Electronic Supplementary Material (ESI) for Journal of Materials Chemistry C.
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**Supporting information for**

# Diverse Modes Regulated Photoresponse and High-Resolution Imaging based on van der Waals Semimetal $PtTe_2$/Semiconductor $MoTe_2$ Junctions

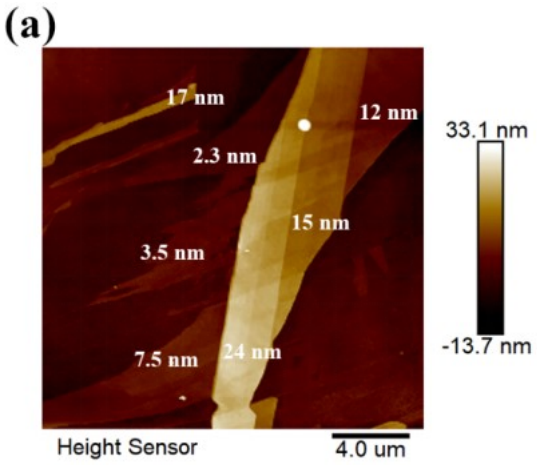



**Figure S1 The AFM image of the $PtTe_2$ nanosheets prepared by the Au-assisted exfoliation method. a** the 2D topological AFM image of $PtTe_2$ nanosheets on Ti/Au $SiO_2$/Si substrate, and the height profiles along the white lines, respectively.

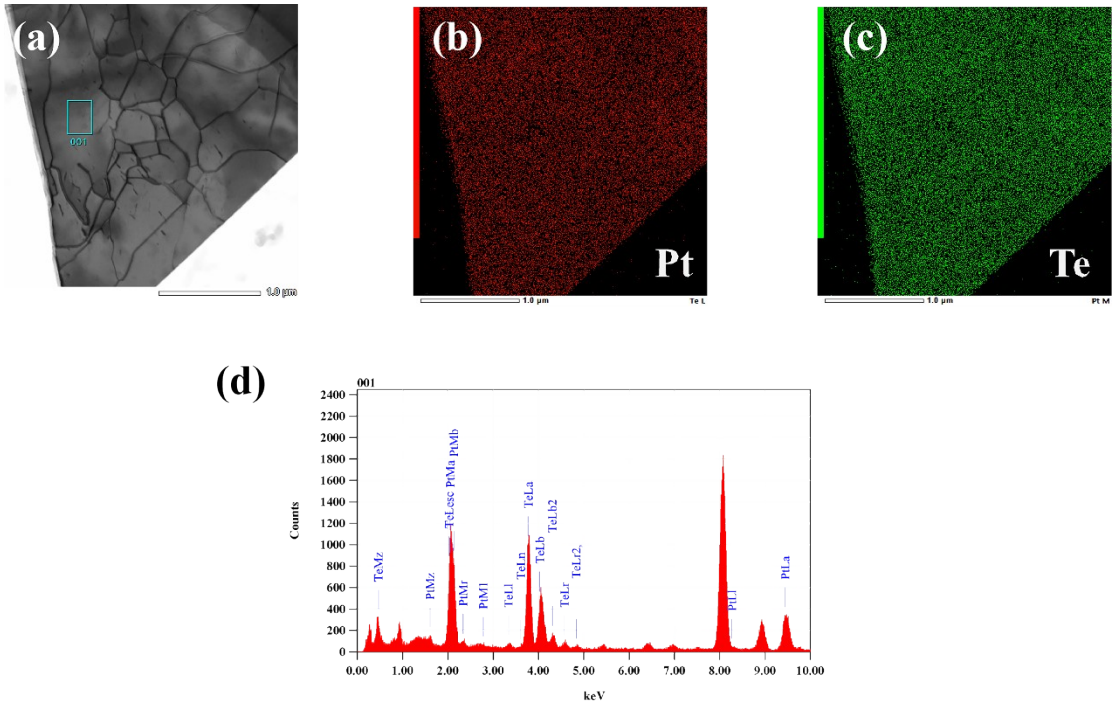



**Figure S2 The HRTEM-EDS mapping analysis of the $PtTe_2$/Au nanosheets. a** Low-magnification TEM image of the exfoliated and as-transferred $PtTe_2$ nanosheets with Au particle. **b** Element mapping of the two detected elements: Pt and **c** Te. **d** EDS spectrum extracted from the light blue rectangle in **a**.

