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

Supplementary Data

Efficient van der Waals layered gallium telluride-based passive photodetector for low-power-density sensing of visible light

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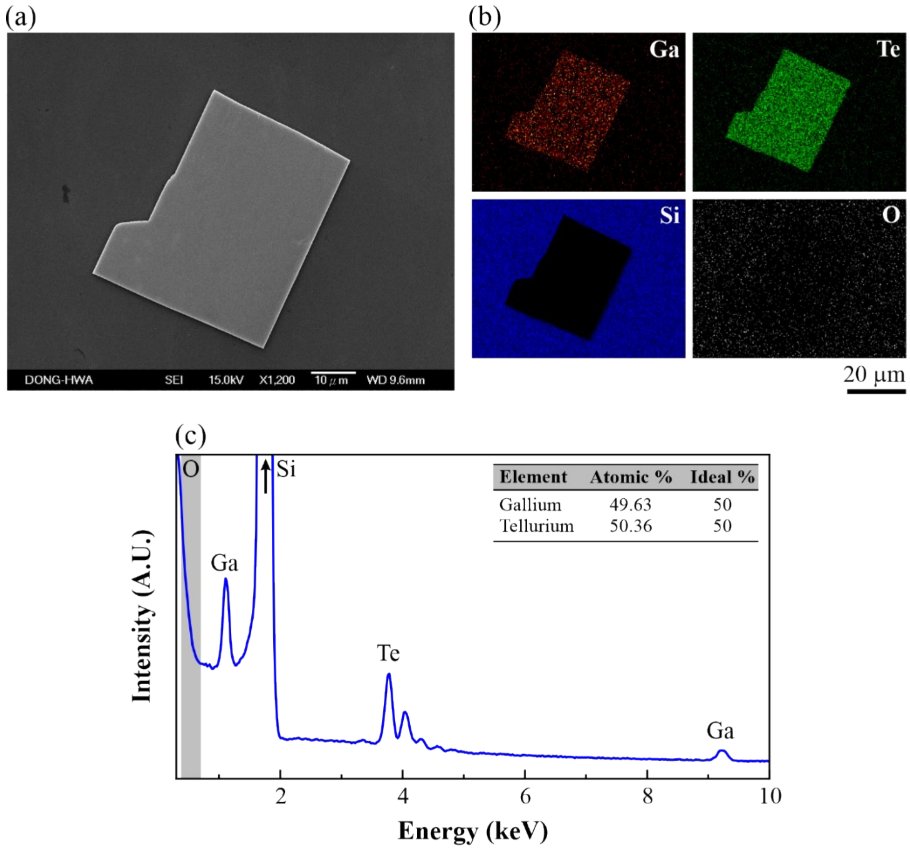

Figure S1. EDX analysis of vdW layered GaTe single crystal flake. (a) SEM image of an exfoliated GaTe flake on silicon. (b) EDX mapping image of gallium, tellurium, silicon (substrate), and oxygen. (c) EDX spectra confirming the presence of gallium and tellurium, in agreement with the ideal atomic ratio of GaTe. No oxygen peak is detected.

