Supplementary Information

Scalable MBE growth of $MoSe_2$/GaTe van der Waals heterostructure for high-speed vis-NIR photodetection

Santanu Kandar [1], Kamlesh Bhatt [1], Shivansh Tiwari[1], Nahid Chaudhary [2], Taslim Khan[1], Ashok Kapoor [1], and Rajendra Singh [1,*]

[1] *Department of Physics, Indian Institute of Technology Delhi, Hauz Khas, New Delhi 110016, India*

[2] *School of Interdisciplinary Research, Indian Institute of Technology Delhi, Hauz Khas, New Delhi 110016, India*

[*] *Corresponding author: rsingh@physics.iitd.ac.in*

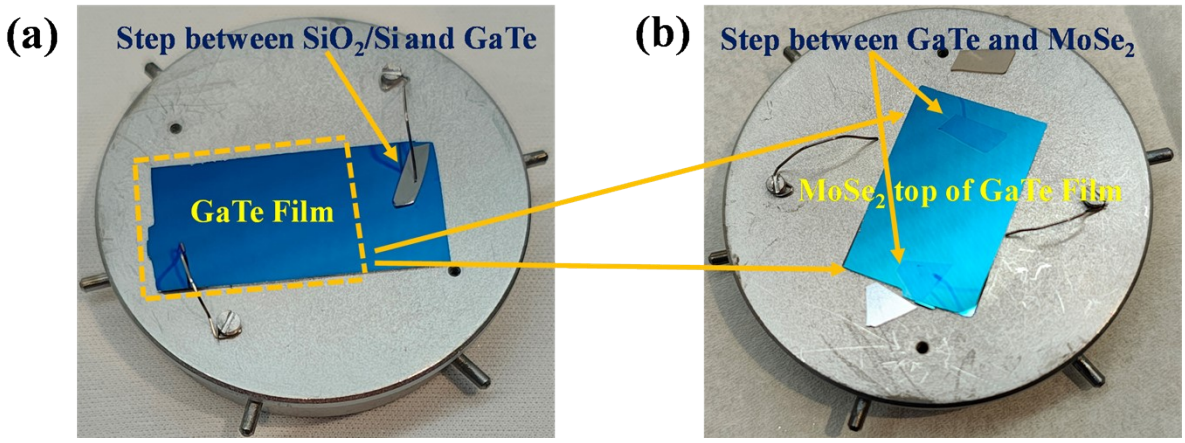

Figure S1. (a) Image of step between GaTe and SiO_2/Si substrate, (b) Image of step between $MoSe_2$ and GaTe film.

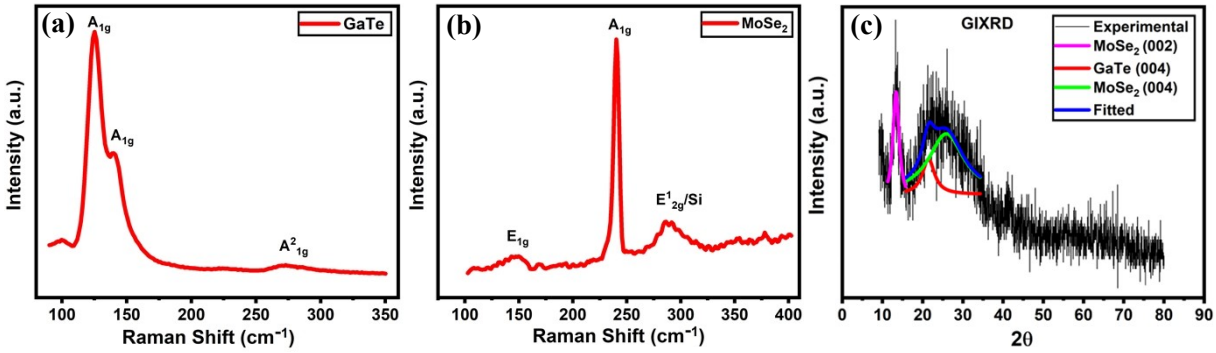

Figure S2. Raman spectroscopy of (a) GaTe and (b) $MoSe_2$ films, (c) XRD of $MoSe_2$/GaTe heterostructure.

