Supplementary Information (SI) for Journal of Materials Chemistry C.

Supporting Information

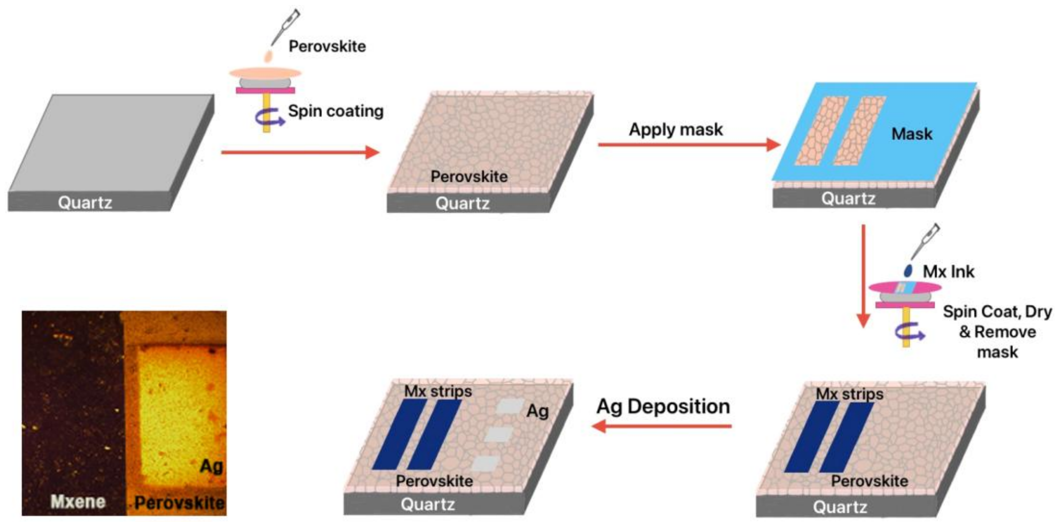
Asymmetric Contact Enabled Self-Powered Flexible Photodetector on Formamidinium Based Perovskite with 2D MXene Electrode

Debabrata Sahu[1], Sanjoy Sur Roy[1], Koushik Ghosh[1] and P. K. Giri[1,2 *]

[1]Department of Physics, Indian Institute of Technology Guwahati, Guwahati 781039, India

[2]Centre for Nanotechnology, Indian Institute of Technology Guwahati, Guwahati 781039, India

[*] Corresponding author; email - giri@iitg.ac.in



Scheme 1: Schematic of the fabrication process of perovskite photodetector with MXene and Ag electrodes and the digital picture of real device.