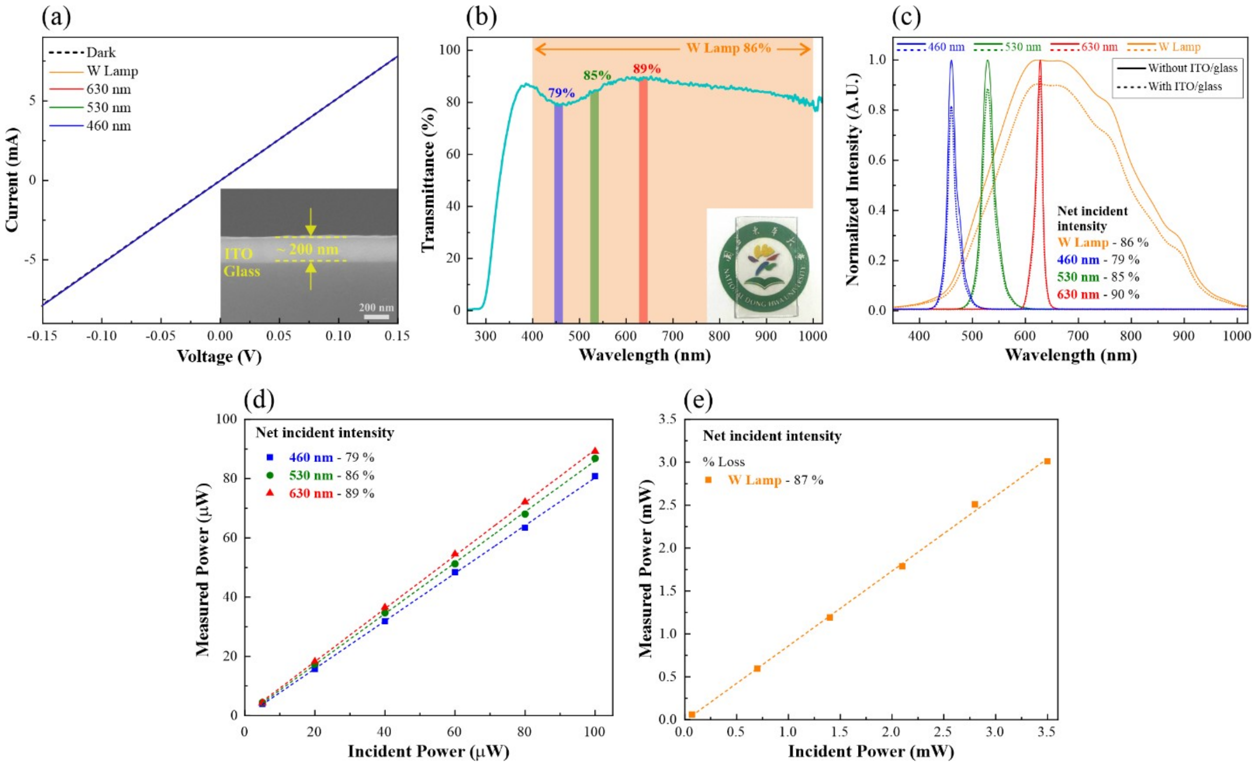

Figure S2. Characterization of the ITO-coated glass used as electric contacts for the photodetector device. (a) I-V measurement of ITO/glass electrode showing excellent conductivity, but no response under exposure to light. Inset: SEM image of the ITO/glass substrate used as transparent electrode for the vdW layered GaTe photodetector device. The transparent electrode has a ~200 nm thick layer of conductive ITO, providing good electrical contact for photodetector experiments. (b) Transmittance spectroscopy of the ITO/glass electrodes highlighting the intensity loss at certain wavelengths. Inset: Photo of ITO-coated glass used as the electric contacts. (c) Intensity of the light sources with and without ITO/glass. (d,e) Actual incident power vs measured power, showing good agreement with the values obtained using transmittance spectroscopy.

