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Supplementary Information:

Quasi-2D Perovskite Antireflection Coating to Boost Performance of Multilayered $PdTe_2$/Ge Heterostructure-Based Near-Infrared Photodetectors

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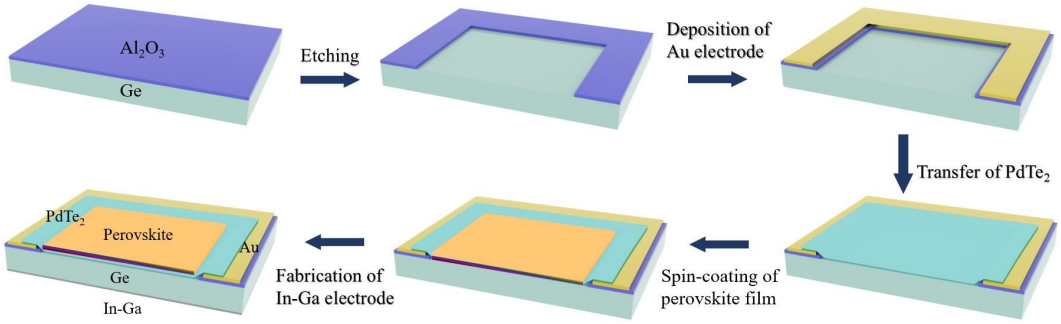

Figure S1. Schematic diagram of the procedures for fabricating $PdTe_2$/Ge heterostructure-based photodetector with quasi-2D perovskite ARC.

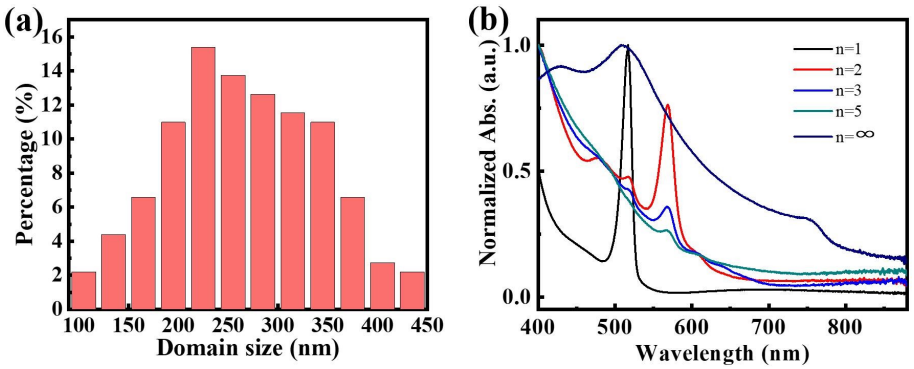

Figure S2. (a) The statistical distribution of the grain size of the $PdTe_2$ multilayer. (b) Normalized absorbance spectra of $(PEA)_2(MA)_{n-1}Pb_nI_{3n+1}$ perovskites with different *n* values.

