

SUPPLEMENTARY INFORMATION

**Photoresponsivity of an all-semimetal heterostructure based
on graphene and WTe₂**

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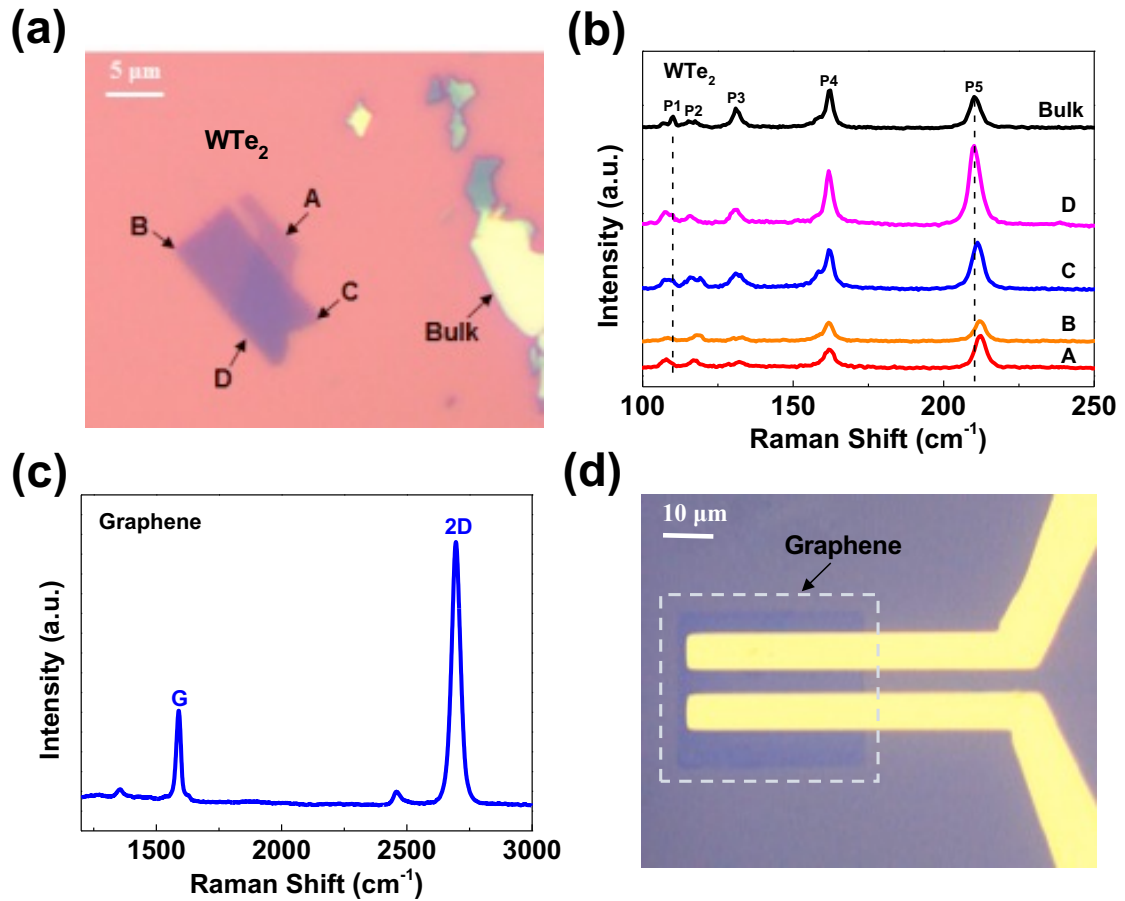


