In-situ integration of Te/Si 2D/3D heterojunction photodetectors toward UV-vis-IR ultra-broadband photoelectric technologies

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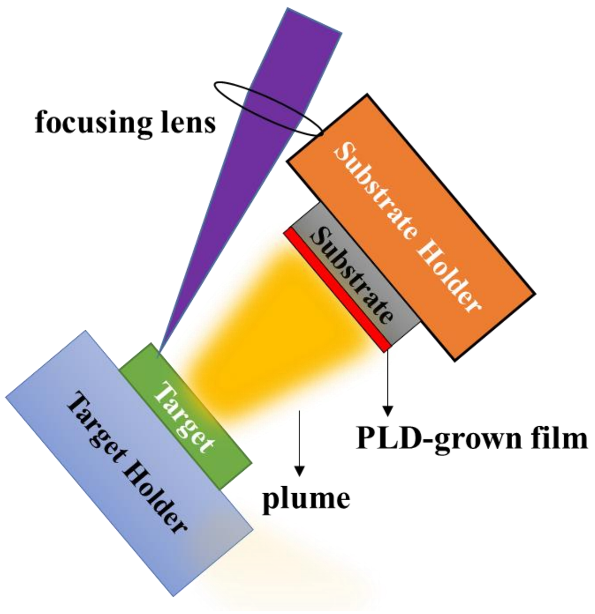

Fig. S1 Schematic illustration of the PLD growth of Te nanofilms.

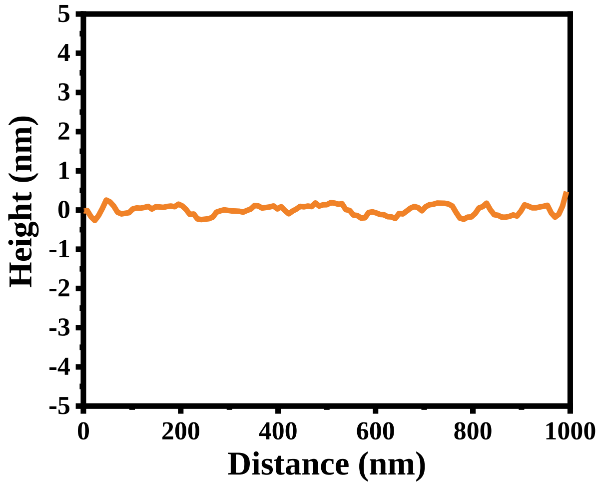

Fig. S2 The AFM height profile along the surface of the PLD-derived Te nanofilm. The surface undulations are extracted to be below 1 nm.

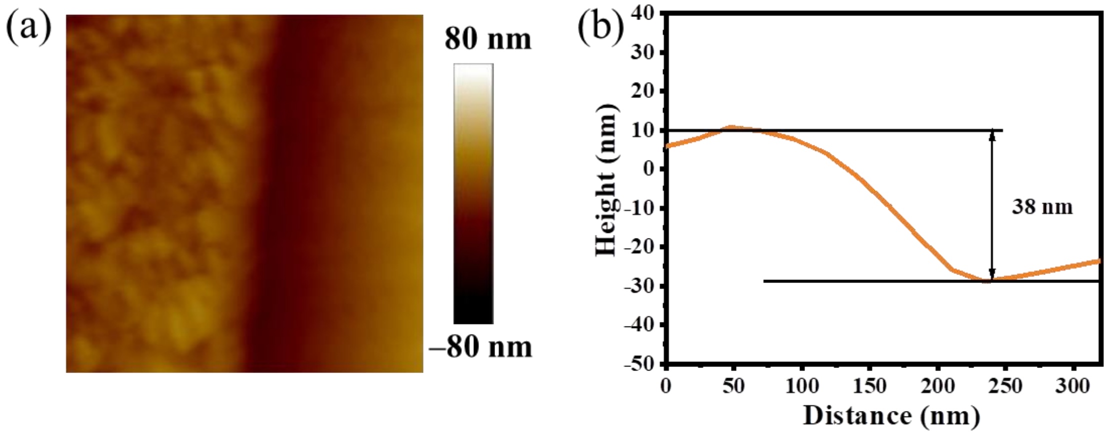

Fig. S3 (a) AFM image of a Te/SiO_2 heterointerface and (b) the corresponding thickness profile across the heterointerface.