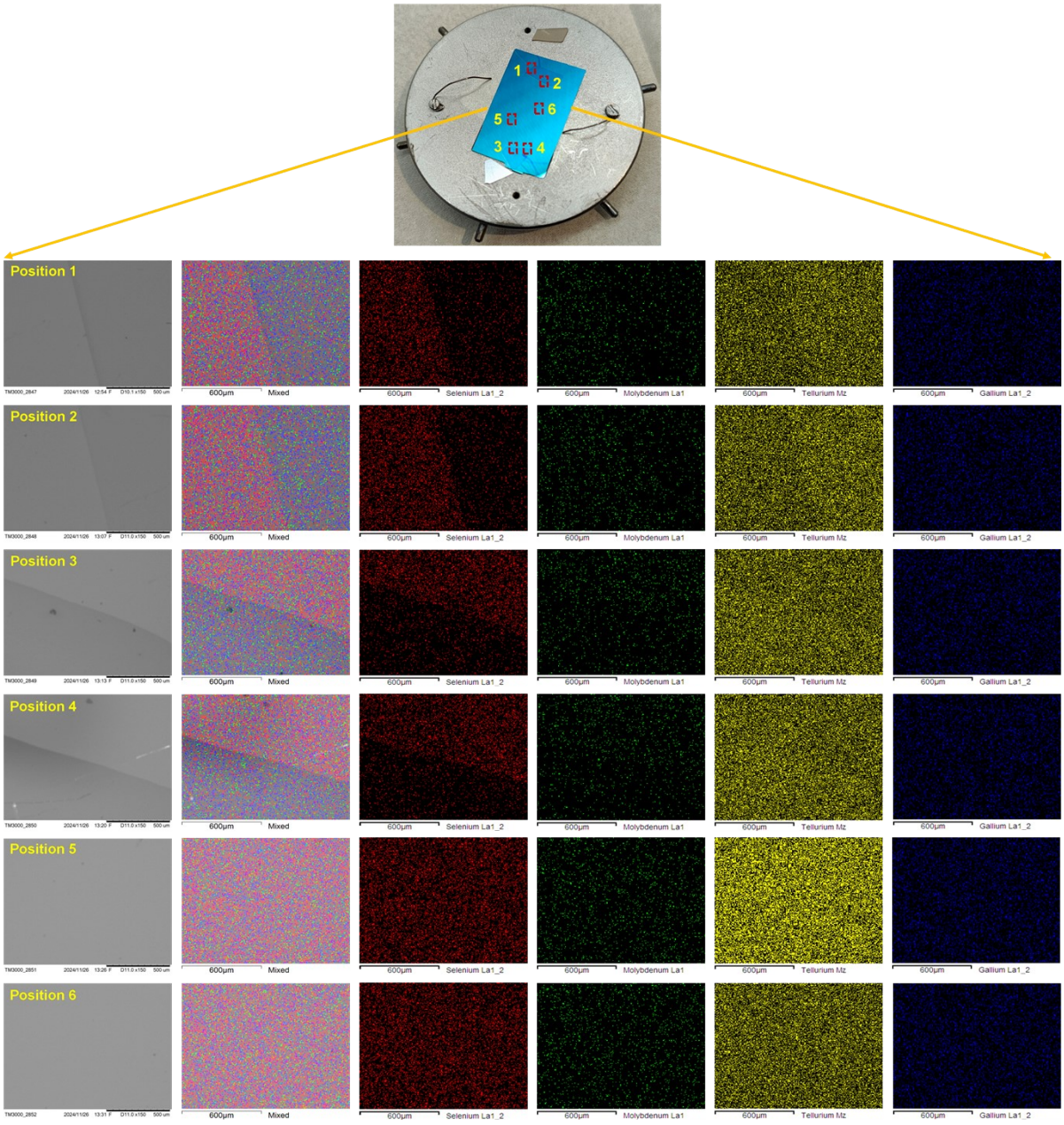

Figure S3. SEM image and EDX elemental mapping of the heterostructures at different positions as marked above.

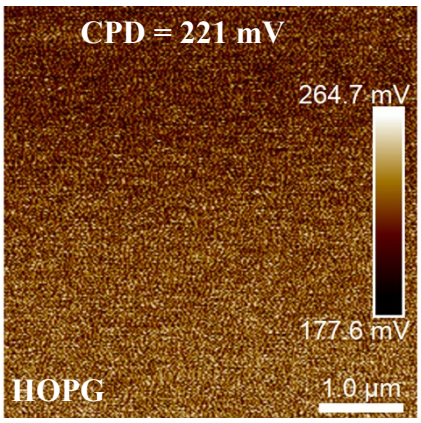

Figure S4. Surface potential image of HOPG substrate (scan area 5×5 μm^2).