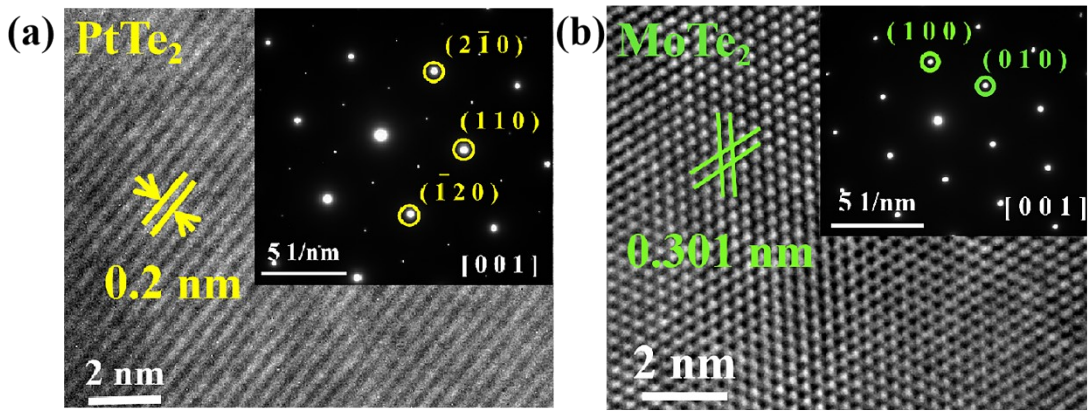



**Figure S3 The HRTEM image and SAED patterns of** (a) individual $PtTe_2$ nanosheets and (b) individual $MoTe_2$ nanosheets.

