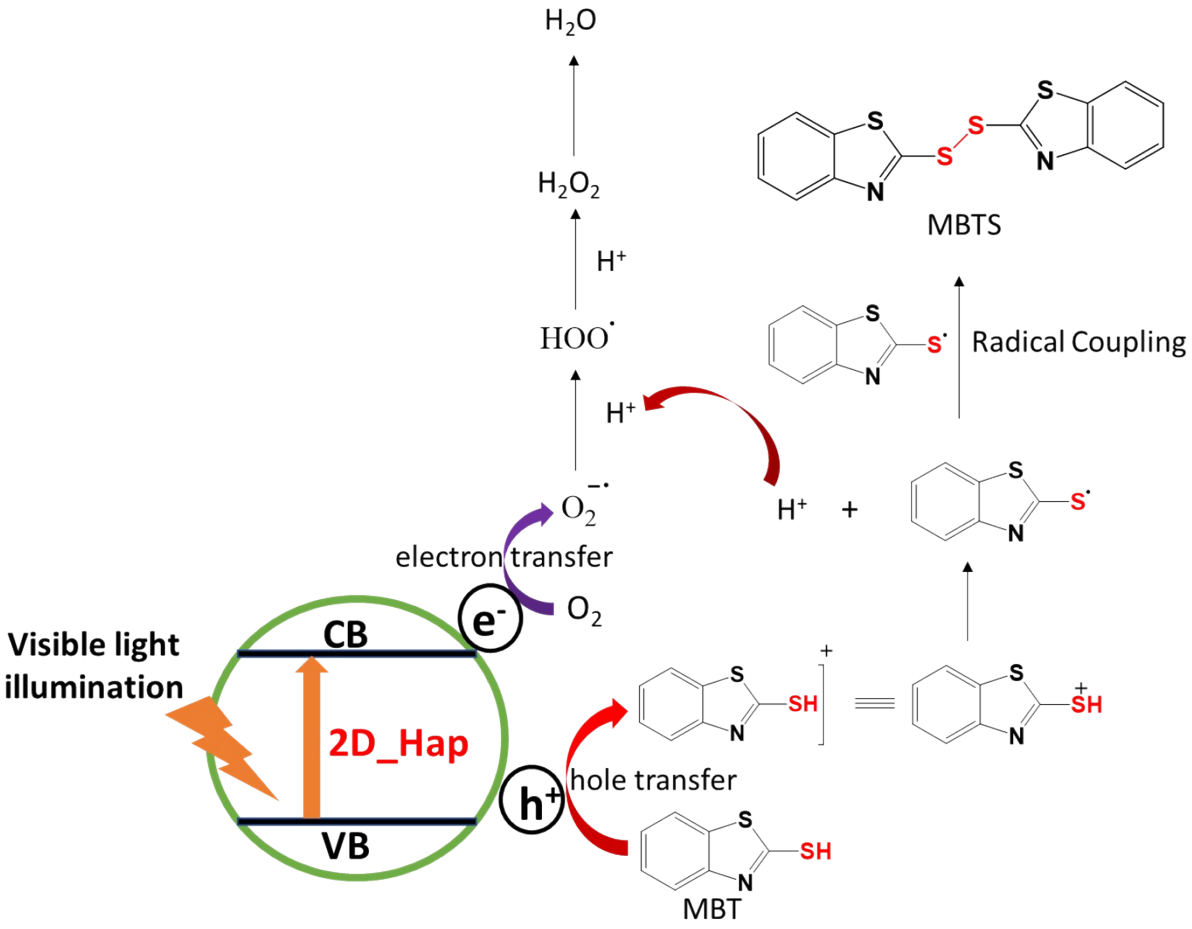


**Fig S16.** Possible photocatalytic degradation mechanism of MBT. [VB: valence band, CB: Conduction band]

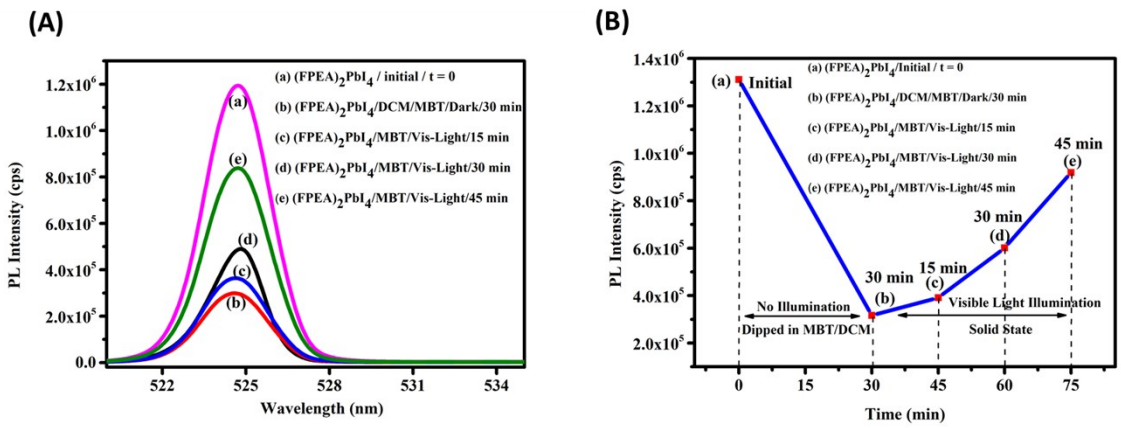


**Fig. S17.** (A) PL emission intensity of $(FPEA)_2PbI_4$ film (a) before, and (b) after dipping into MBT solution in dark, showing MBT molecules are adsorbed at the surface. While after illumination, increase in PL intensity (c, d and e) of the 2D-HaP as a function of time indicates degradation of MBT in solid-state. (B) The decrease in the magnitude of PL emission intensity values after dipping in the MBT solution in DCM and light mediated enhancement of PL intensity.