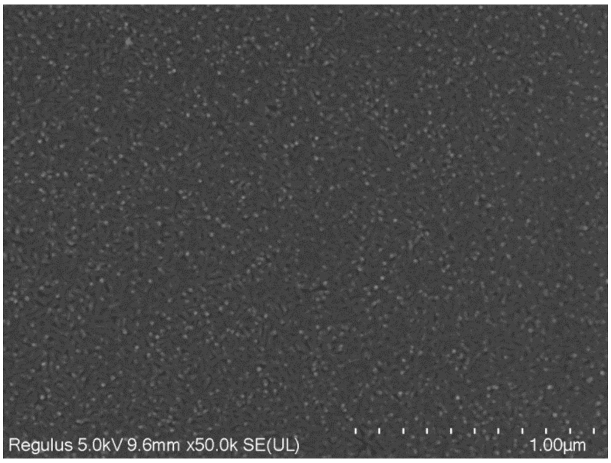

Fig. S4 SEM image of a Te nanofilm.

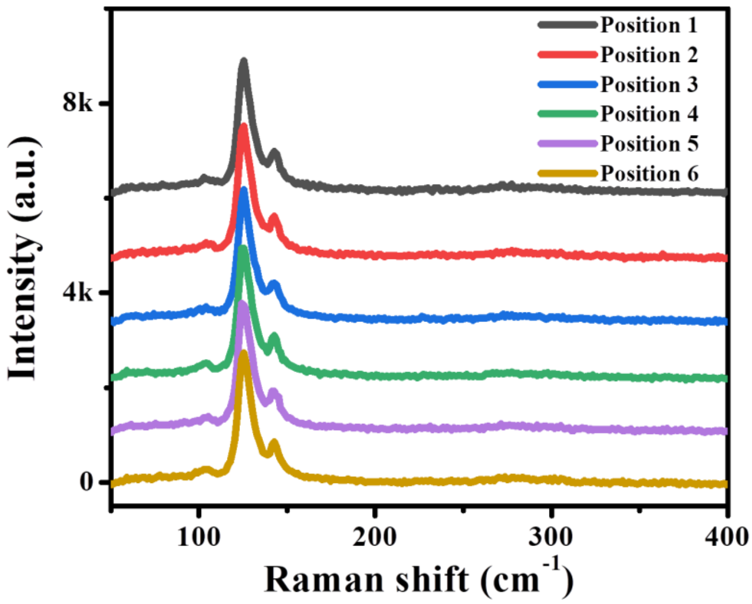

Fig. S5 Raman spectra of random multiple points of a PLD-derived 2-inch Te nanofilm.

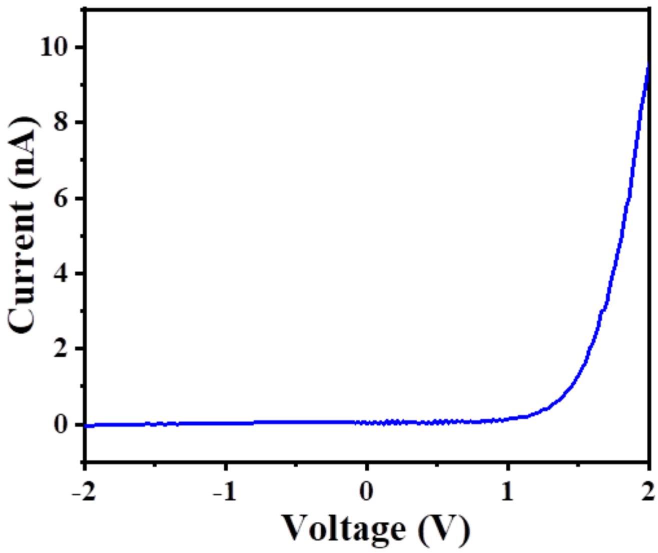

Fig. S6 Rectifying characteristic of a Te/Si heterojunction diode.