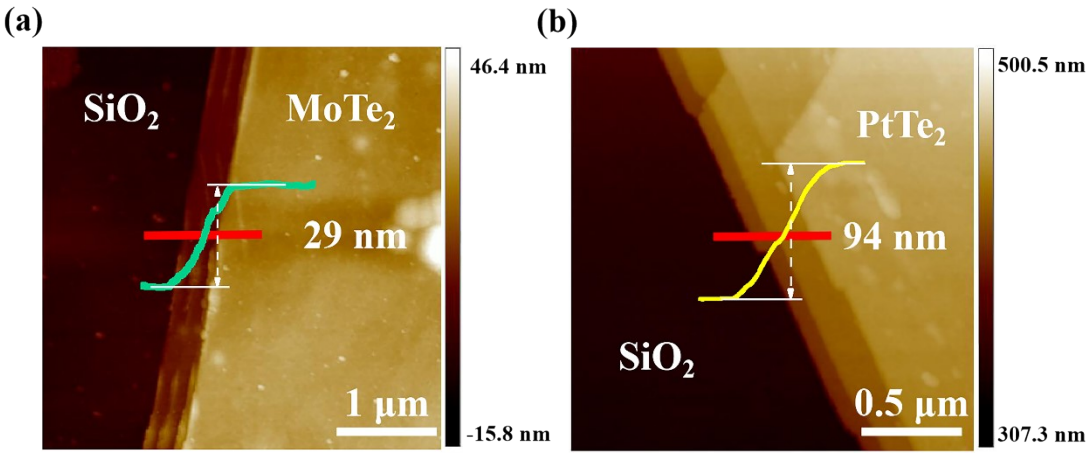



**Figure S4 AFM image of $PtTe_2$ and e $MoTe_2$ along the red, respectively.**

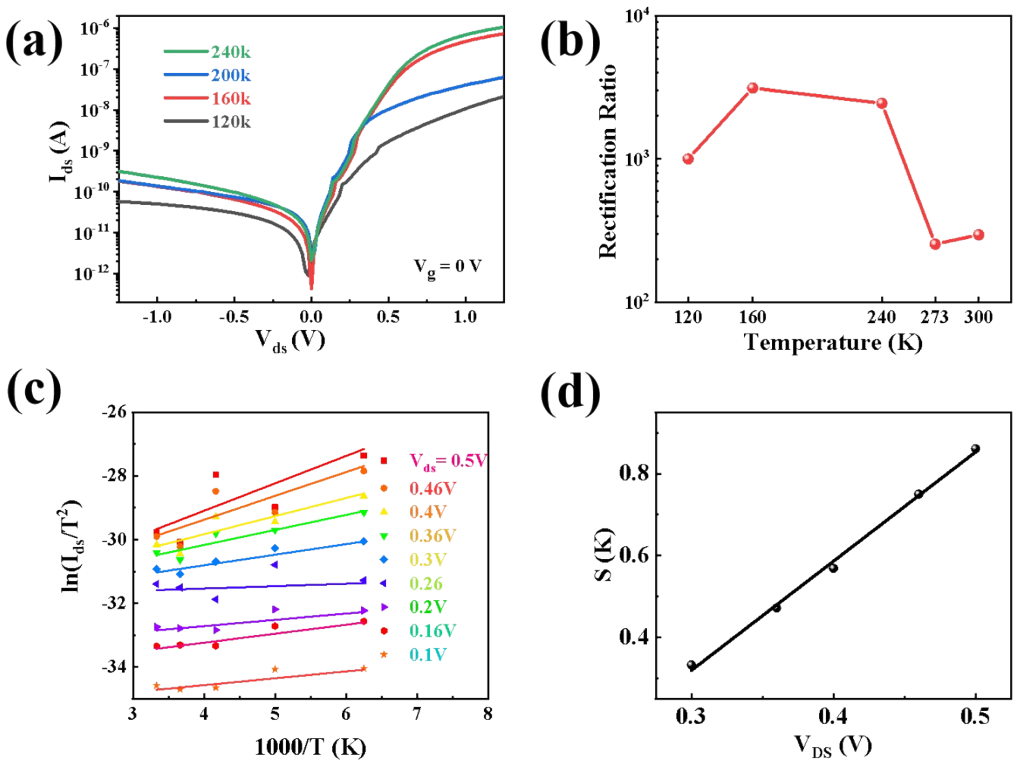



**Figure S5 a.** $I_{ds}$–$V_{ds}$ curves of the $PtTe_2$/$MoTe_2$ vertical Schottky junction diode with changing the temperature in dark and vacuum condition. **b.** The rectification ratio at different temperatures under the source-drain voltage variation of -2 V - +2 V. **c.** Arrhenius curve. **d.** The slope S-$V_{DS}$ curve fitted by the Arrhenius curve in **Fig. S5c**.