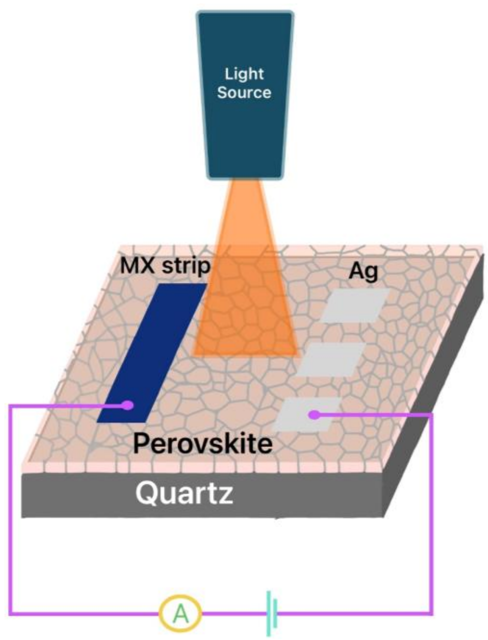


Figure S1. Schematic of the photodetector device structure

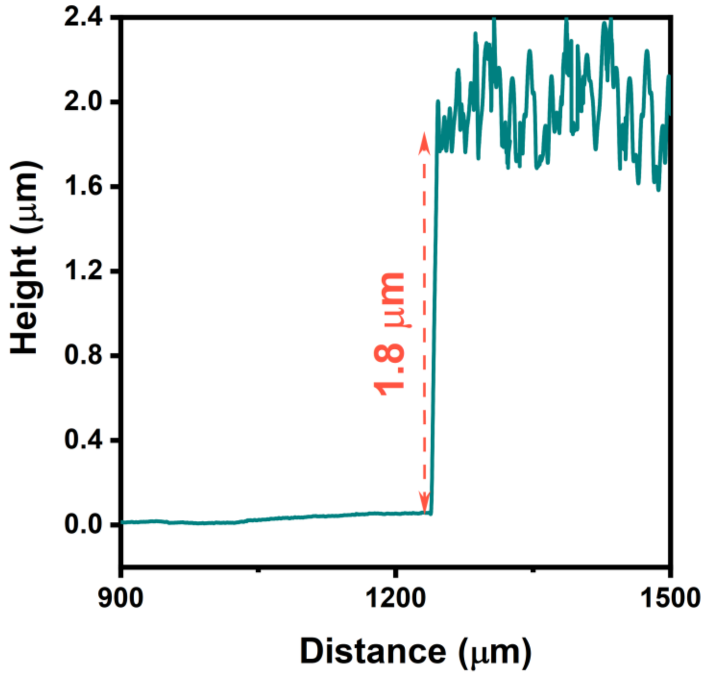


Figure S2. Height/ thickness profile of MXene film used as an electrode.

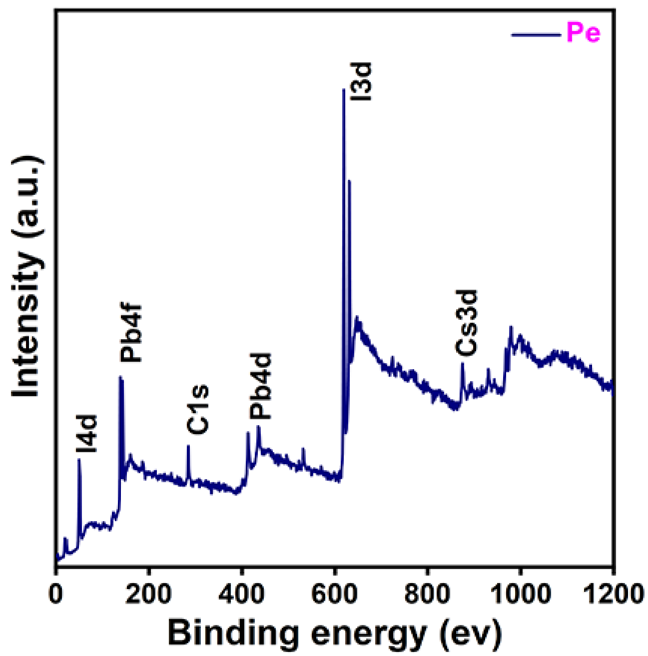


Figure S3. XPS survey scan spectra of perovskite film.

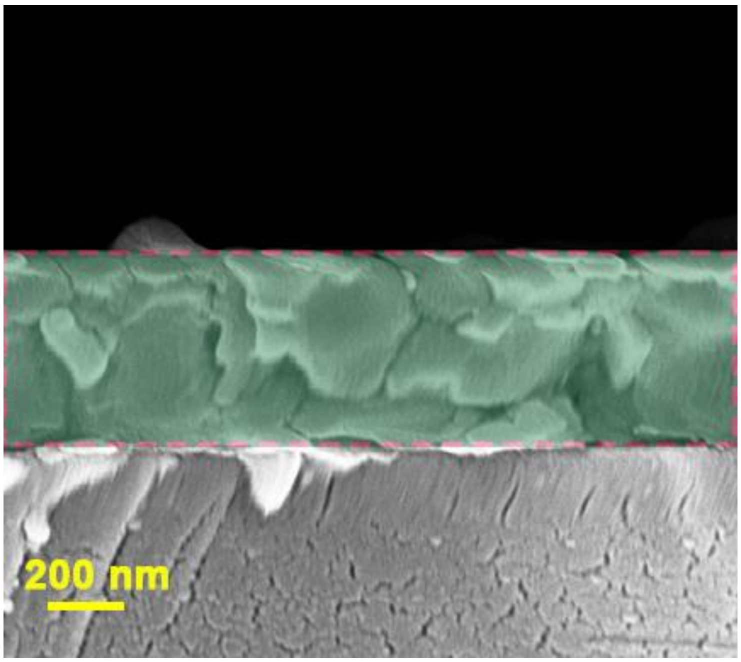


Figure S4. Cross-sectional FESEM image of perovskite thin film in the device.

