Electronic Supplementary Material (ESI) for Nanoscale Advances.

Supporting Information

Te/SnS_2 Tunnelling Heterojunctions as High-performance Photodetector with Superior Self-powered Properties

*Xuanhao Cao, Zehong Lei, Shuting Zhao, Lili Tao, Zhaoqiang Zheng, Xing Feng, Jingbo Li and Yu Zhao**

X. Cao, Z. Lei, S. Zhao, Dr. L. Tao, Dr. Z. Zheng, Prof. X. Feng, Prof. Y. Zhao

Guangdong Provincial Key Laboratory of Information Photonics Technology, Guangdong Provincial Key Laboratory of Functional Soft Condensed Matter, School of Material and Energy, Guangdong University of Technology, Guangzhou 510006, China

E-mail: zhaoyu@gdut.edu.cn

Prof. J. Li

Guangdong Key Lab of Chip and Integration Technology, Institute of Semiconductors, South China Normal University, Guangzhou 510631, P.R. China

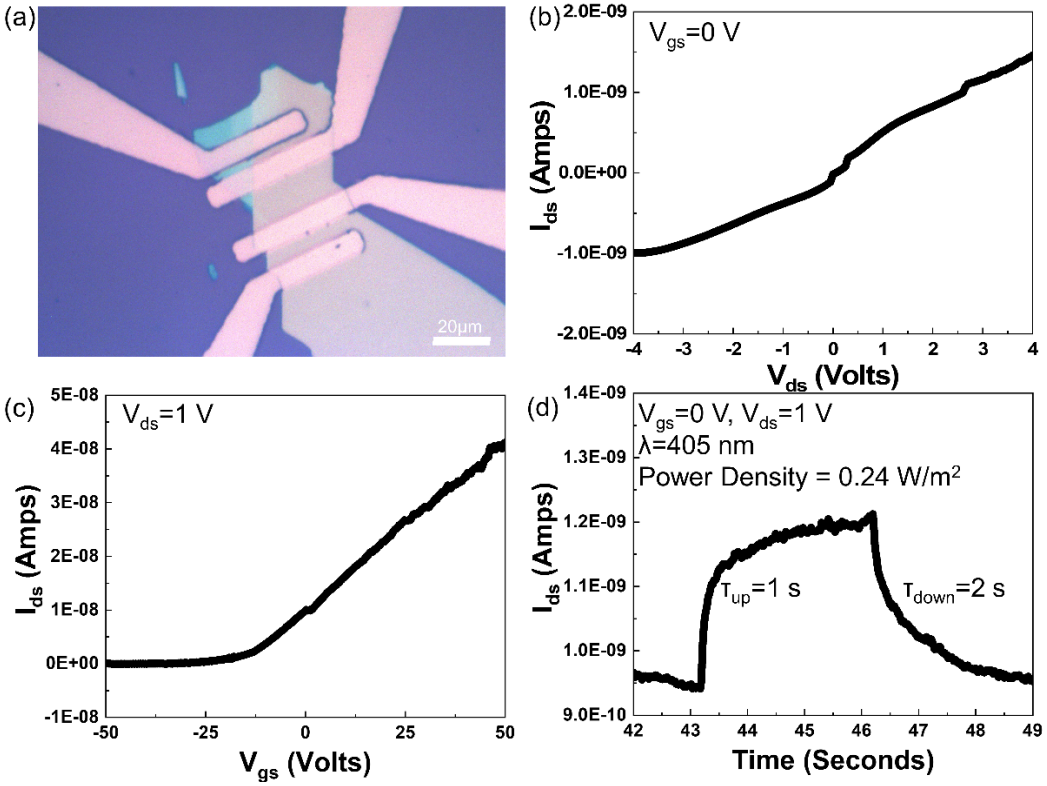

Figure S1. (a) The optical image of SnS_2 device. (b) The I_{ds}–V_{ds} curve of the SnS_2 device at V_g = 0 V. (c) The transfer (I_{ds}–V_{gs}) curve of the SnS_2 device at V_{ds}=1 V.(d) The photoresponse of the SnS_2 device at V_{ds}=1 V and V_g=0 V under the irradiation of 405 nm.