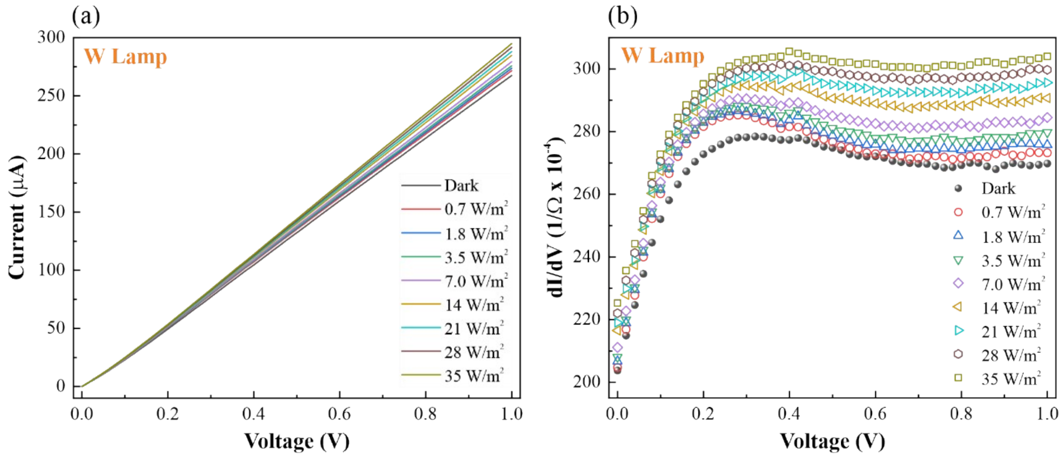

Figure S3. Power-dependent I-V measurement of the vdW layered GaTe single crystal under W lamp irradiation. (a) I-V curve of the photodetector device. (b) The corresponding dI/dV curve under W Lamp irradiation from 0.7 W/m^2 to 35 W/m^2. The power-dependent I-V measurements agrees well with the photoresponse, both indicating that the generated photocurrent is proportional to the irradiation power density

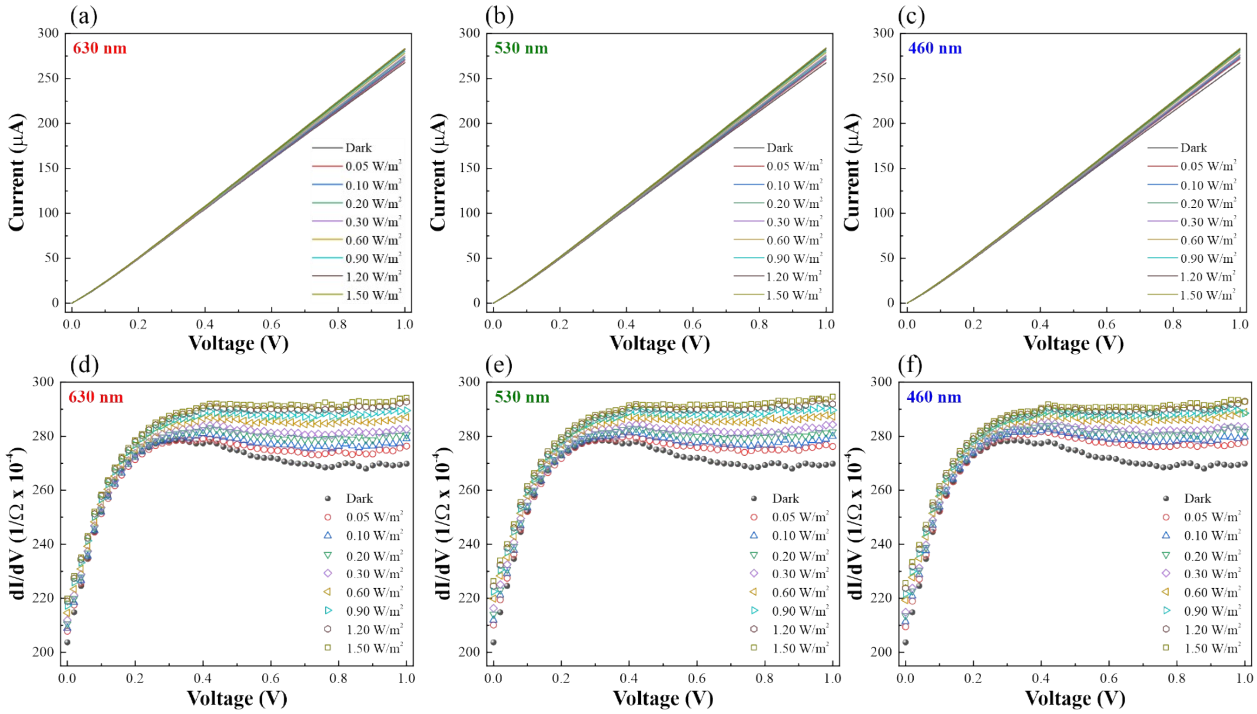

Figure S4. Low-power density *I-V* measurement of the vdW layered GaTe single crystal. (a-c) I-V curve of the photodetector device under low-power irradiation (0.05 – 1.50 W/m^2) at various wavelengths. (b) The corresponding dI/dV curves under irradiation at 630 nm, 530 nm, and 460 nm from 0.05 W/m^2 to 1.5 W/m^2.