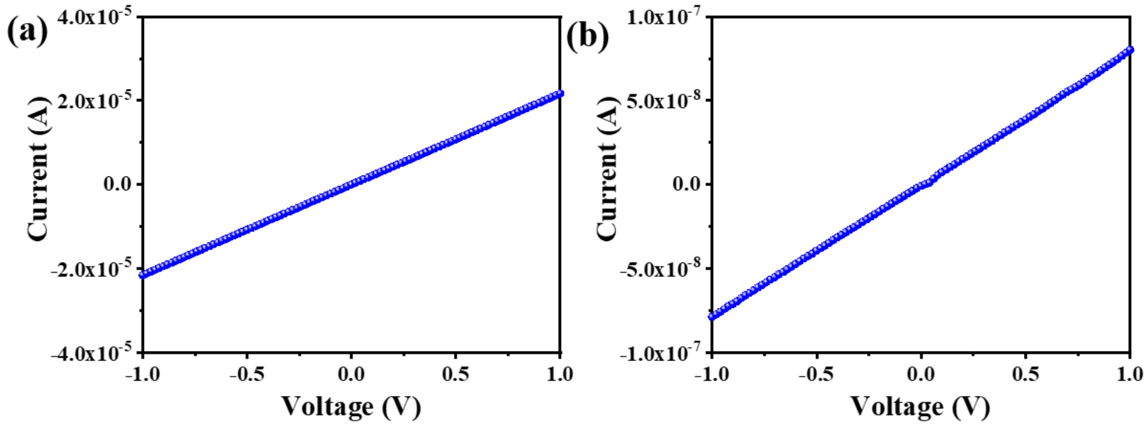

Fig. S7 The I-V curves of (a) Ag-Si-Ag and (b) Ti/Au-Te-Ti/Au.

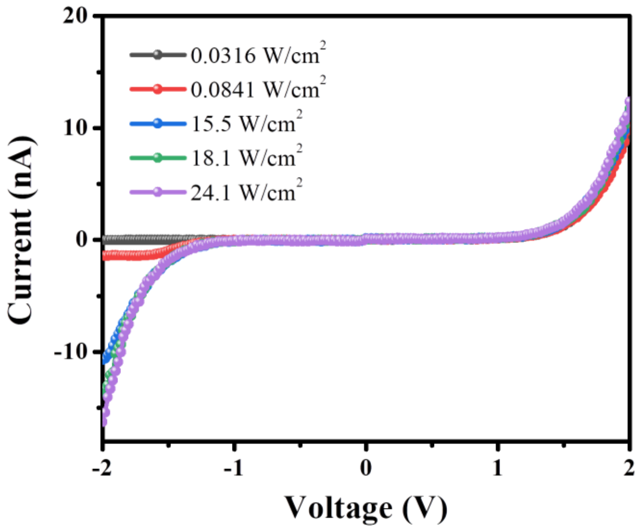

Fig. S8 I-V curves of a Te/Si heterojunction photodetector under illumination with various light intensities.

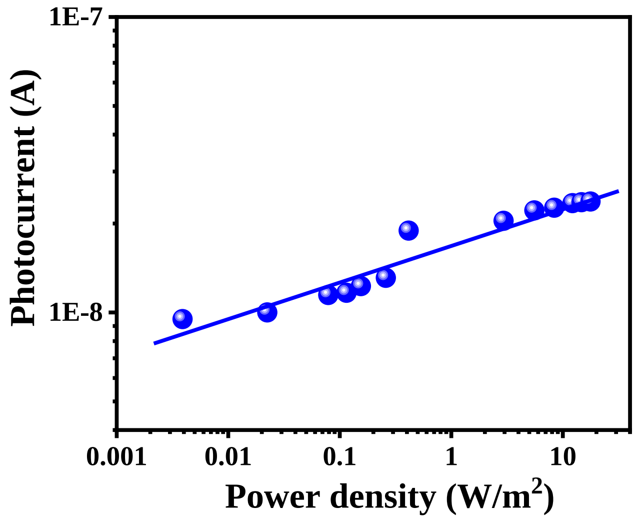

Fig. S9 Photocurrent as a function of light power density of a Te/Si heterojunction photodetector under 405 nm illumination.