The effective channel area of the SnS_2 device is about 201 μm^2, and R=5.21 A/W can be calculated by Equation

$$R_{\lambda} = \frac{\Delta I_{ph}}{P_{\lambda} S}$$

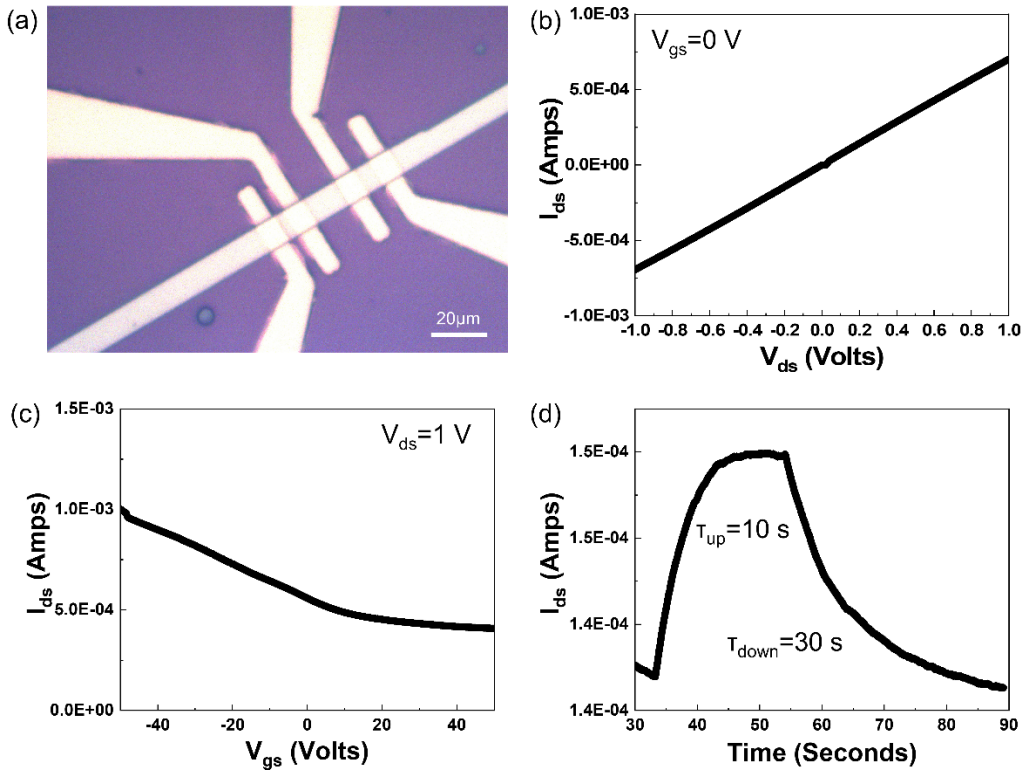

Figure S2. (a) The optical image of Te device. (b) The I_{ds}–V_{ds} curve of the Te device at V_g = 0 V. (c) The transfer (I_{ds}–V_{gs}) curve of the Te device at V_{ds}=1 V.(d) The photoresponse of the Te device at V_{ds}=1 V and V_g=0 V under the irradiation of 405 nm.

The effective channel area of the Te device is about 71 μm^2, and R=130 A/W.