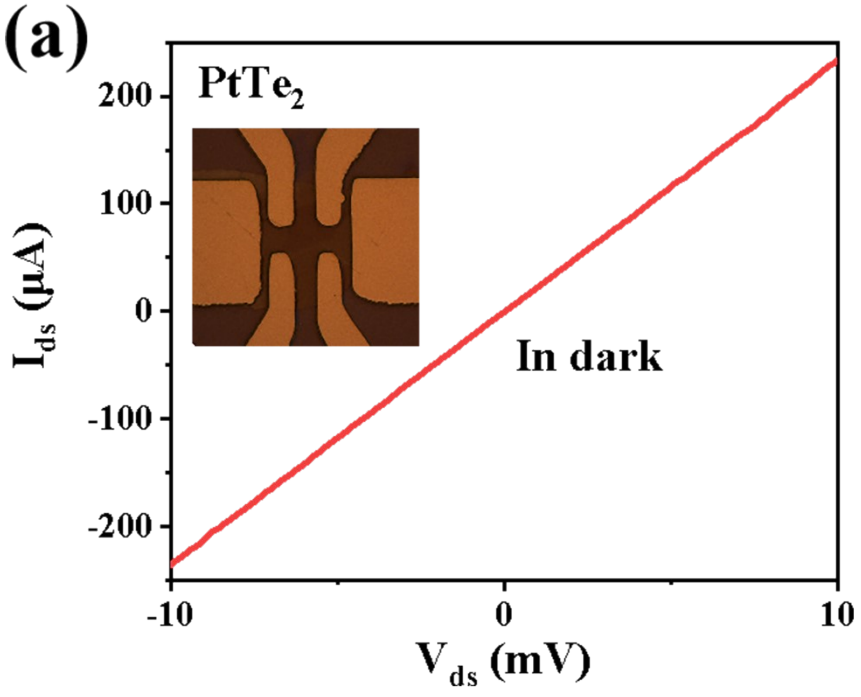



**Figure S6 Electrical performance of another ultrathin $PtTe_2$ FET. a.** $I_{ds}$-$V_{ds}$ curve.

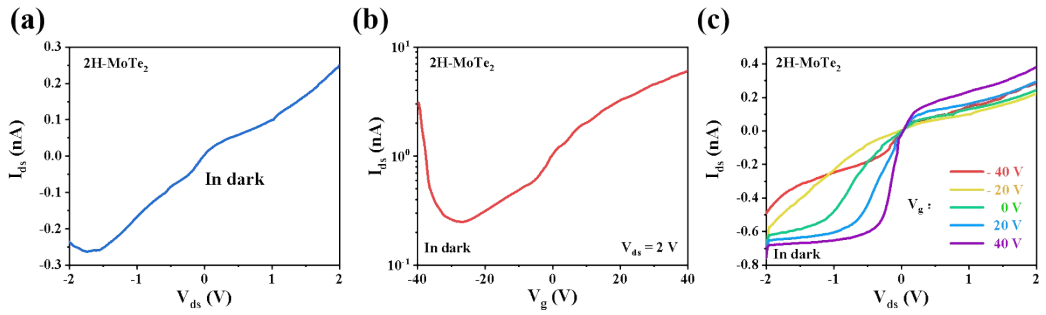



**Figure S7 Electrical performance of another thin $MoTe_2$ FET. a.** $I_{ds}$-$V_{ds}$ curve. **b.** Tranfer characteristic at $V_{ds}$ = 2 V scanning from -40 V to 40 V. **c.** Output curves at various gate voltages.

