Supporting Information

2D Perovskite Microsheets for High-Performance Photodetectors

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Experimental Section

Preparation of 2D perovskite microsheets

(PEA)I and (PEA)Br was prepared according to a previous literature.[14] The (PEA)X (X=I or Br) and SnI_2 (Acros, 99.999%) with a mole ratio of 2:1 was dissolved in N,N-dimethylformamide (DMF) (Acros, 99.9%) and stirred for at least 3 h in a glovebox filled with argon gas. The concentration of the solution was controlled to be 0.5 mol L^{-1}. The solution was then diluted 100 times by a DMF/chlorobenzene (1:1 volume ratio) co-solvent. Then, the diluted solution was further diluted by CB/acetonitrile (2:1 volume ratio) co-solvent to the concentration of 0.025 mmol L^{-1}, 0.05 mmol L^{-1}, 0.075 mmol L^{-1} or 0.1 mmol L^{-1}. Si/SiO_2 substrates were cleaned ultrasonically in acetone, ethanol, and isopropyl alcohol for 20 min sequentially, dried by N_2-flow and followed by a 15 min UV-ozone treatment. The substrates were then transferred into the glove box and preheated at a certain temperature (60℃, 70℃, 80℃, 90℃, 100℃) on a hot plate. 10 μL of the diluted solution was dropped onto the Si/SiO_2 surface and dried on the hot plate.

Device fabrication and measurements

60 nm Au electrodes were thermal evaporated (pressure ≤ 10^{-4} Pa) onto the as prepared samples with a copper grid shadow mask. The rib width of the coper grid is 6 μm. The device performance was studied on Summit 11000 AP probe station (CASCADE microtech) equipped with a B1500A Semiconductor Device Analyzer (Agilent Technologies).

Characterization

X-ray diffraction (XRD) patterns were recorded on Bruker D8 ADVANCE diffractometer (Cu K_α radiation, λ = 1.5406 Å). UV-vis absorption spectra were taken out from a Lambda 35 UV-vis spectrometer (PerkinElmer). Stady-state photoluminesence (PL) was measured on a LabRAM HR Evolution (Horiba Jobin

Yvon) Raman spectrometer with a 532-nm laser. Scanning electron microscopy (SEM) images were obtained on a Sirion-200 field-emission scanning electron microscope (FEI). Atomic force microscopy images were carried out by the use of Bruker Dimension Icon microscope. Optical microscopy images were obtained on Olympus BX 51M optical microscope.

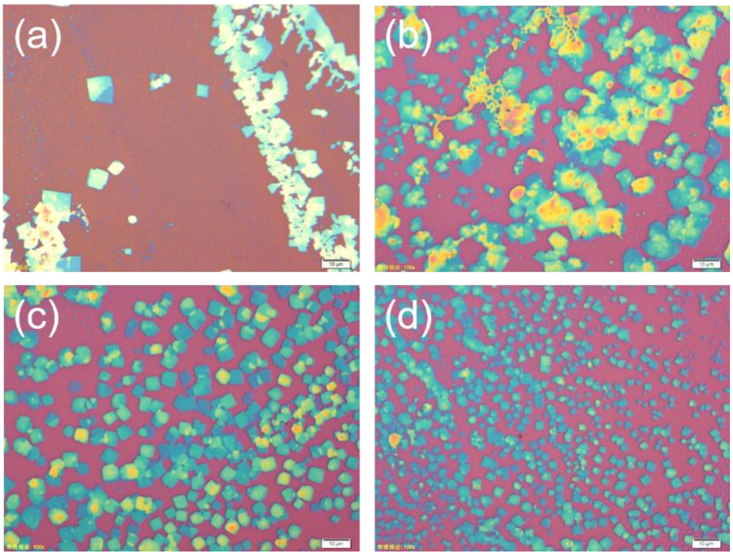

Fig. S1 Optical microscopy images of $(PEA)_2SnI_4$ microsheets grown at 70℃ (a), 80℃ (b), 90℃ (c), 100℃ (d). Scale bar: 10 μm.