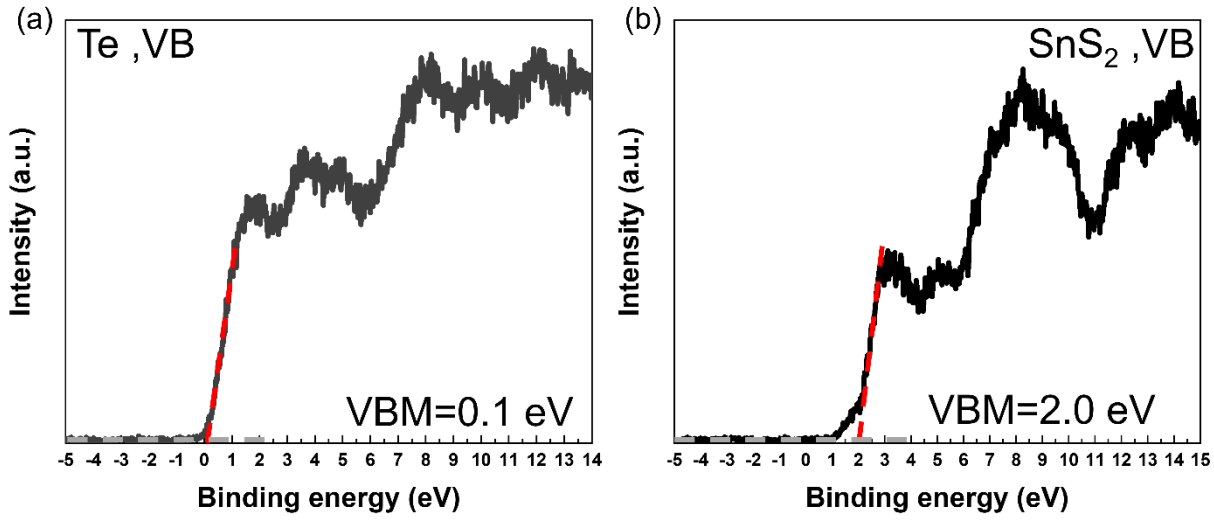

Figure S3. X-ray photoelectron spectroscopy of (a) Te and (b) SnS_2. The intercept of X axis indicates the energy level of valence-band maximum (VBM) with respect to Fermi level of the probe that has work functions of 4.28 eV. Therefore, the VBM of Te and SnS_2 is -4.38 and -6.28 eV with respect to vacuum level, respectively.

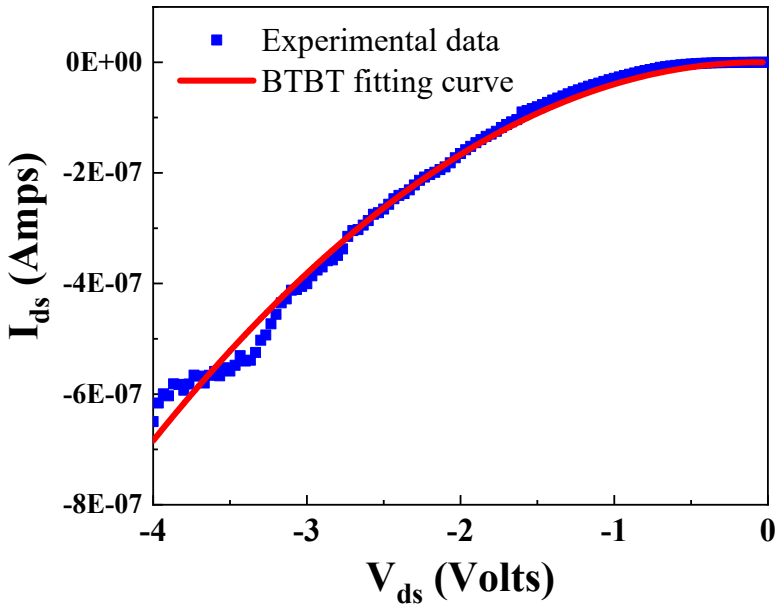

Figure S4. The reverse I-V curve is fitted using the theoretical relation $I = C_1 V^2 exp(\frac{C_2}{V})$ given in the previous literature (S. M. Sze, K. K. Ng, *Physics of Semiconductor Devices*, John Wiley & Sons, Hoboken, New Jersey, USA 2006). The experimental result is fitted well and give the relation $I = -4.38 \times 10^{-8} \times V^2 exp(\frac{-0.097}{V})$ with R^2=0.992, confirming the tunneling mechanism of the electron transport under reverse bias.

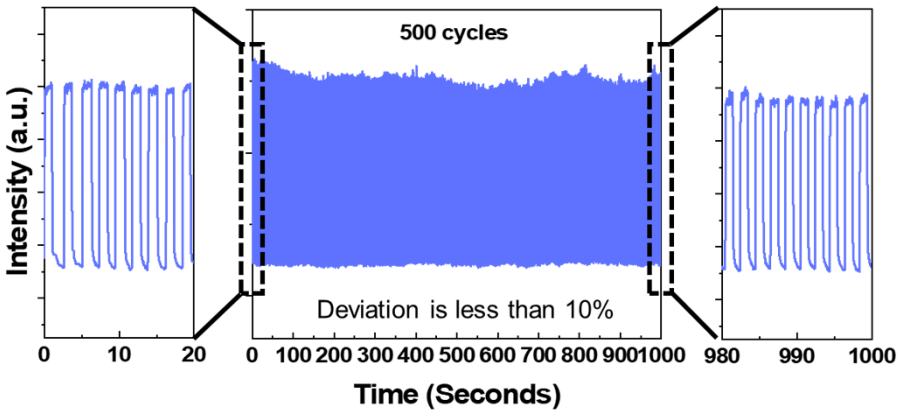

Figure S5. The photoresponse of the Te/SnS_2 heterojunction for 500 continuous cycles of irradiation (405 nm laser).