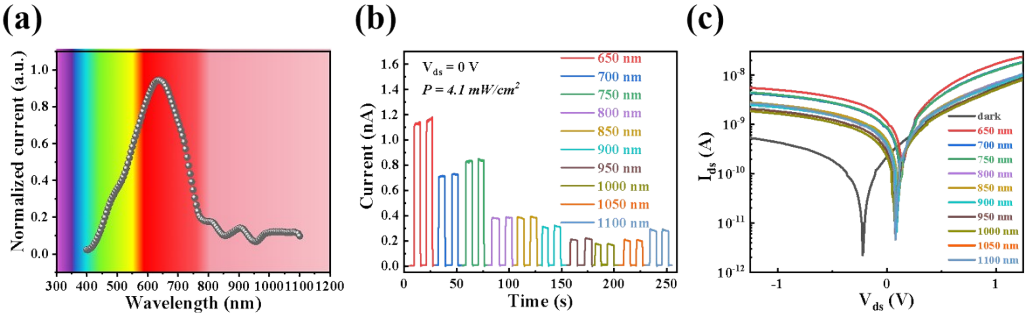
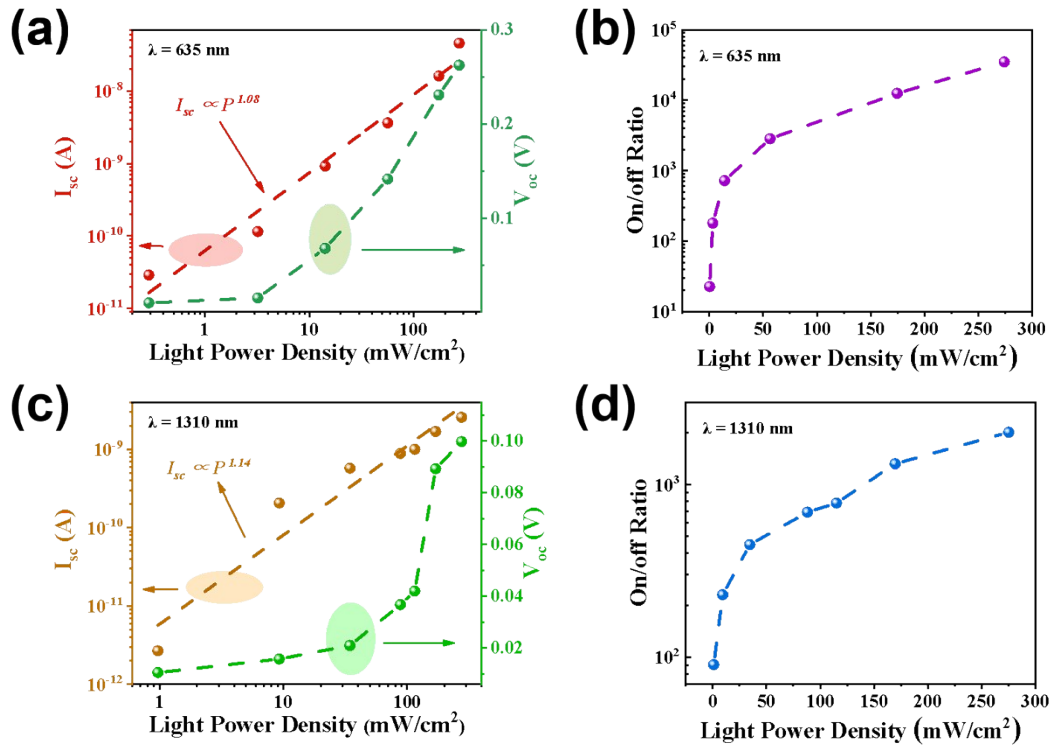



**Figure S8 Optoelectrical properties of the $PtTe_2$/$MoTe_2$ vertical heterojunction under illumination of different wavelength. a.** The normalized $I_{ph}$ as a function of illumination wavelength from 650 to 1100 nm at zero bias and zero source-drain voltages. **b.** The $I_{ph}$ under the varied illumination wavelength from 650 to 1100 nm at zero gate voltage and zero source-drain voltage. The incident power P = 4.10 mW $cm^{-2}$. **c.** Logarithmic $I_{ds}$-$V_{ds}$ curves in the dark and under different wavelengths illumination.



**FigureS9 a, b** $I_{sc}$ and $V_{oc}$ and light on/off ratio of $PtTe_2/MoTe_2$ heterostructure under different laser powers intensity of 635 nm, respectively. **c, d** $I_{sc}$ and $V_{oc}$ and light on/off ratio of the heterostructure under different laser powers intensity of 1310 nm, respectively.