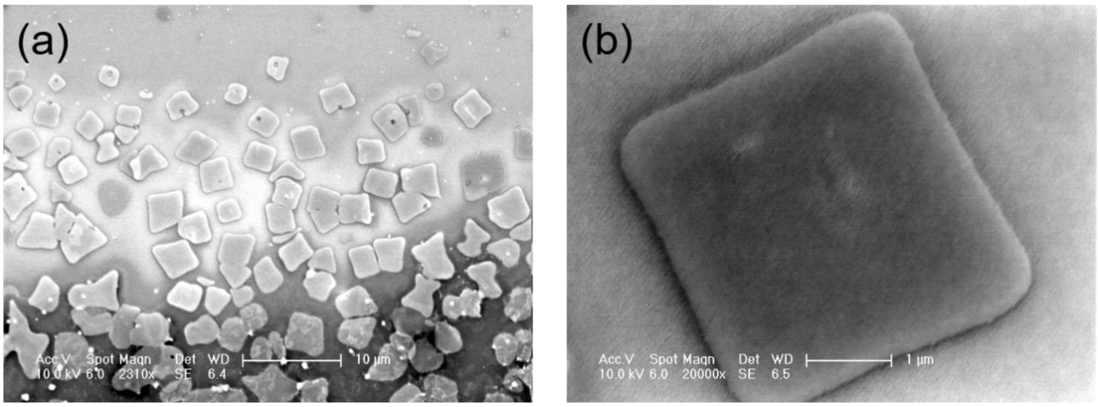

Fig. S2 SEM images of $(PEA)_2SnI_4$ microsheets.

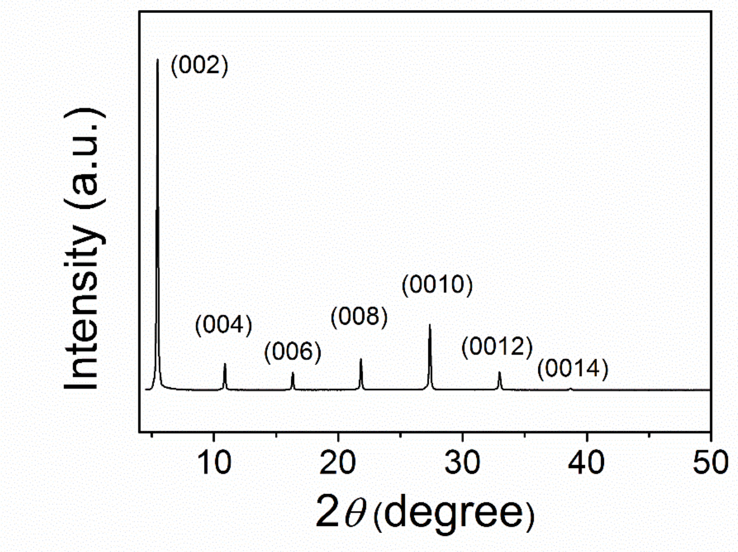

Fig. S3 XRD pattern of $(PEA)_2SnI_4$ microsheets.