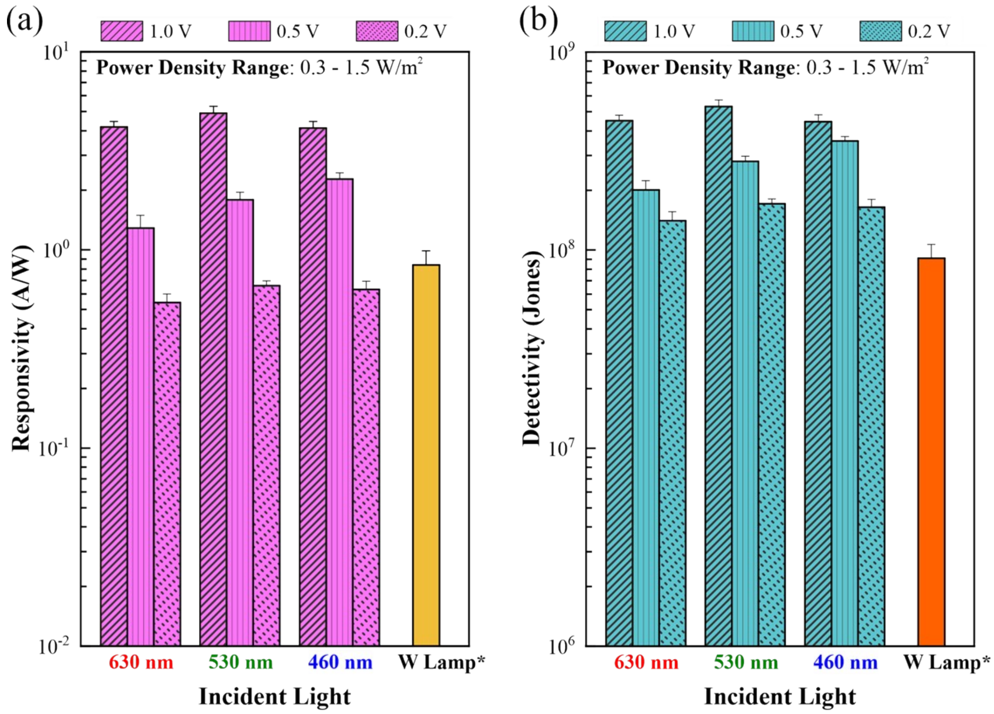

Figure S5. Photodetector parameters of the vdW layered GaTe single crystal in the higher power density region. (a) Responsivity of the vdW layered GaTe single crystal at 0.3 – 1.5 W/m^2. (b) Calculated detectivity from the responsivity data. *W lamp range is 0.7 – 35 W/m^2 and operated at 1.0 V, included for comparison.