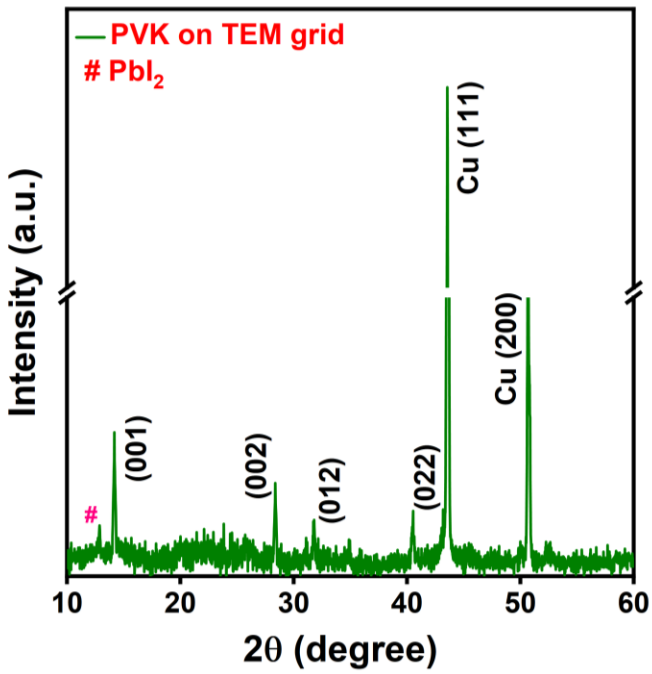


Figure S5. XRD pattern of the Perovskite film spin-coated on the TEM grid.

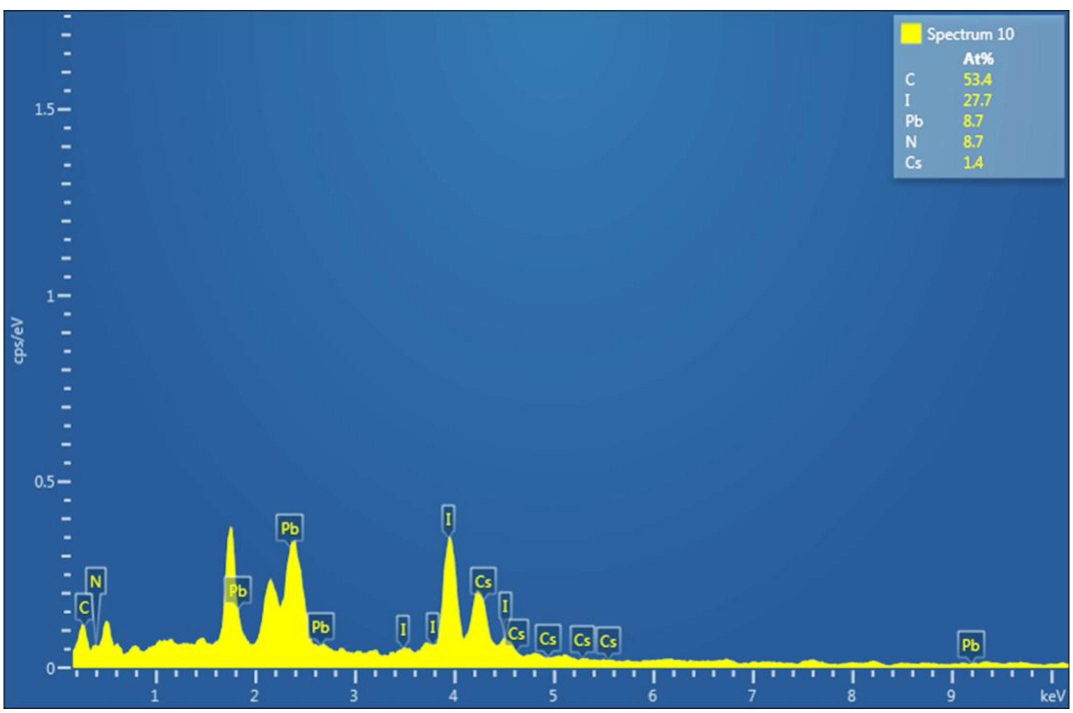


Figure S6. EDS spectrum of the $FA_{0.88}Cs_{0.12}PbI_3$ perovskite film.