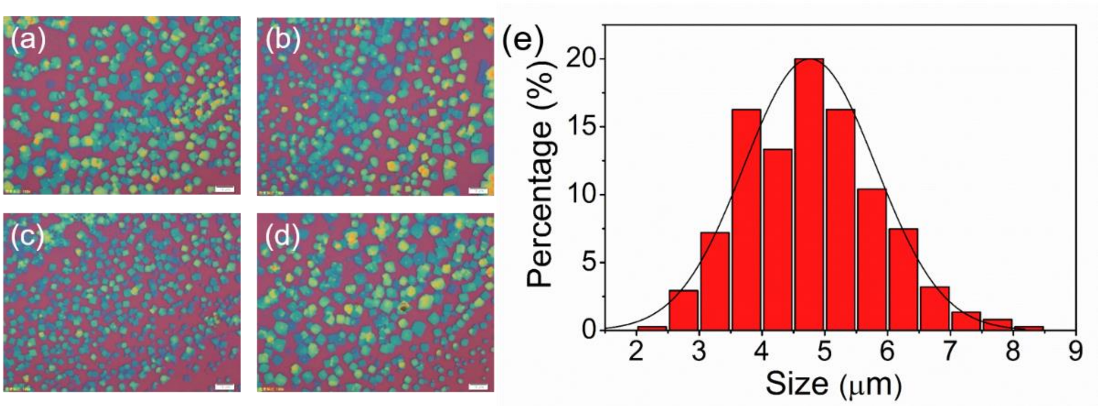

Fig. S4 (a-d) Optical microscopy images of $(PEA)_2SnI_4$ microsheets. Scale bar: 10 μm. (e) Statistics of lateral size.

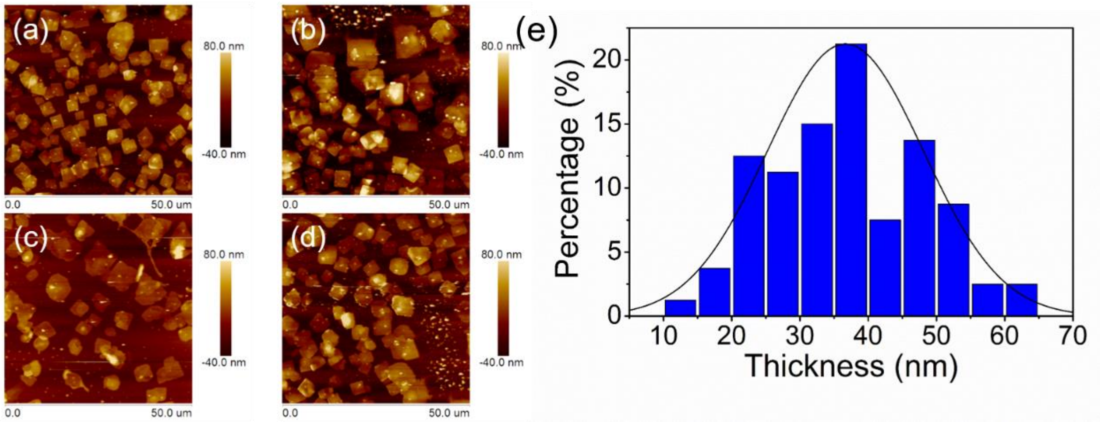

Fig. S5 (a-d) AFM images of $(PEA)_2SnI_4$ microsheets; (e) statistics of thickness.

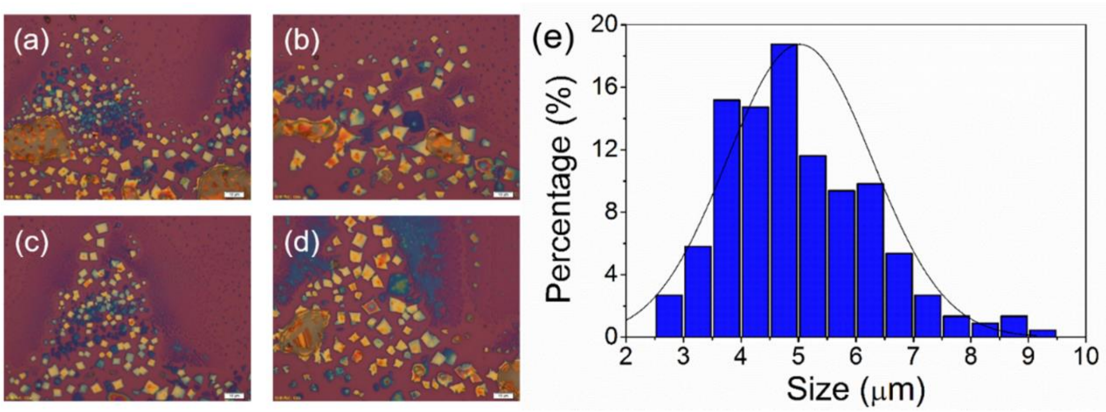

Fig. S6 (a-d) Optical microscopy images of $(PEA)_2SnI_3Br$ microsheets. Scale bar: 10 μm. (e) Statistics of lateral size.