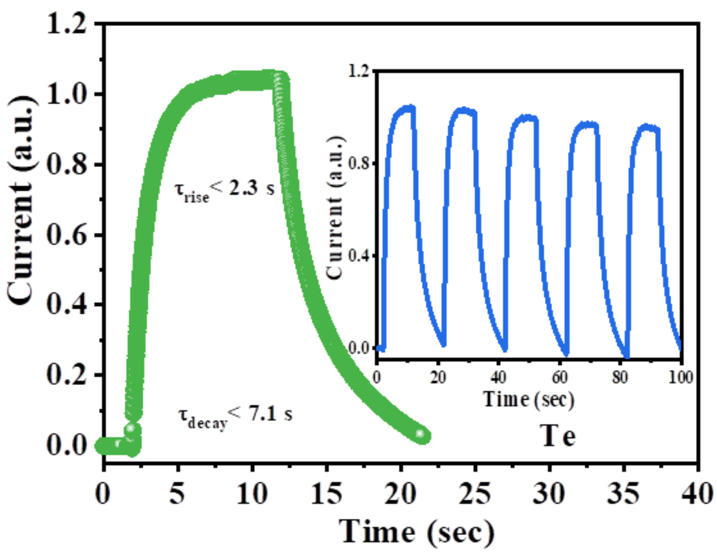

Fig. S10 Photoswitching curve of a pure Te photodetector.

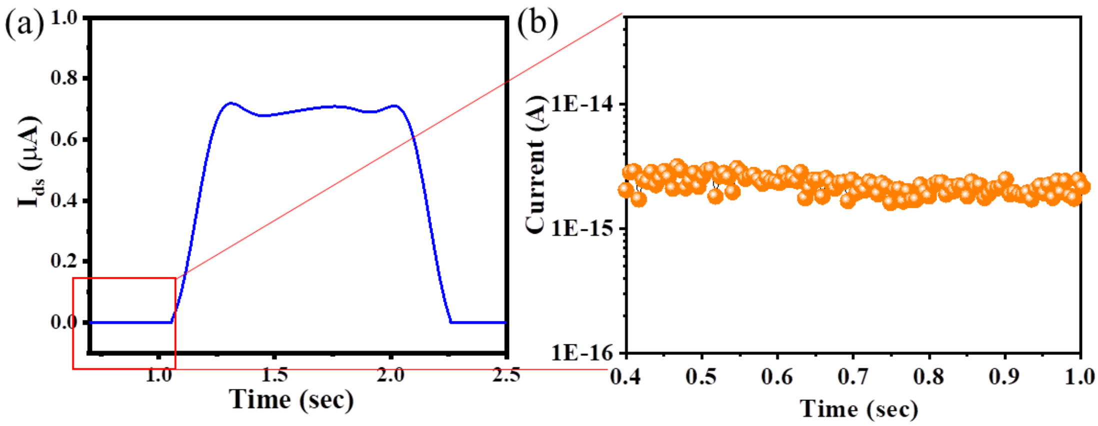

Fig. S11 (a) A single photoswitching cycle of a Te/Si heterojunction photodetector acquired with a slow sampling working mode and (b) an enlarged view of the dark current.

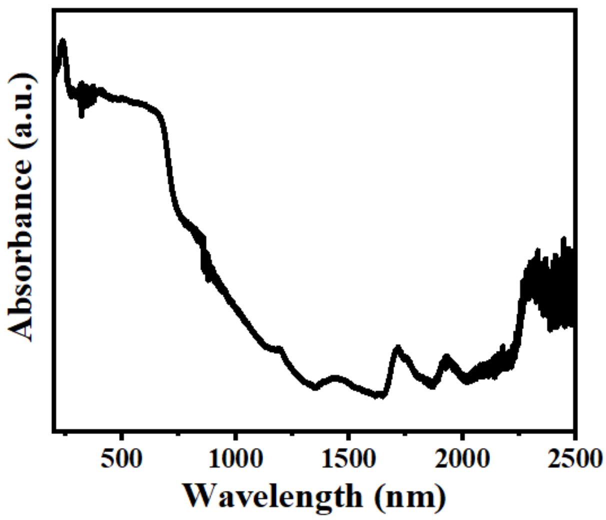

Fig. S12 The absorption spectrum of the PLD-derived Te nanofilm.