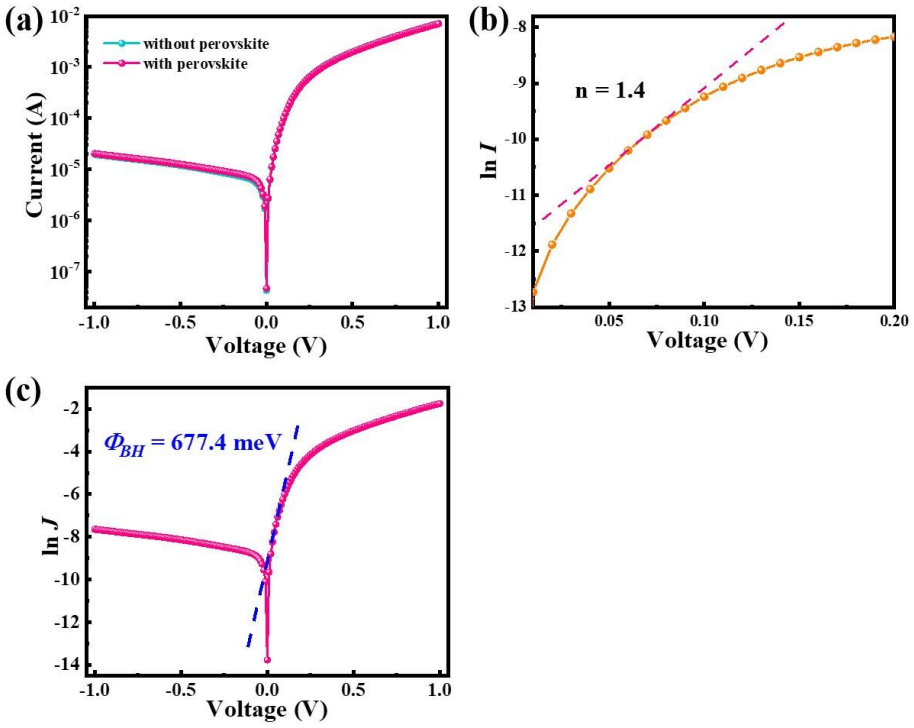

Figure S3. (a) *I-V* curves of the $PdTe_2$/Ge heterostructures without and with quasi-2D perovskite ARC in the darkness. (b) ln*I-V* curve for estimating the diode ideality factor (*n*). (c) The plot of ln*J-V* curve for calculating the barrier height of the heterostructure.

The diode characteristics of the $PdTe_2$/Ge heterostructure could be described by majority carriers over a zero bias barrier height (Φ_{BH}), from the $PdTe_2$ to Ge, based on the thermionic emission theory:[1]

$$J(T,V) = J_S(T)\left[\exp\left(\frac{eV}{nK_BT}\right) - 1\right]$$

where e, K_B and T represent elementary charge, Boltzmann constant, and temperature, respectively. The saturation current density $J_S(T)$ is expressed as:

$$J_S(T) = A^* T^2 exp(-\frac{e\Phi_{BH}}{K_BT})$$

where A^* denotes the effective Richardson constant, and the value is 142.8 $Acm^{-2}K^{-2}$ for n-Ge.[2] In addition, $J_S(T)$=6.23×10^{-2} $mAcm^{-2}$ could be deduced from the ln$J$-V curve in Fig. S3(c). Therefore, the Φ_{BH} was estimated to be ~677.4 meV based on the above equations.

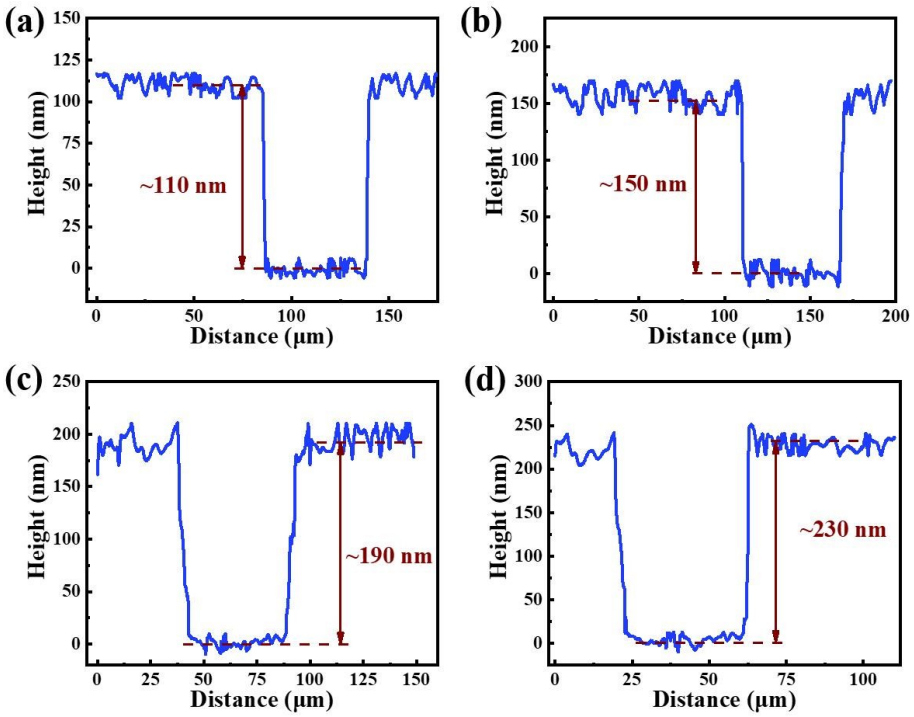

Figure S4. Height profile of the quasi-2D perovskite films with different thicknesses.