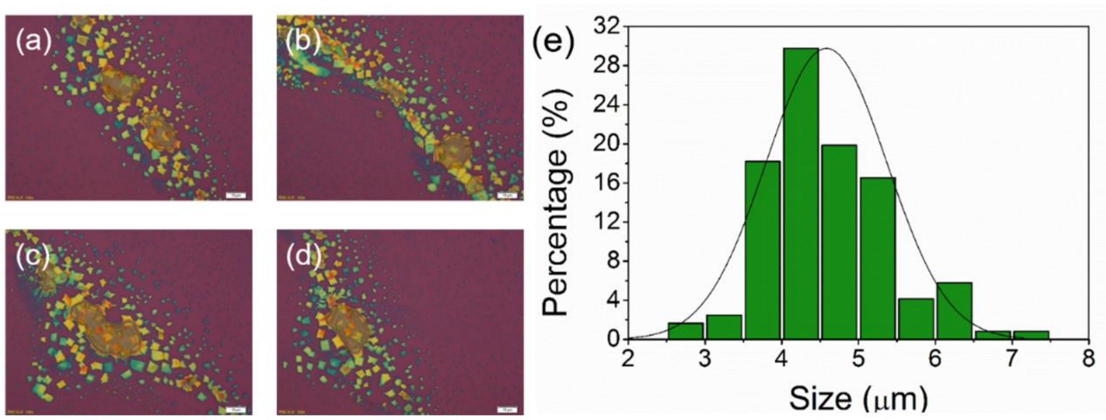

Fig. S7 (a-d) Optical microscopy images of $(PEA)_2SnI_2Br_2$ microsheets. Scale bar: 10 μm. (e) Statistics of lateral size.