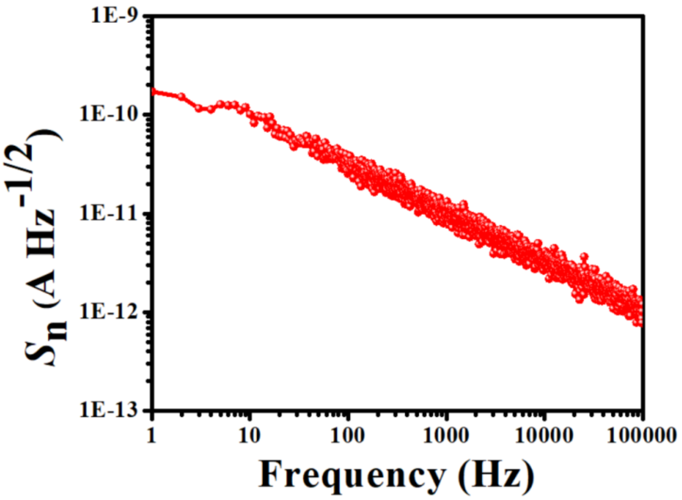

Fig. S13 Current noise spectral density of a Te/Si heterojunction photodetector.

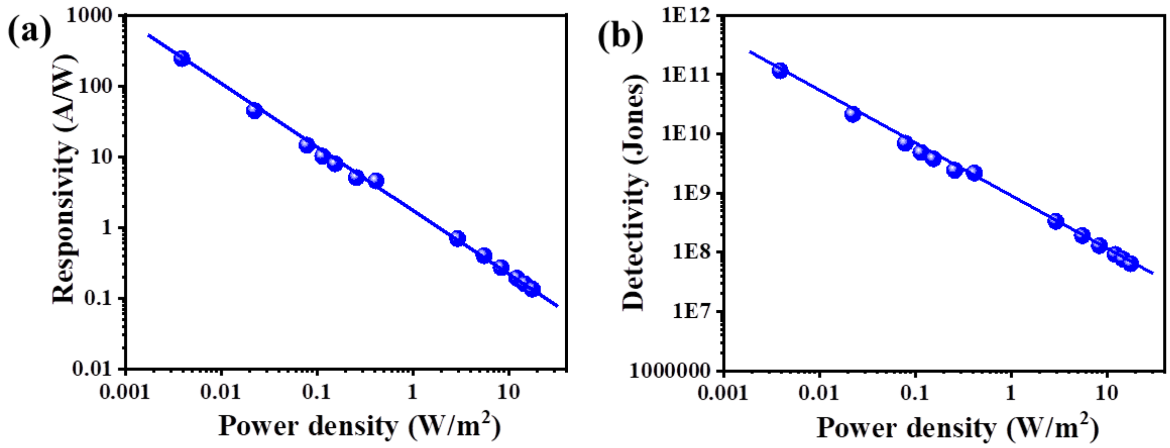

Fig. S14 (a) Responsivity and (b) detectivity of a typical Te/Si heterojunction photodetector as a function of light power density under 405 nm illumination.