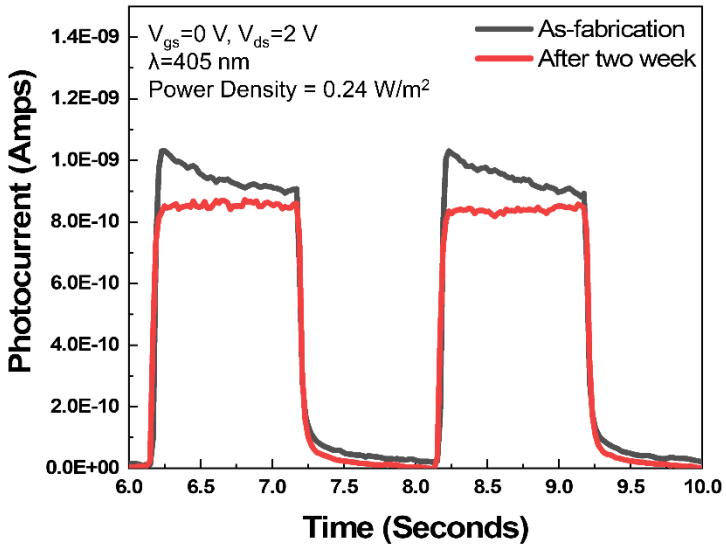

Figure S6. Photorespons of Te/SnS_2 heterojunctions as fresh one and that after two weeks.

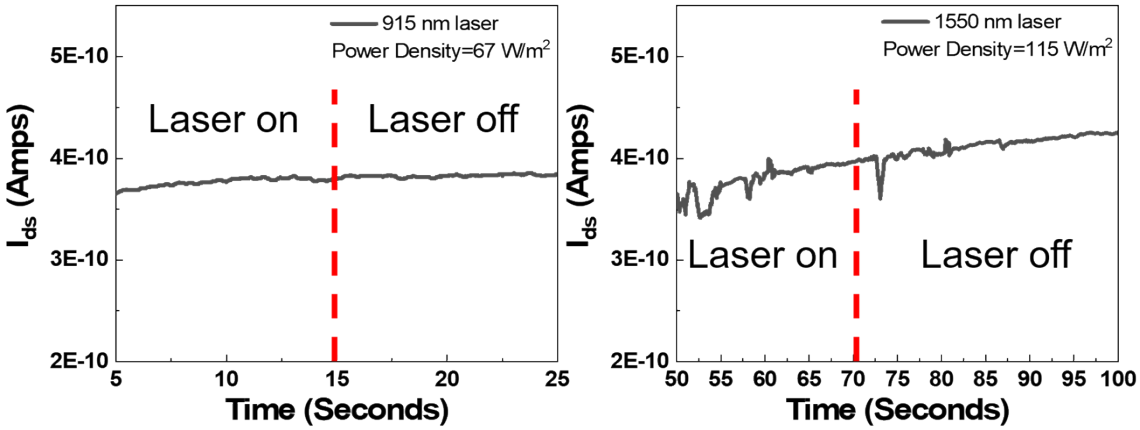

Figure S7. The measured current of Te/SnS_2 heterojunction under the irradiation of 915 and 1550 nm laser.

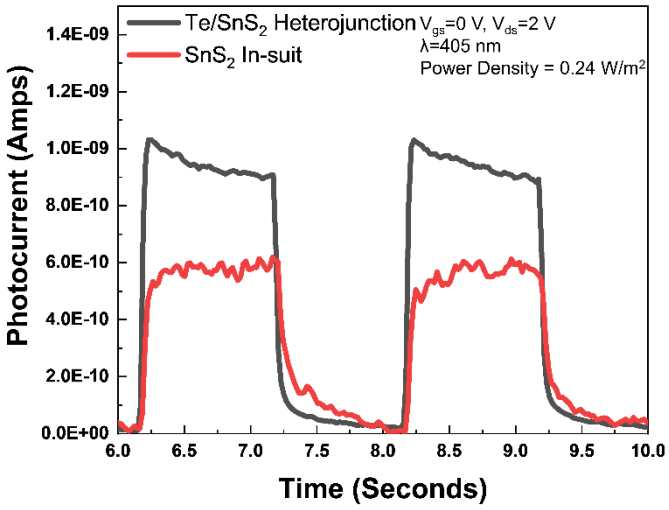

Figure S8. The responding photocurrent of Te/SnS_2 heterojunction and its constituent SnS_2.