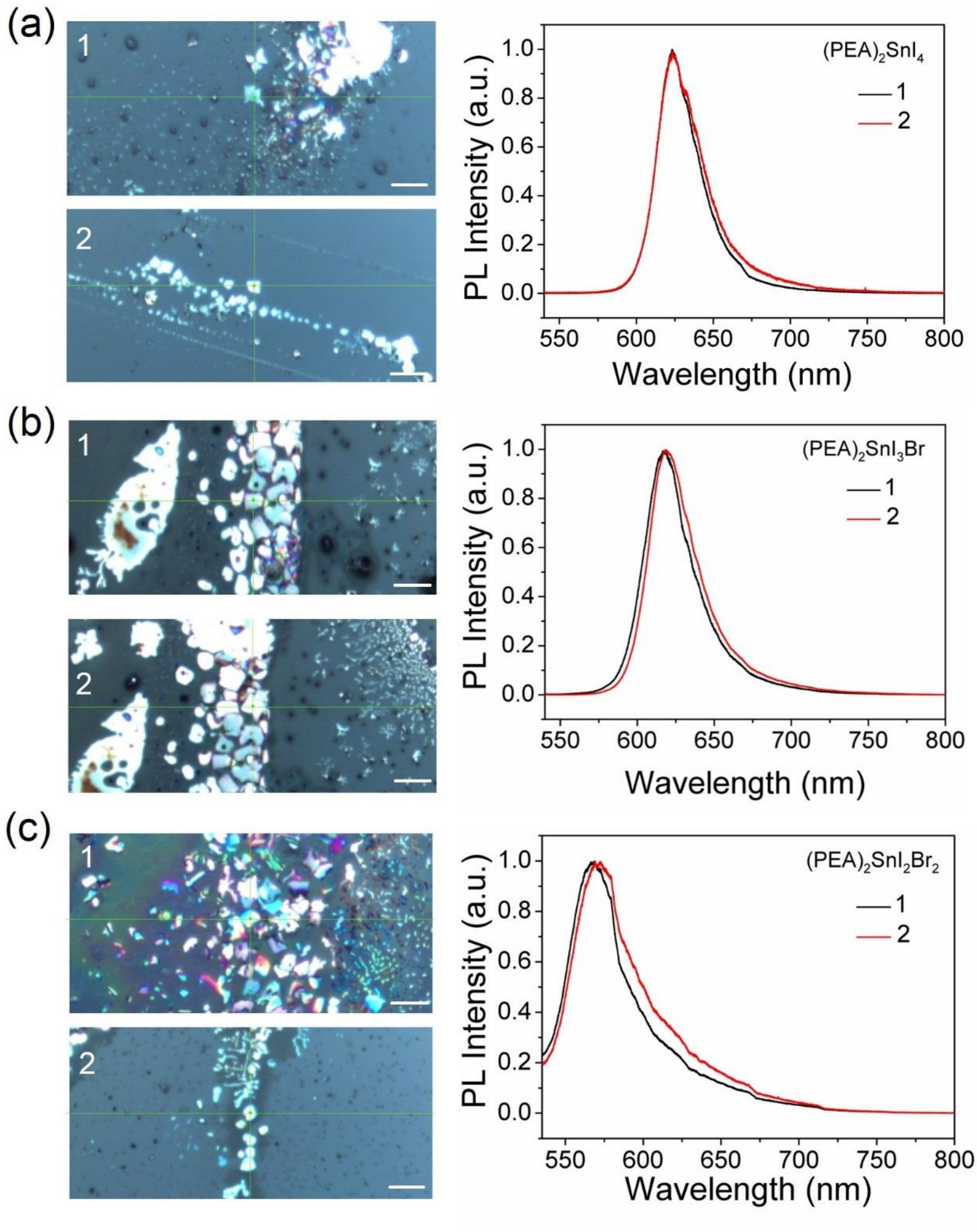

Fig. S8 Optical microscopy images and PL spectra for $(PEA)_2SnI_4$ (a), $(PEA)_2SnI_3Br$ (b), and $(PEA)_2SnI_2Br_2$ (c) microsheets. Scale bar: 10 μm.

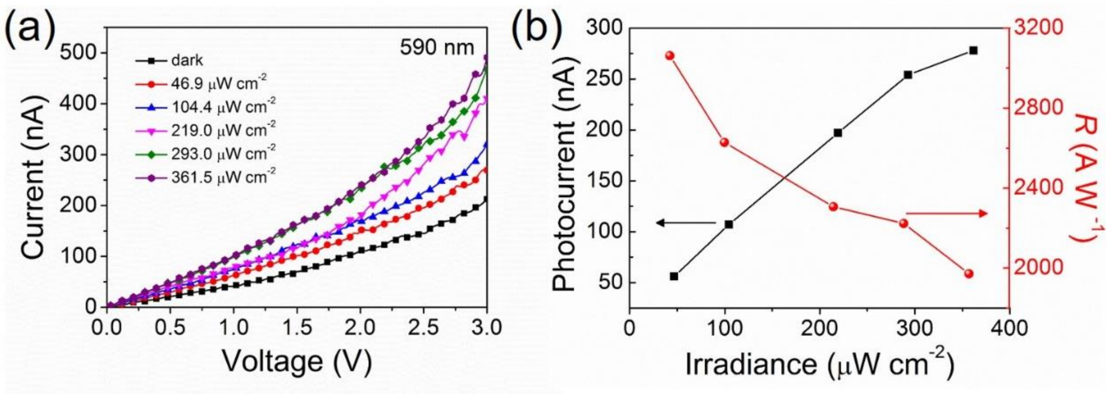

Fig. S9 (a) *I-V* curves of $(PEA)_2SnI_4$ device under dark and irradiation with different intensity (590 nm). (b) Irradiance dependence of photocurrent and photoresponsivity for $(PEA)_2SnI_4$ device at 3 V bias (590 nm).