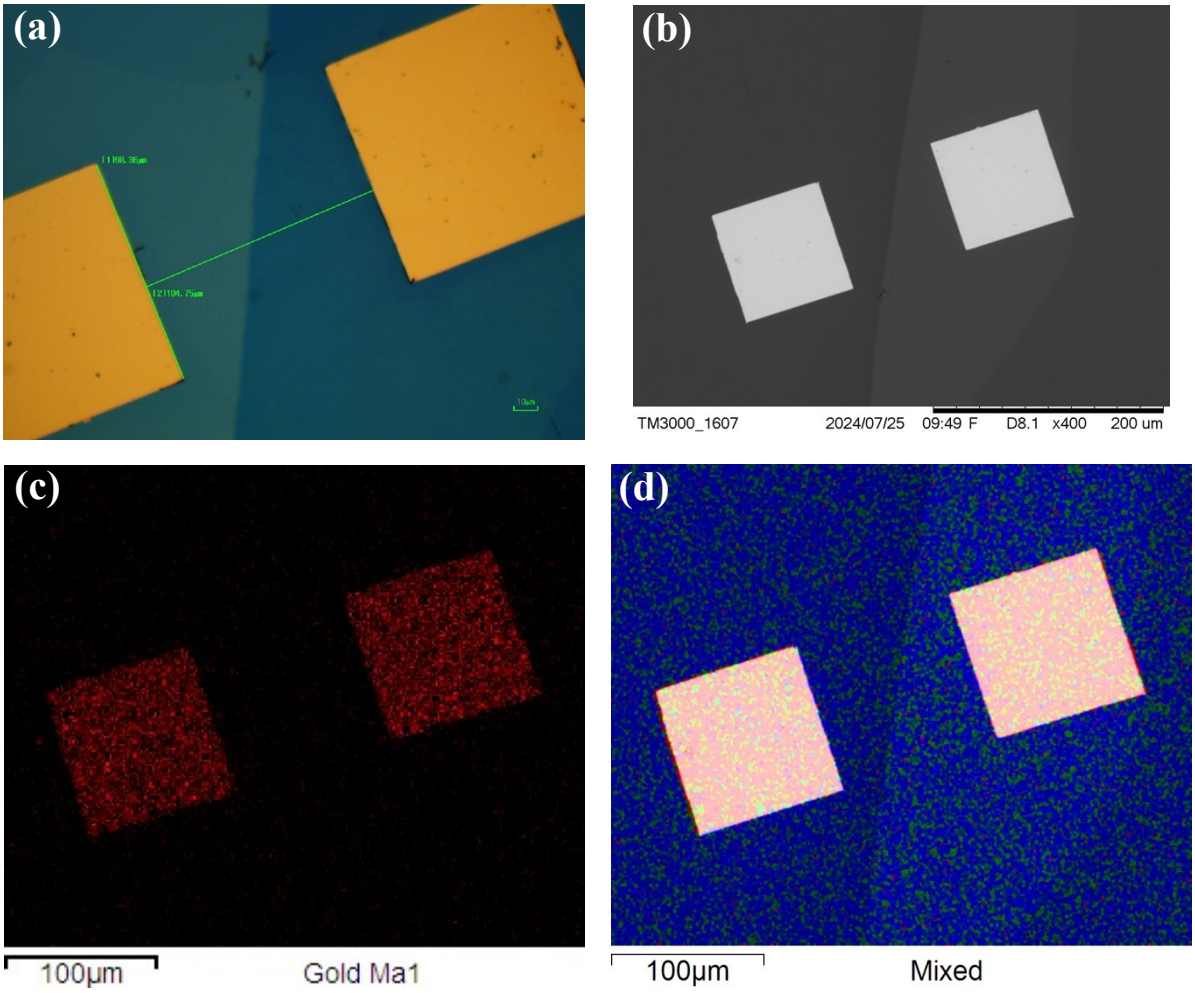

Figure S5. (a) Optical image of the device, (b) SEM image of the device, (c) EDX mapping of Au, (d) EDX mixed mapping of Ti, Au, Al and Ga.