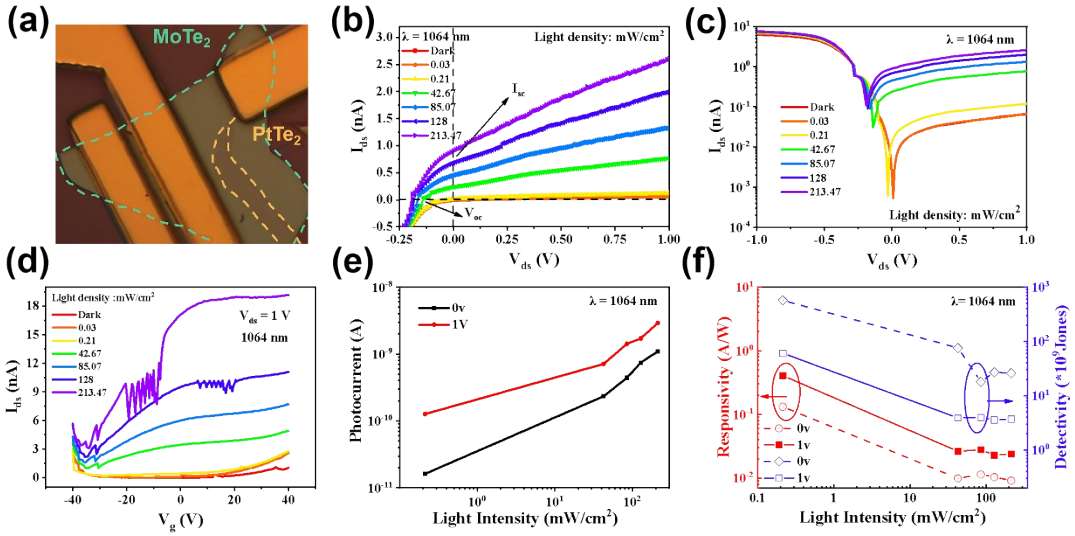



**Figure S10 Photoresponse performance of another $PtTe_2/MoTe_2$ vertical heterojunction using thin $PtTe_2$ of the thickness of ~20 nm. a.** Optical microscope image of the stacked $PtTe_2/MoTe_2$ heterostructure. **b.** $I_{ds}$–$V_{ds}$ liner curves of the $PtTe_2/MoTe_2$ vertical Schottky junction diode with changing the incident power density under the light illumination of 1064 nm. **c.** $I_{ds}$–$V_{ds}$ log curves of the $PtTe_2/MoTe_2$ vertical Schottky junction diode with changing the incident power density under the light illumination of 1064 nm. **d.**Transfer curves relate to light power density at $V_{ds}$ = +1 V under 1064 nm illuminations. **e.** Photocurrent curves relate to light power density at $V_{ds}$ = +1 V and 0 V under 1064 nm illuminations. **f.** Responsivity and detectivity ($V_{ds}$ = +1 V and 0 V) relate to light power density under 1064 nm illuminations.

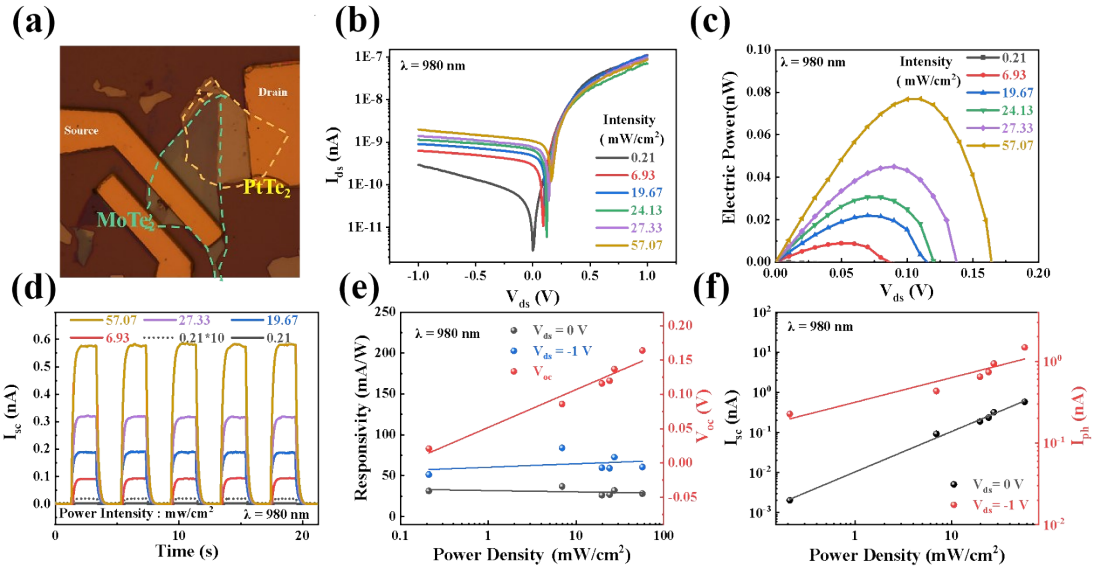



**Figure S11 Photoresponse performance of another $PtTe_2/MoTe_2$ vertical heterojunction using thin $PtTe_2$ of the thickness of ~50 nm. a.** Optical microscope image of the stacked $PtTe_2/MoTe_2$ heterostructure. **b.** $I_{ds}$–$V_{ds}$ curves of the $PtTe_2/MoTe_2$ vertical Schottky junction diode with changing