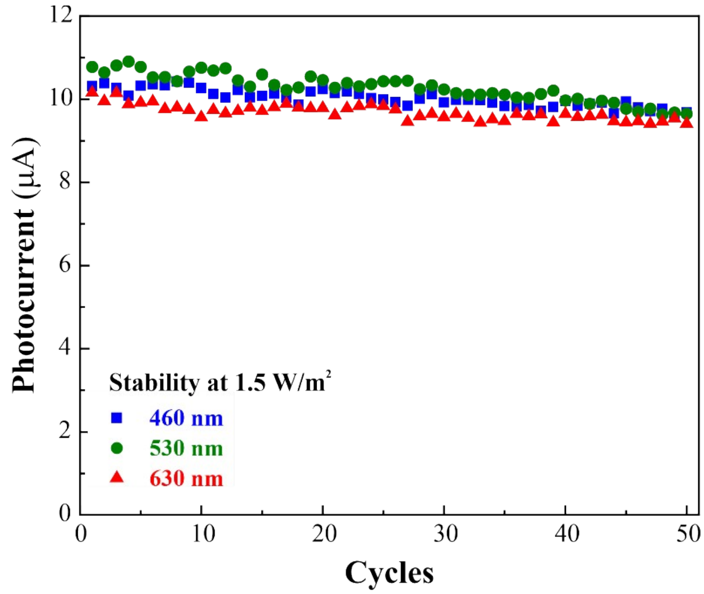

Figure S6. Cyclic Stability**.** Stability of the photodetector device under variable wavelength irradiation at the highest power density (1.5 W/m^2).