Figure S1. (a) Optical image of a WTe_2 sample exfoliated on SiO_2/Si substrate. Optical contrast shows the thickness of WTe_2 flakes is increase from position A to D. (b) Raman spectra of bulk and ultrathin WTe_2 flakes in (a). Distinctive peaks, labelled as P1-P5, are clearly observed. As guided by the dotted lines, they follow a systematic shift with increasing the number of layers, the thicknesses of positon A-D are 2~8 monolayers of WTe_2 , which is consistent to the previous report [1]. (c) Raman spectroscopic characterization of monolayer graphene. It shows a strong 2D peak and G peak, and the Raman intensity ratio of the 2D/G mode is >2 , indicating the high quality of our monolayer graphene [2]. (d) Optical micrograph of a fabricated pure graphene device. Monolayer graphene as channel is represented in the dashed square. The channel area is the same with graphene/ WTe_2 heterostructure device in original text.

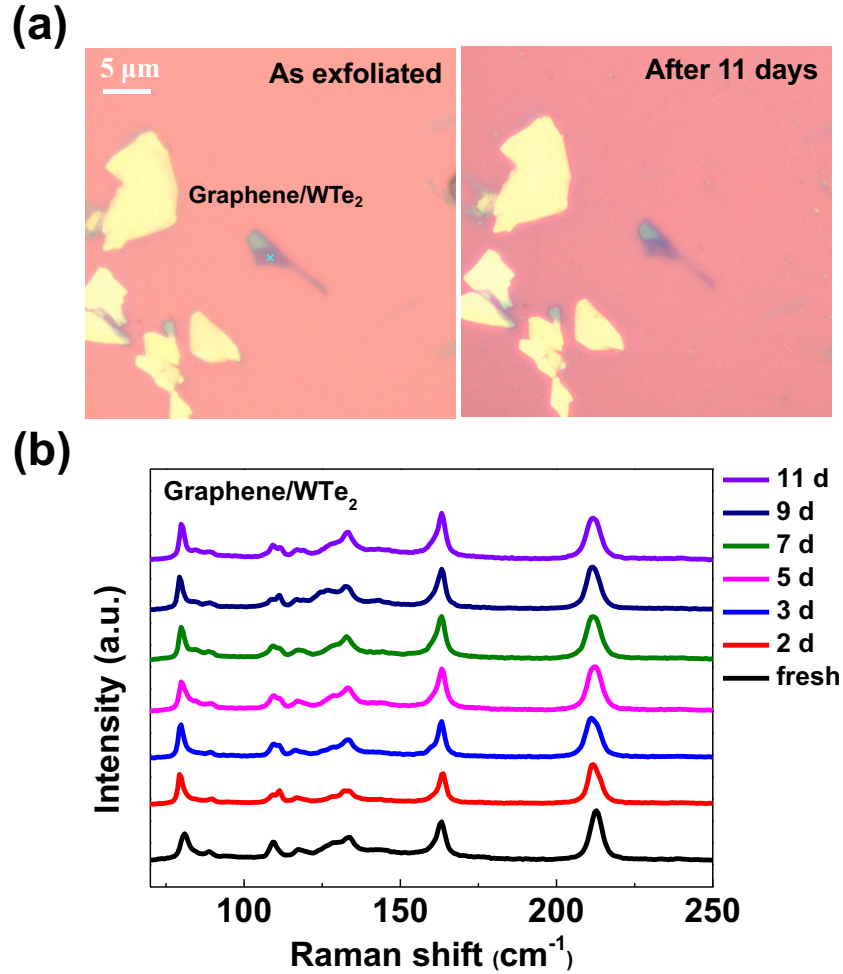


Figure S2. Optical microscope images and Raman spectroscopy results of graphene/WTe₂ hybrid film at sequential stages after its fresh deposition on the Si/SiO₂ substrate under ambient conditions. (a) Optical microscope images of fresh graphene/WTe₂ and exposed to air for 11 days. The thickness of WTe₂ flake beneath of graphene is 6 nm. (b) Raman spectrum of graphene/WTe₂ hybrid film in (a) during 11 days. Note that the Raman spectrum were recorded at the same region as marked “x” in (a).