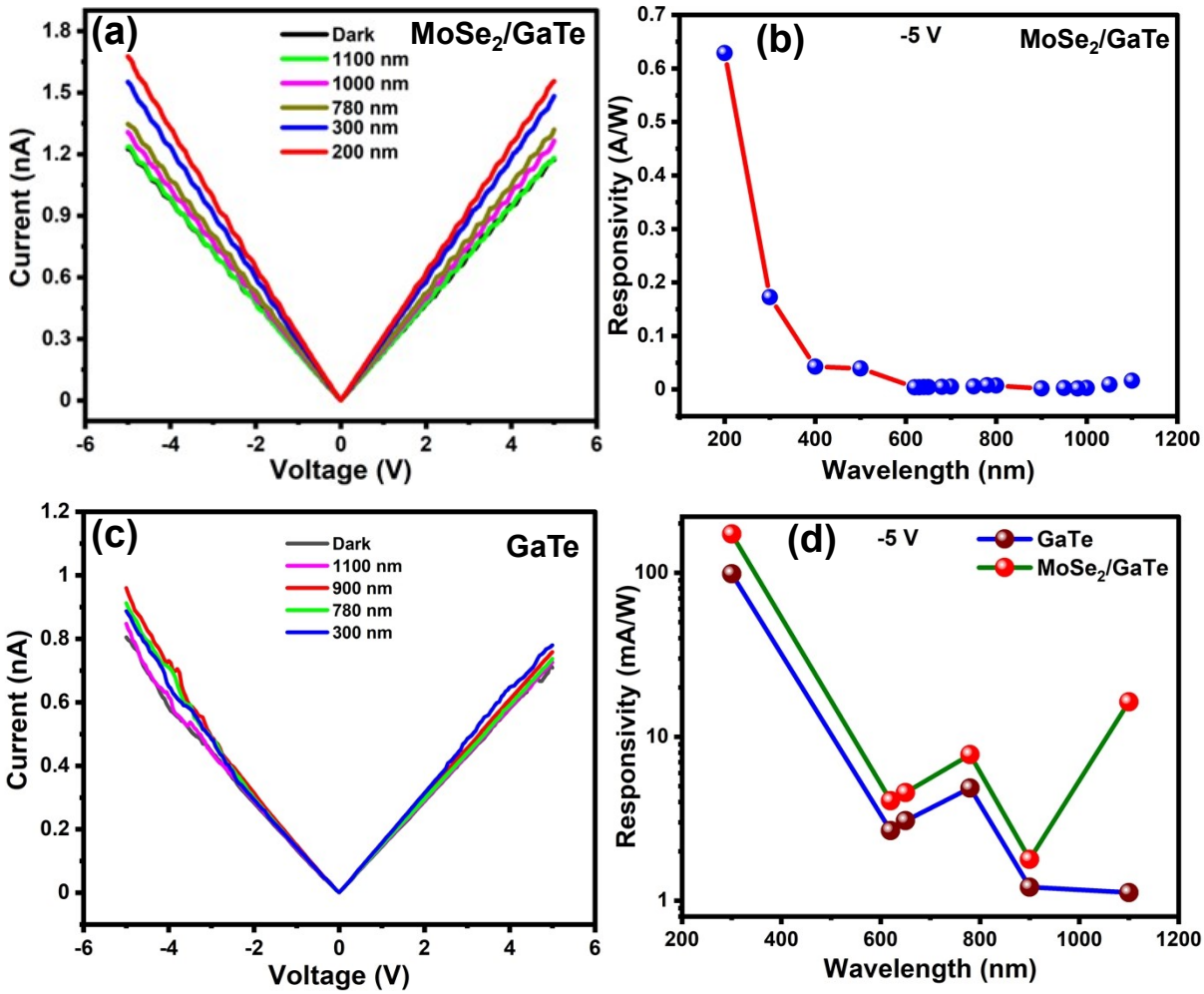

Figure S6. (a) I-V characteristics of $MoSe_2$/GaTe heterostructure, (b) Responsivity of $MoSe_2$/GaTe heterostructure, (c) I-V characteristics of GaTe, (d) Responsivity comparison of GaTe and $MoSe_2$/GaTe heterostructures.