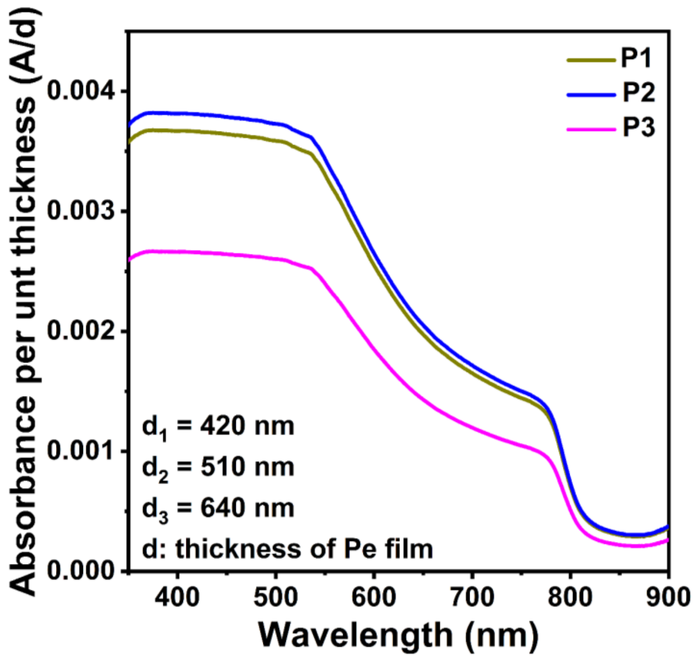


Figure S7. Thickness normalized absorption spectra of samples P1, P2, and P3.

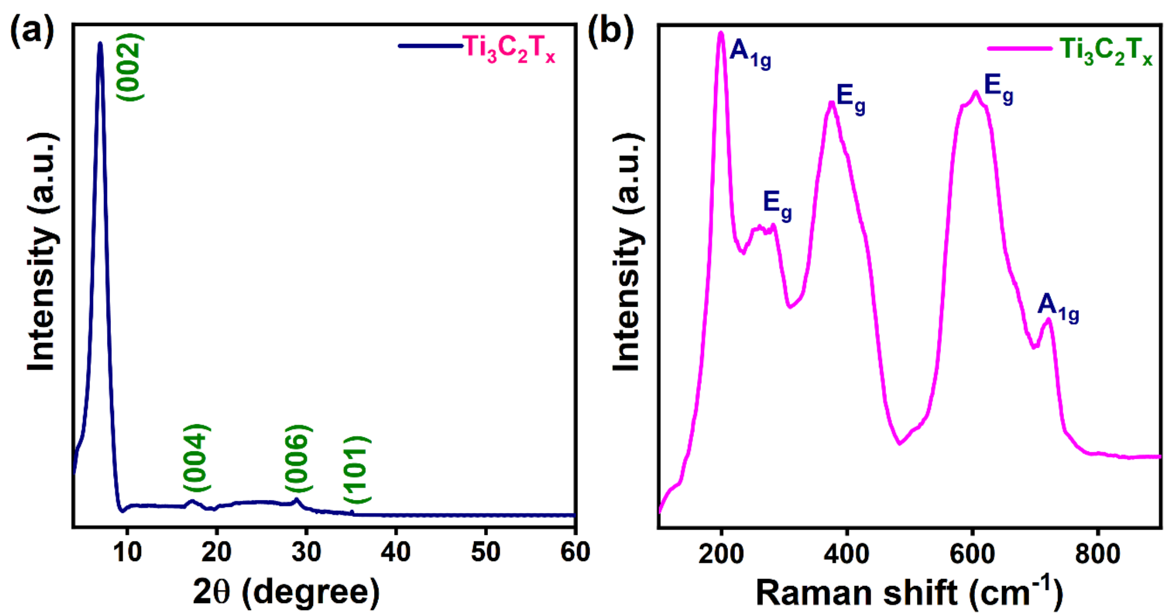


Figure S8. (a) XRD pattern and (b) Raman spectrum of MXene nanosheet.