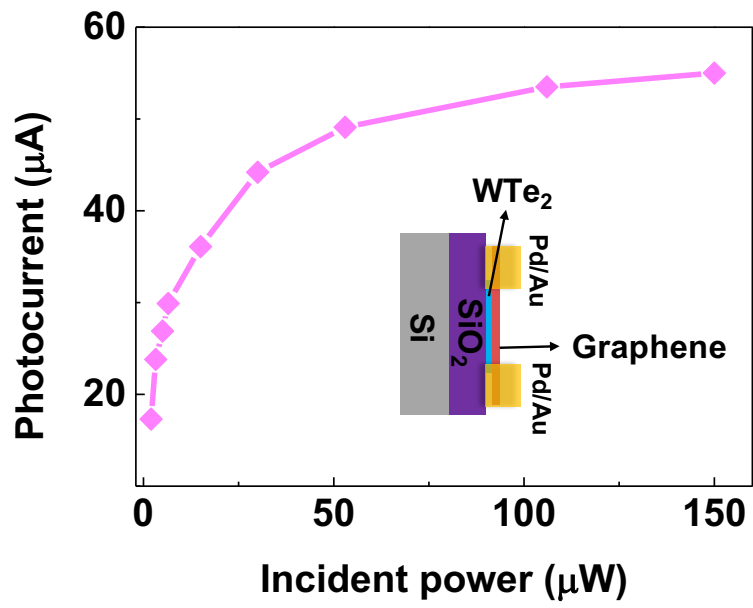


Figure S3. Photocurrent of the graphene/ WTe_2 heterostructure device as a function of the incident light power under 650 nm at $V_{\text{DS}} = 1$ V. Inset: schematic of the hybrid device.

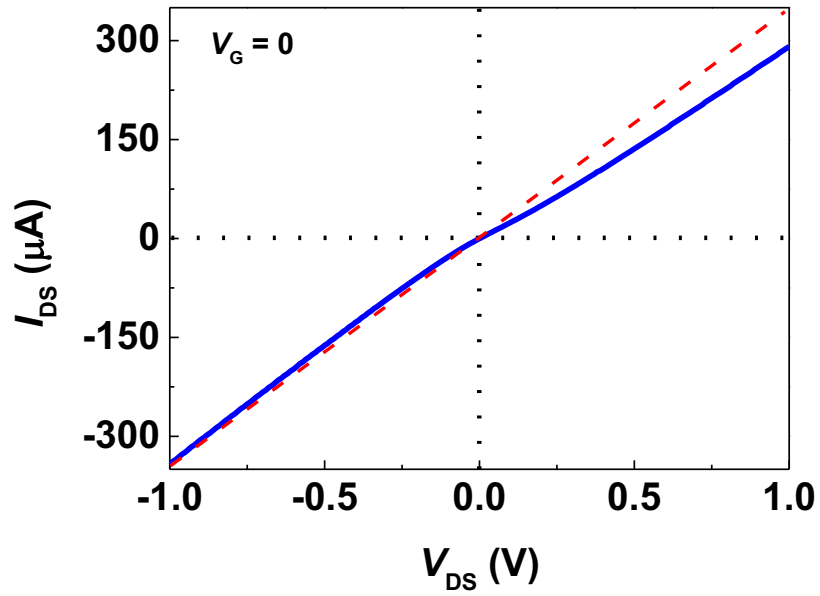


Figure S4. The current-bias voltage (I - V) characteristic of the staggered graphene/WTe₂ hybrid device in dark at $V_G = 0$.

1. Lee, J. *et al.* Single- and few-layer WTe₂ and their suspended nanostructures: Raman signatures and nanomechanical resonances. *Nanoscale* **8**, 7854-7860 (2016).
2. Fu, X. *et al.* Graphene/ZnO nanowire/graphene vertical structure based fast-response ultraviolet Photodetector. *Appl. Phys. Lett.* **100**, 223114 (2012).