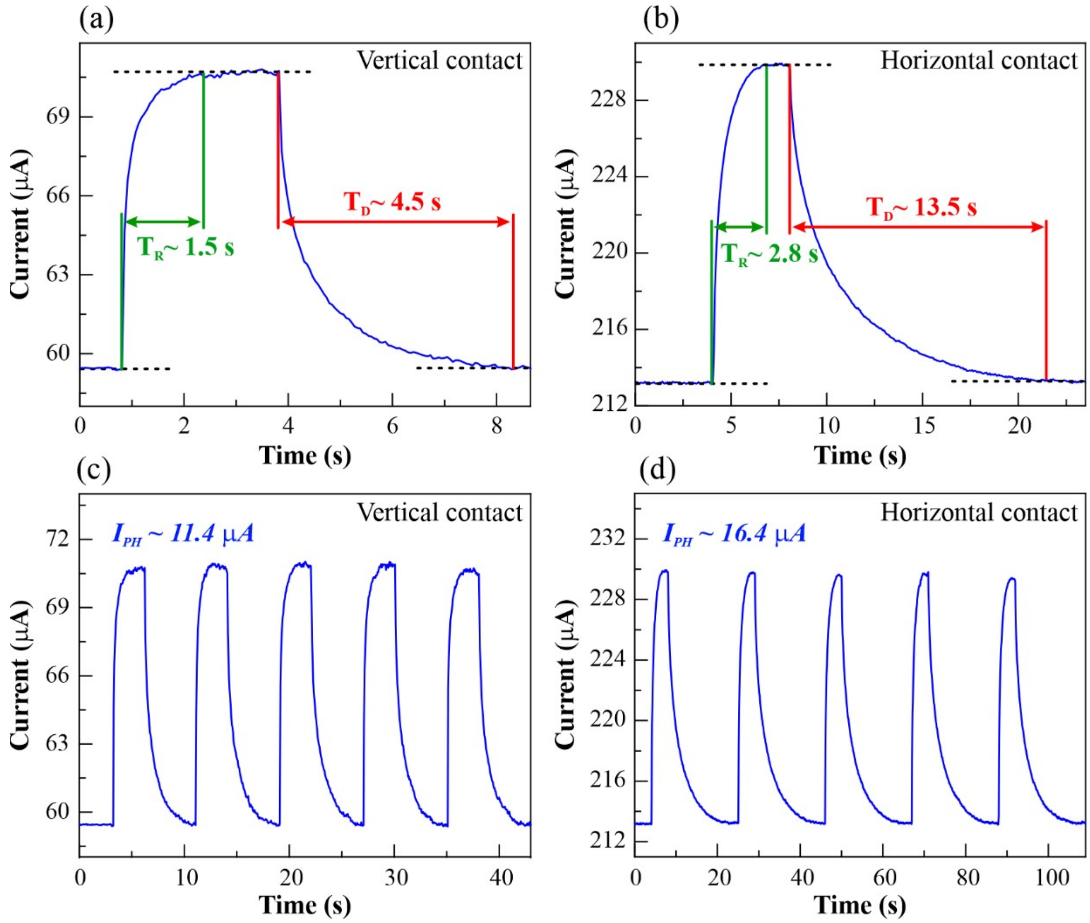

Figure S7. Photoresponse of device based on vertical and horizontal contact. Single ON-OFF cycle that shows the response and decay times of (a) vertical contact and (b) horizontal contact. Five ON-OFF cycles of (c) vertical contact and (d) horizontal contact to obtain the average generated photocurrent. Device using vertical contacts exhibit better response time at the cost of reduced photoresponse. This is generally the case for photodetectors due to the inverse relationship between response time and responsivity [1]. In addition, the ITO/glass vertical contacts act as a sealed environment for the vdW layered GaTe single crystal, which is known to degrade in ambient air conditions.

Table S1: Reports on cyclic stability of GaTe-based photodetectors

Material	Power Density (W/m^2)	No. of cycles	Ref
Multilayer GaTe FET	29	2	[2]
GaTe nanosheet FET	805	6	[3]
GaTe nanowire FET	32	5	[4]
Multilayer GaTe FET	300	7	[5]
Multilayer GaTe FET	141.3	6	[6]
GaTe Thin Film FET	7300	2	[7]
GaTe nanowire and nanosheet (2-terminal)	200	1	[8]

Table S2: Two-terminal photodetector device based on 2D chalcogenides and halides

Material	Synthesis	Incident Light (nm)	Power (W/m^2)	*R* (A/W)	*D* (Jones)	T_R / T_D	Operating Voltage (V)	Ref
Graphene/Cu_2 SnS3	CVD and spin coating	850	1.08	110	10^{12}	10.2 s / 11.3 s	2.5	[9]
GaSe Nanobelt	CVD on silicon	265	0.249	663	-	0.44 s / 3.24 s	3	[10]
GaSe Nanosheet	*2D Semiconductors*, Exfoliated	380	3.5	2.6	10^{12}	0.7 s / 1.2 s	5	[11]
GaSe Nanosheet	Modified Bridgman	254	~ 2 - 10	2.8	-	0.02 s / 7 s	5	[12]
Few layer GaS	*HQ graphene*, exfoliated	405	5000	10^3	10^{12}	3 µs / 8.5 µs	2	[13]
2D GaS Film	CVD	275	1.02	4.7	10^{12}	66 ms / 66 ms	20	[14]
SnS_2 Nanosheets	Modified Bridgman	350-750	3.6	8.82	10^{11}	1.2 s / 3 s	2	[15]
MoS_2	*Moly Hill Mine*, Exfoliated	740	120	~10	-	20 s / 21 s	10	[16]
$MoSe_2$	Exfoliation from bulk	532	4.4	10^3	10^{10}	33.6 ms / 51.6 ms	5	[17]
Black phosphorus	*HQ graphene*, exfoliated	1520-1580	25.1 mW	2.64	10^8	-	2	[18]
Multilayered WS_2 film	PLD on silicon	635	180	0.7	10^9	4.1 s / 4.4 s	9	[19]
WS_2 nanosheets film	Hydrothermal intercalation exfoliation of bulk WS_2	532	590.9	0.004	10^9	11.6 s / 7.9 s	5	[20]
$RuCl_3$	CVT	1600	100-200 µW	10^{-4}	-	8 ms / 8 ms	1	[21]
$ReSe_2$	CVD on Cu foil	530	27	470	-	0.5 s / 1.0 s	2	[22]
GaTe Nanowire	PVT on sapphire	325-800	200	460-1580	~10^{10}	~ few tens of seconds	1	[8]
Multilayer GaTe	**Bridgman**	**W filament + 630, 530, & 460**	**0.05 – 35**	**15.1-17.8**	**~10^9**	**1.4 s / 2.6 s**	**V = 0.2 V, 0.5, 1.0 V**	**This work**

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