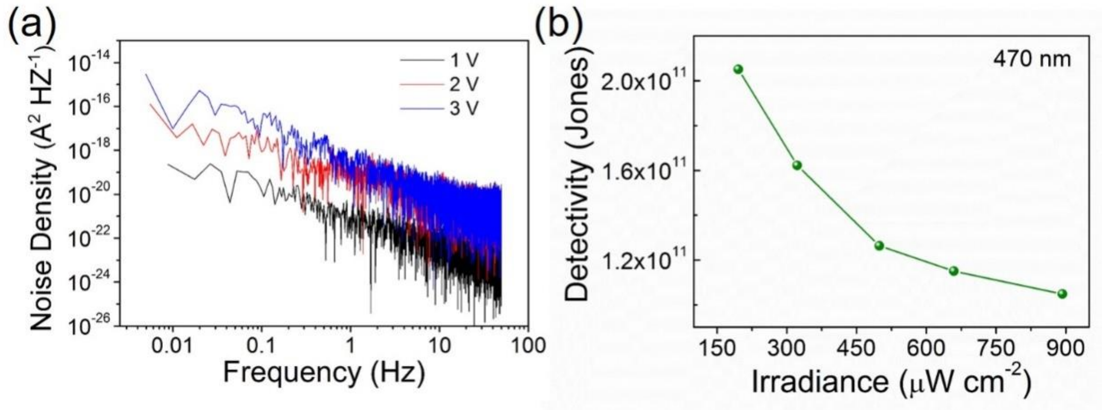

Fig. S10 (a) Noise analysis for $(PEA)_2SnI_4$ device under different bias. The noise density was obtained from the Fast Fourier Transform of the dark current versus time. (b) Irradiance dependence of detectivity of $(PEA)_2SnI_4$ device at 3 V bias (470 nm).

Sn perovskite device gave noise current (I_n) of ~10 pA $Hz^{-1/2}$ at high frequencies.[1] Specific detectivity (D^*) was calculated by using the equation $D^* = S^{1/2}/\mathrm{NEP} = S^{1/2}/(I_n/R)$, where NEP is the noise equivalent power, I_n is the noise current (A $Hz^{-1/2}$), S is the effective area of the device, R is the photoresponsivity of the device.

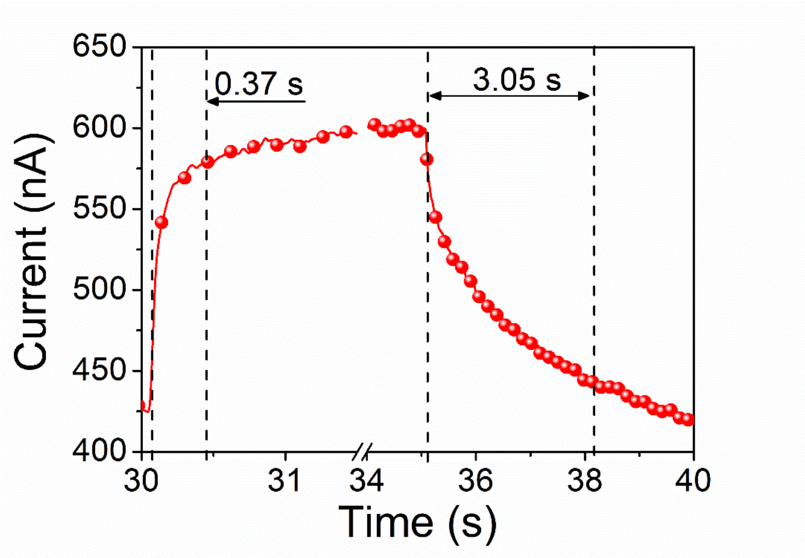

Fig. S11 An enlarged view of the temporal photocurrent response during on-off illumination switching with 5 s interval.

Table S1 The photoresponsivity comparison between pure perovskite photodetectors.

materials	device structures	photoresponsivity ($A\ W^{-1}$)	references
$CH_3NH_3PbI_3$ film	phototransistor	320	[2]
$(C_4H_9NH_3)_2(CH_3NH_3)_2Pb_3I_{10}$ film	two-electrode photodetectors	12.78×10^{-3}	[3]
$CH_3NH_3PbI_3$ 2D nanocrystal	phototransistor	12	[4]
$(PEA)_2SnI_4$ film	phototransistor	1.9×10^{4}	[5]
$(PEA)_2PbBr_4$ 2D crystal	interdigital graphene electrodes	2100	[6]
$(PEA)_2SnI_4$ microsheet	photoconductor	3290	This work

References

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