the incident power density under the light illumination of 980 nm. **c.** Variation of output electrical power with various light illumination power densities under light illumination of 980 nm. **d.** Photoresponse ($V_{ds}$ 0 V) and $V_{oc}$ relate to light power density under 980 nm illuminations. **e.** Responsivity ($V_{ds}$ = -1 V and 0 V) and $V_{oc}$ relate to light power density under 980 nm illuminations. **f.** Photocurrent curves relate to light power density at $V_{ds}$ = -1 V and 0 V under 980 nm illuminations.

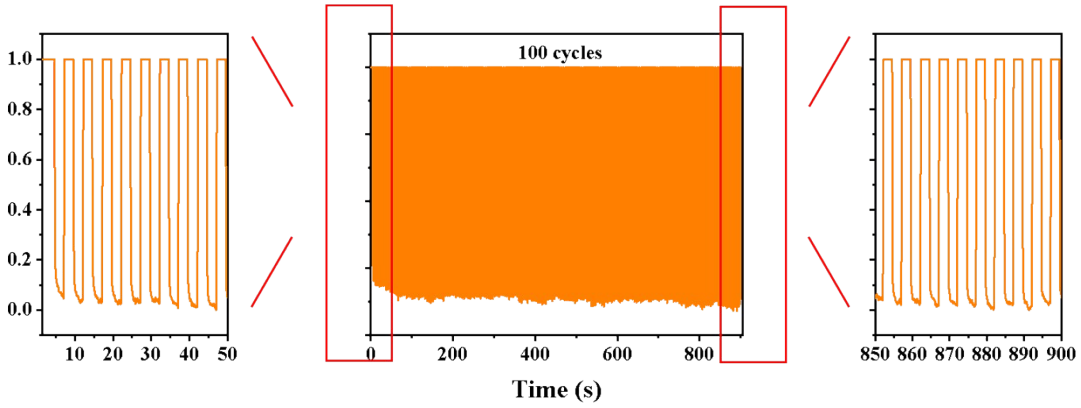



**Figure S12.** Stability test of photoswitch behavior at $V_{ds}$ = 0 V under 532 nm illumination.

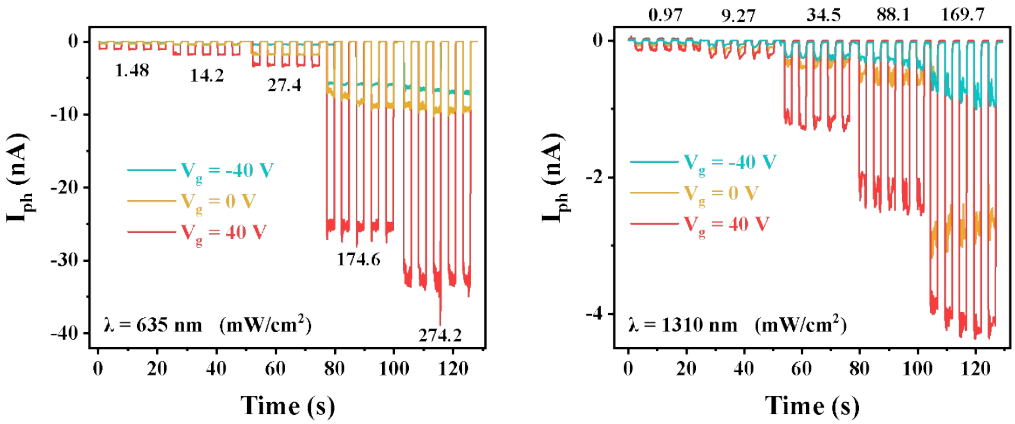



**Figure S13.** The time-resolved photoresponse of the device under 635 nm illumination with various light power densities at the $V_g$ = −40 V, 0 V, 40 V, respectively. **Figure S14.** The time-resolved photoresponse under 1310 nm.