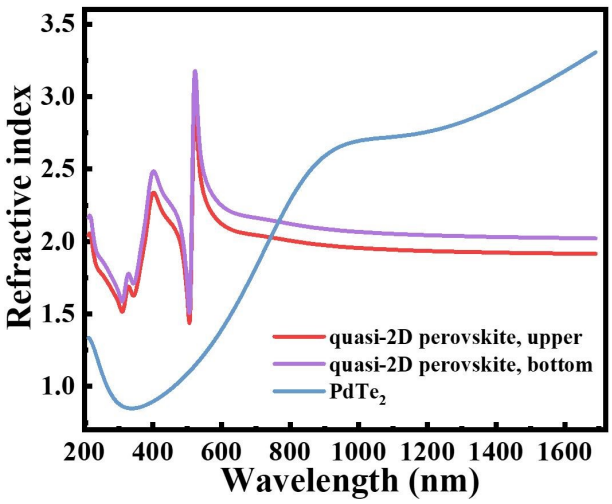

Figure S5. Refractive index of the quasi-2D perovskite film with a thickness of ~192.8 nm and $PdTe_2$ multilayer with a thickness of ~56.7 nm.

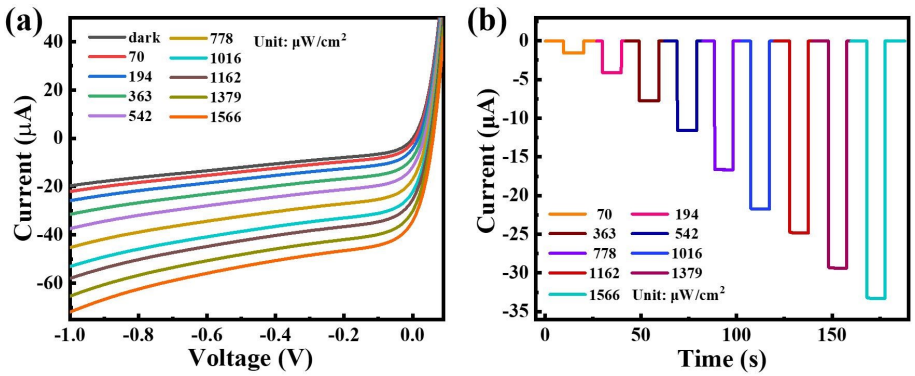

Figure S6. (a) *I-V* curves and (b) time-dependent photoresponse of the $PdTe_2$/Ge heterostructure-based photodetector under 1550 nm NIR light illumination with different intensities.

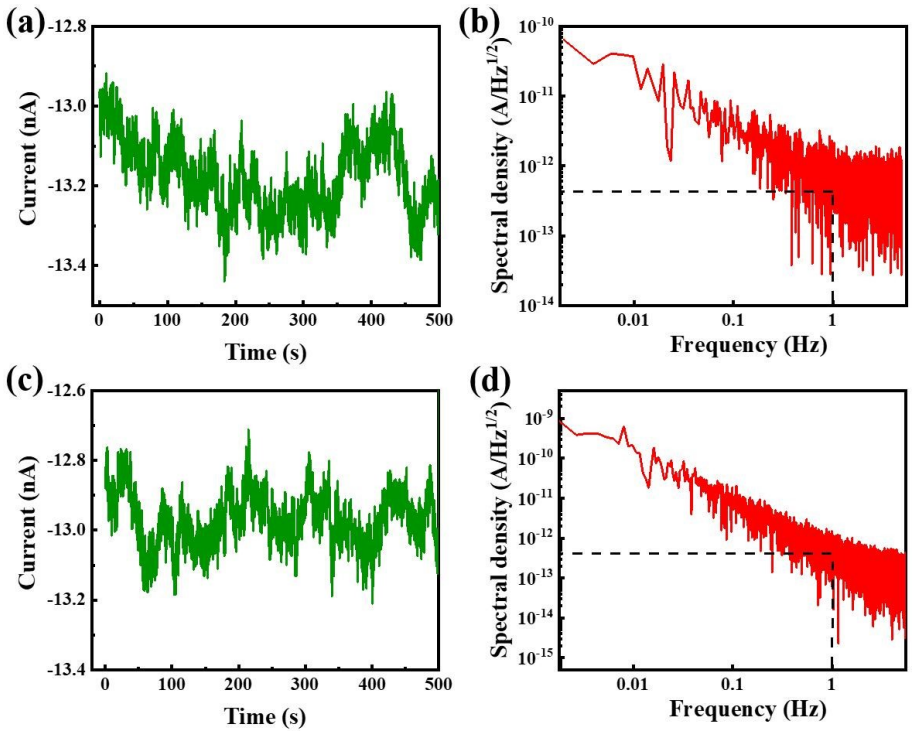

Figure S7. (a) The noise of the dark current and (b) analysis of noise spectral density of the $PdTe_2$/Ge heterostructure-based photodetector at zero bias. (c) The noise of the dark current and (d) analysis of noise spectral density of the $PdTe_2$/Ge heterostructure-based photodetector with quasi-2D perovskite ARC at zero bias.