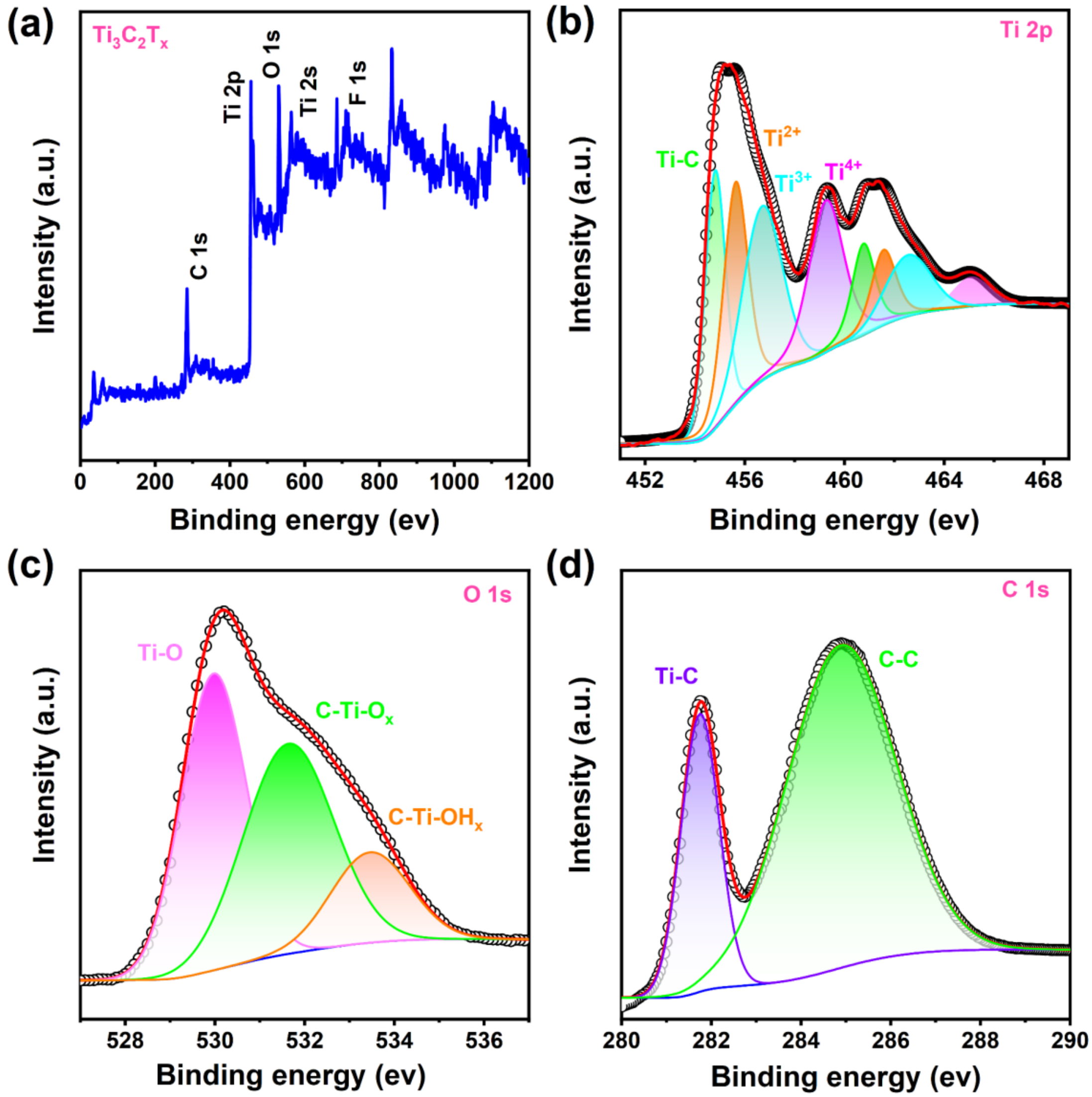


Figure S9. (a) XPS survey spectrum, and (b, c, d) high-resolution XPS spectra of Ti 2p, O 1s, C 1s, respectively, of MXene nanosheets.