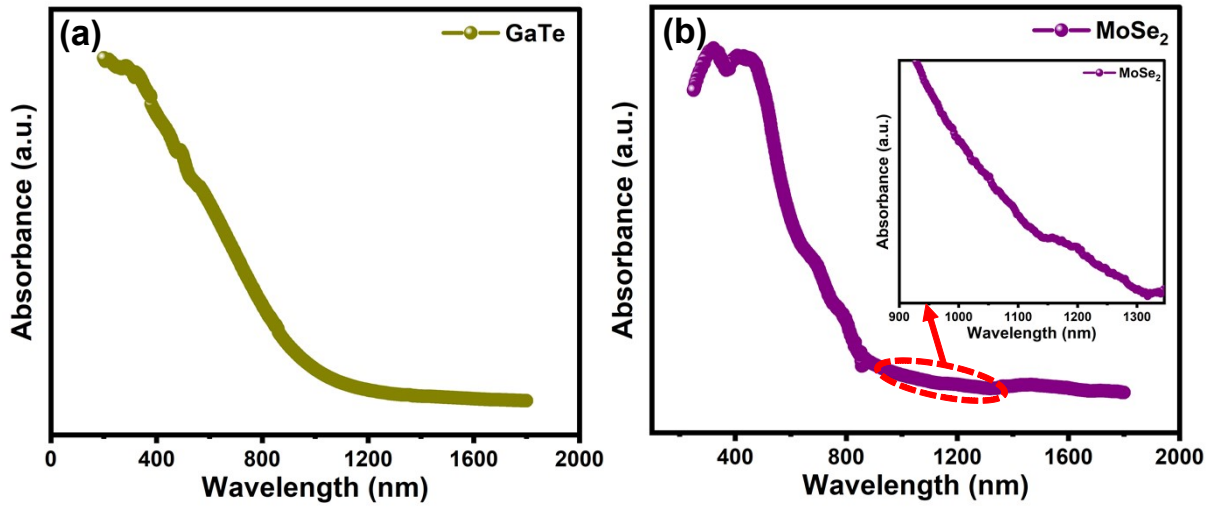

Figure S7. Absorbance spectra of (a) GaTe and (b) $MoSe_2$ (inset is the zoomed-in absorption spectra in NIR region).

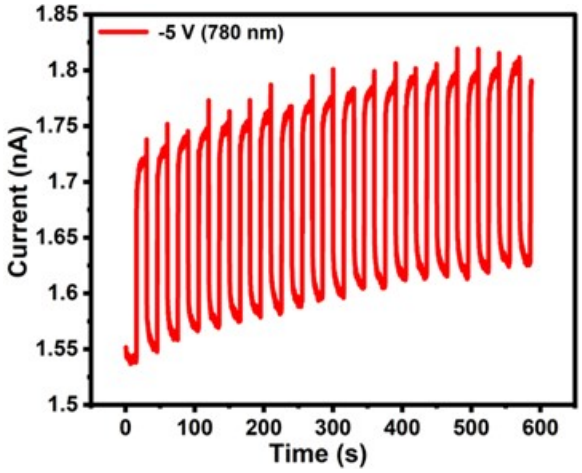

Figure S8. Device stability data (20 cycles) under 780 nm illumination.

Table 1:

Material	Growth Technique	Scalability	Wavelength Range	Responsivity	Device Speed (Rise/Fall)	Remarks	Ref.
MoS_2	Mechanical exfoliation	Flakes	532 nm	0.25-4.1 A/W	2s	Not scalable	1
$SnSe_2$/ MoS_2	CVD	Triangular flakes	500 nm	-	-	No uniformity Not scalable	2
MoS_2/ WS_2	Transfer method	Flakes	633 nm	1.42 A/W	-	Not scalable	3
CdSe/ graphene	CVD	Flakes	633 nm	10 mA/W	82 ms	No uniformity Not scalable	4
Graphene/$MoSe_2$/ Au	Mechanical exfoliation	Flakes	450 to 900 nm	89.5 mA/W	9.6/12.8 ms	Not scalable	5
GaTe-MoS_2	Vertical Bridgman technique & CVT	Flakes	633 nm	1.365 A/W	< 10 ms	Not scalable	6
GaTe/ graphene	MBE	Large-area uniform growth	325 to 1064 nm	0.3 A/W	9/7 ms	Scalable Not good for NIR detection	7
$MoSe_2$/ GaTe	MBE	Large-area uniform growth	200 to 1100 nm	0.6 A/W	44/67 ms	1. Scalable up to wafer scale 2. Photo response in UV, Visible and NIR	**This work**

References:

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