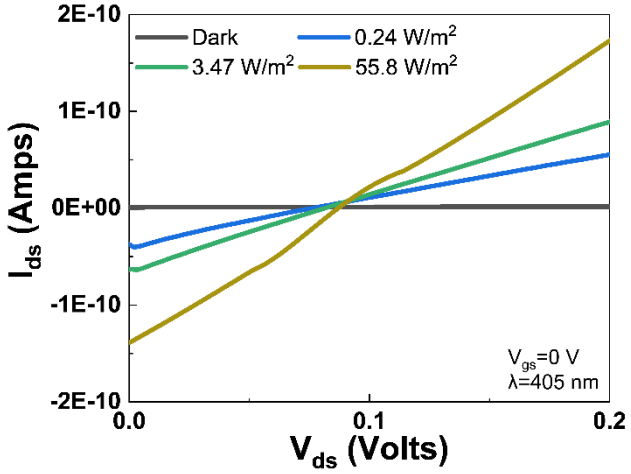

Figure S9. I−V curves of the Te/SnS_2 heterojunction device measured under light illumination of 405 nm with varied light intensities.

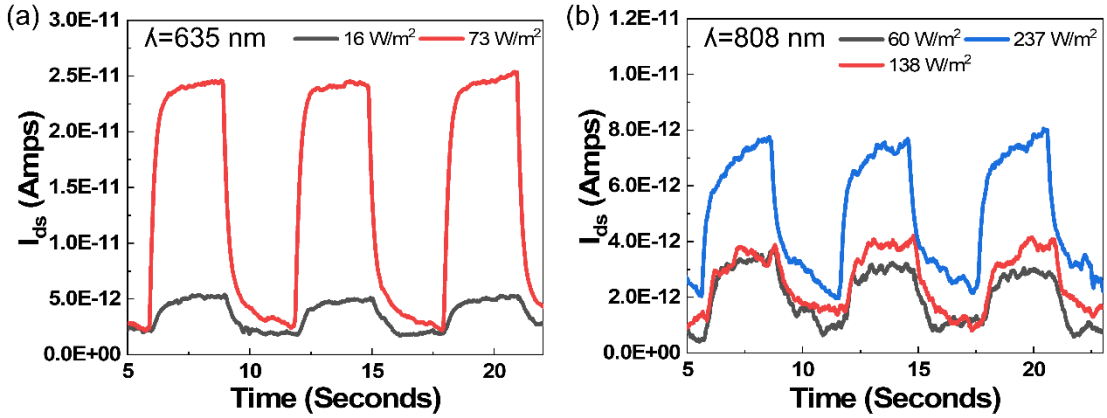

Figure S10. Photoresponse of the heterostructure device under zero bias with (a) 635 nm and (b) 808 nm laser irradiation

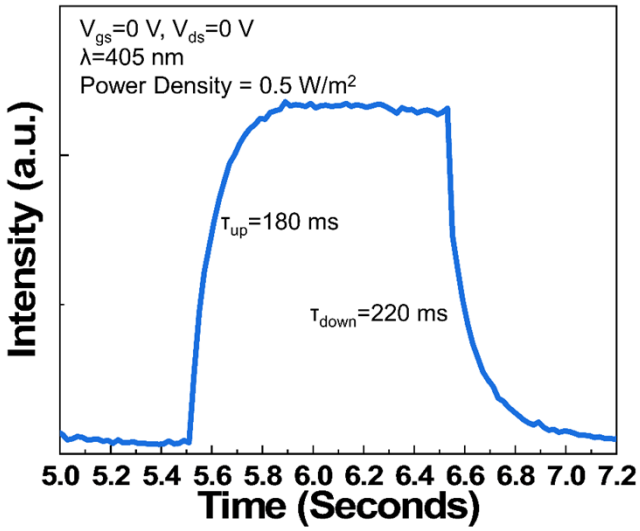

Figure S11. Photoresponse of the heterostructure device under zero bias and 405nm laser irradiation