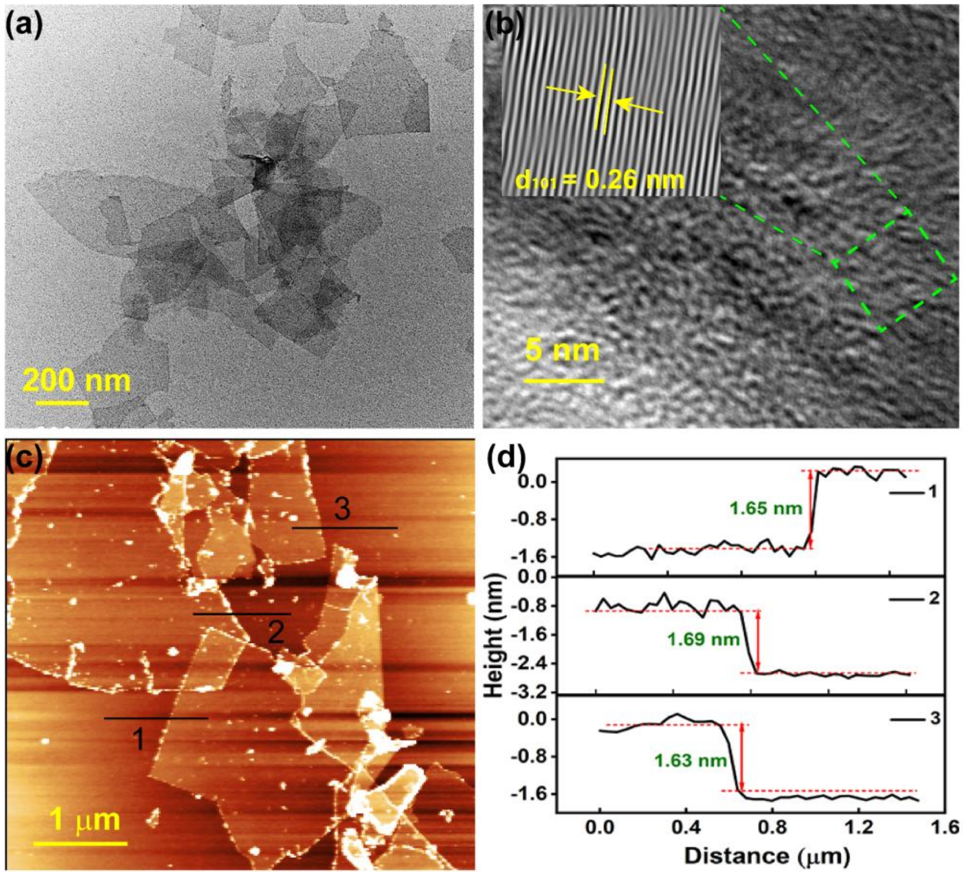


Figure S10. (a) TEM image, (b) HRTEM lattice image, (c) AFM image, and (d) the corresponding height profile of MXene nanosheets.