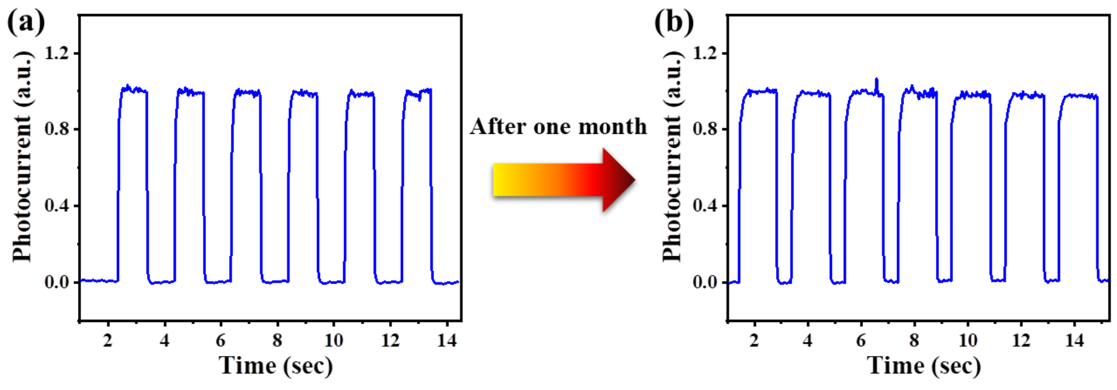

Fig. S15 (a) The photoswitching curves of an as-fabricated Te/Si heterojunction photodetector and (b) that after a one-month storage in air.

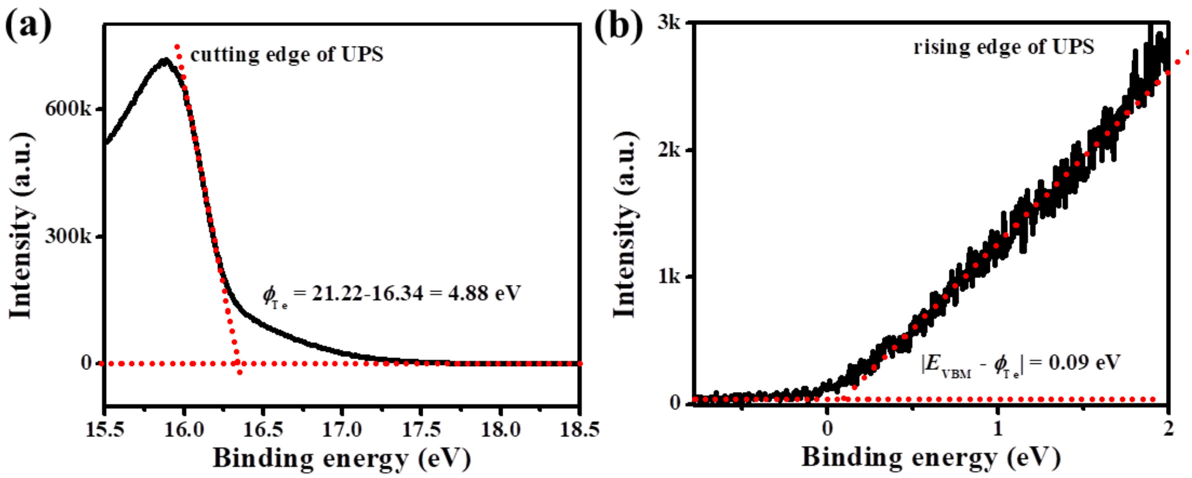

Fig. S16 (a) The cutting edge and (b) rising edge of the UPS spectrum of the PLD-derived Te nanofilm. ϕ_{Te} is the work function of Te. E_{VBM} is the energy level of the valence band maximum. The Fermi level is extracted to be 0.09 eV higher than the valence band maximum.

Supporting Information Note 1

Responsivity (*R*):

Responsivity is a performance metric to evaluate the capability to generate photocurrent. It can be calculated by dividing the photocurrent by incident power on the active area:

$$R=\frac{I_{\text{light}}-I_{\text{dark}}}{PA},$$

where I_{light} is the channel current under illumination, I_{dark} is the channel current in dark, P is the power density of incident light and A is the active area of the device.

External quantum efficiency (EQE):

EQE is performance metric to evaluate the capability of photons to generate free carriers circuiting across the external circuit. It can be calculated by dividing the cycling times of photocarriers to the number on incident photons:

$$EQE=\frac{hcR}{e\lambda},$$

where h is the Planck constant, c is the velocity of light, e is the charge of an electron and λ is the wavelength of light.

Detectivity (*D):**

Detectivity is a parameter to evaluate the weak-light detection capability of photodetectors. It can be calculated by

$$D^*=\frac{\sqrt{A}R}{S_{\text{n}}},$$

where S_{n} is the current noise spectral density of the photodetector.