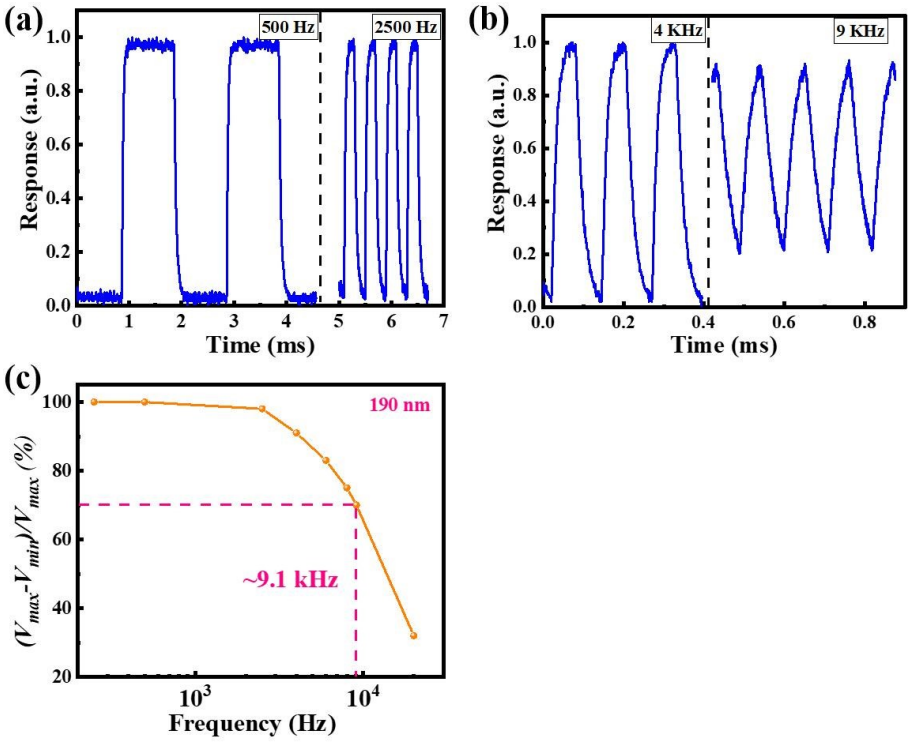

Figure S8. (a) and (b) are temporal photoresponse of the device under 1550 nm light illumination

with varied modulating frequencies. (c) Relative balance $(V_{max}-V_{min})/V_{max}$ *versus* frequency of the incident light, giving a -3 dB cutoff frequency of about 9.1 kHz.

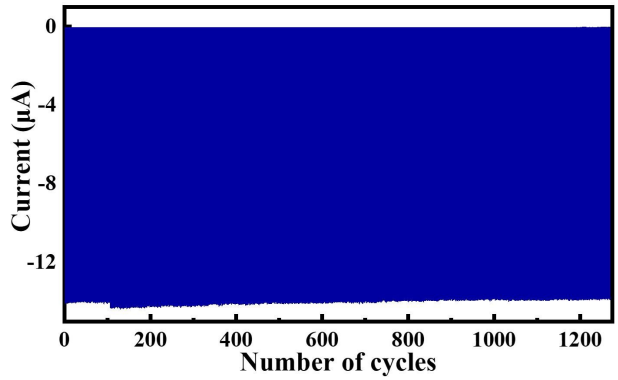

Figure S9. Temporal photoresponse of the device under 1550 nm light illumination during operation over 1200 cycles.

References

1 E. Shi, H. Li, L. Yang, L. Zhang, Z. Li, P. Li, Y. Shang, S. Wu, X. Li, J. Wei, K. Wang, H. Zhu, D. Wu, Y. Fang and A. Cao, *Nano Lett.*, 2013, **13**, 1776–1781.

2 S. M. Sze and K. K. Ng, *Physics of Semiconductor Devices*, 2007.