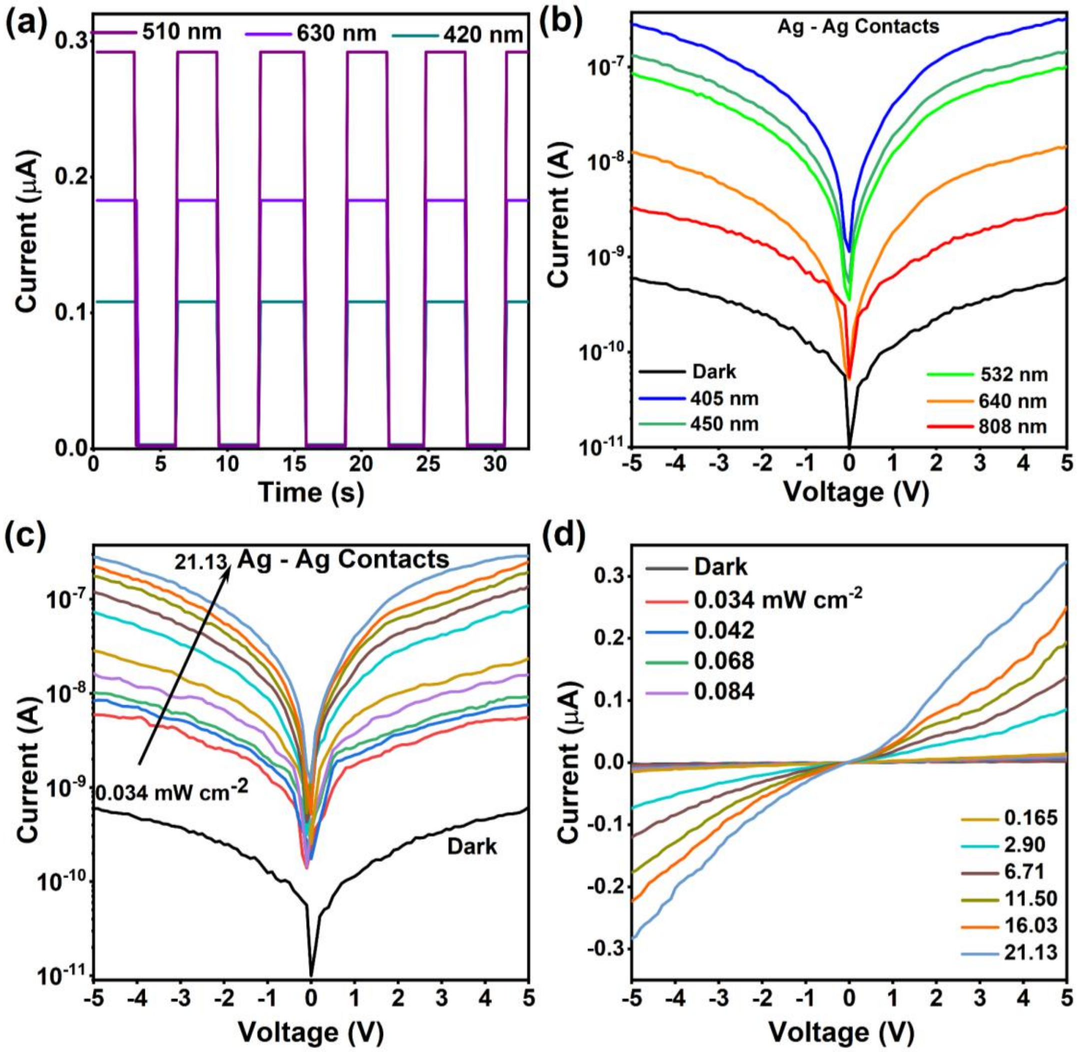


Figure S11. (a) Temporal photoresponse of the PD with different perovskite thicknesses of 420 nm, 510 nm, and 630 nm. (b) I-V characteristics of Ag-Pe-Ag PD with different wavelengths. (c) Dark and photo I–V characteristics of the device under 405 nm laser illumination at different intensities. (d) I-V characteristics of the device under dark and illumination.

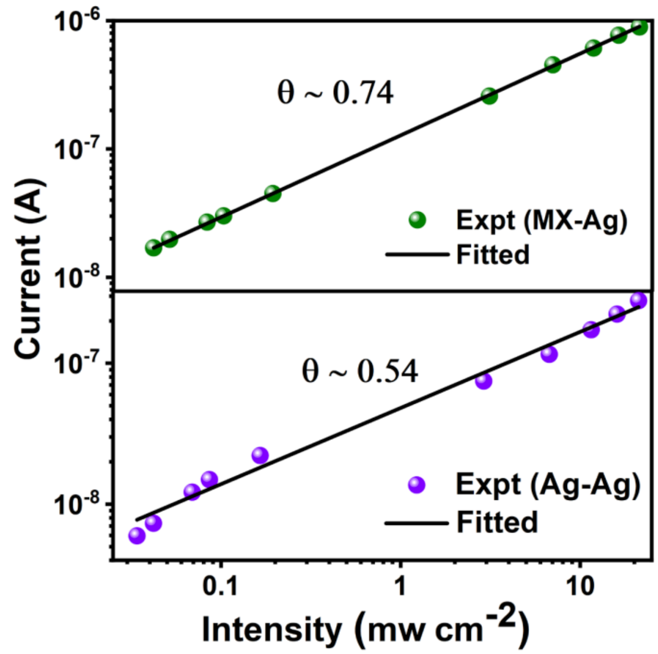


Figure S12. Photocurrent as a function of light intensities for the PDs with asymmetric contact (MX-Ag) and symmetric contact (Ag-Ag).

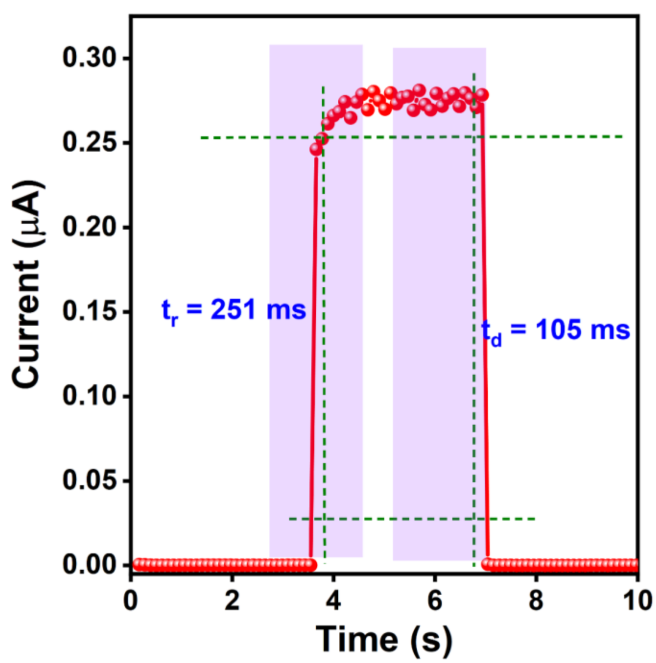


Fig. S13. Photocurrent growth and decay profiles of the Ag-Pe-Ag PD.

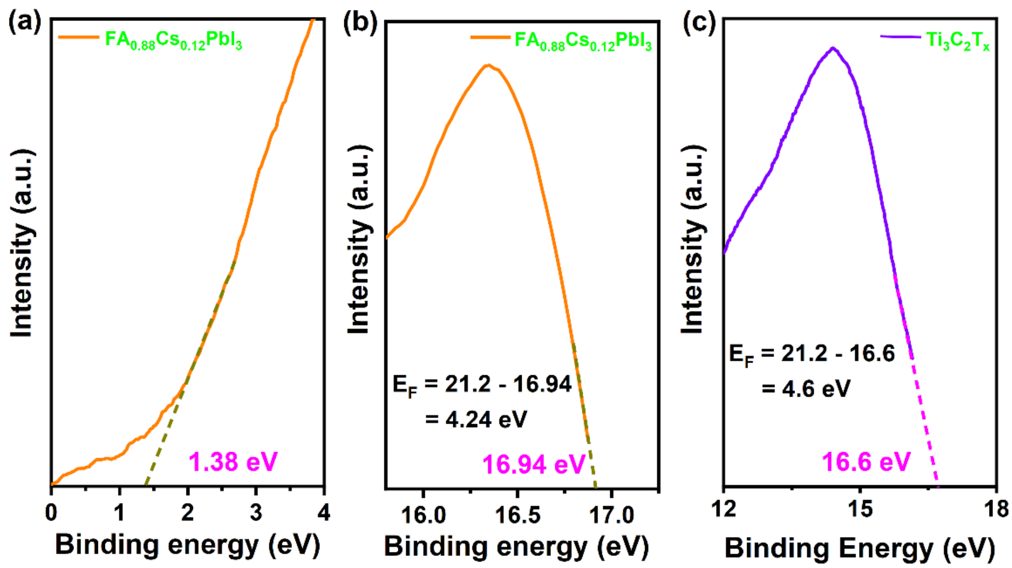


Figure S14. UPS spectra of (a, b) perovskite thin film and (c) MXene nanosheets.

Table S1. Details of the fitting parameters for time-resolved photoluminescence (TRPL) spectra of perovskite film.

Sample	A_1	τ_1 (ns)	A_2	τ_2 (ns)	A_3	τ_3 (ns)	τ_{avg} (ns)
S2	43.4	29.43	31.8	3.07	4951.4	0.55	9.61

Details Calculation of the responsivity and specific detectivity of hybrid device:

Responsivity: $$\mathbf{R} = \frac{I_{ph}}{A\,P}$$

Where I_{ph} represents the photocurrent, the difference between light current and dark current. A is the effective device area, and P denotes the light intensity.

$$\mathbf{I_{ph} = I_{\lambda} - I_d}$$

$I_{\lambda} = 1.28086 \times 10^{-7}$ A, $I_d = 6.09936\times10^{-11}$ A.

Effective device area (A) = 3×10^{-4} cm^2, Intensity (P) = 0.165 mW cm^{-2}, λ = 405 nm

$\mathbf{R} = (1.80799 \times 10^{-7} \times 10^3) / (3\times10^{-4} \times 0.165)$ A/W = **2.58 A/W**.

$$\mathbf{D^*} = \frac{R(\lambda)}{\left(2\,e\,\frac{I_d}{A}\right)^{1/2}}$$

Where e is the charge of an electron.

$\mathbf{D^*} = (2.58) \times (3\times10^{-4})^{1/2} / (2\text{x}1.6\text{x}10^{-19} \times 6.09936 \times 10^{-11})^{1/2}$ = **1.013 × 10^{13} Jones**.