Supplementary information

High photosensitivity and broad spectral response of multi-layered germanium sulfide transistors

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Table S1. Summary of performance metrics of the IV-VI group-based 2D photodetectors

<table>
<thead>
<tr>
<th>Materials</th>
<th>Spectral window</th>
<th>Channel thickness/length</th>
<th>Measurement condition</th>
<th>Incident power</th>
<th>R_λ (A/W)</th>
<th>τ_l/τ_t</th>
<th>EQE (%)</th>
<th>D* (Jones)</th>
<th>Response time</th>
<th>Ref.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multi-layered SnS₂</td>
<td>Visible</td>
<td>~80 nm/2 μm</td>
<td>V_g = 0 V V_d = 2 V</td>
<td>0.24 μW</td>
<td>8.8×10⁻³ (457 nm)</td>
<td>~3.0×10⁻¹</td>
<td>NR</td>
<td>2×10⁹</td>
<td>~5 μs</td>
<td>S1</td>
</tr>
<tr>
<td>Multi-layered SnS₂</td>
<td>Visible</td>
<td>~108 nm/5 μm</td>
<td>V_d = 10 V</td>
<td>1 mW/cm²</td>
<td>2         (450 nm)</td>
<td>~5.1×10¹</td>
<td>NR</td>
<td>NR</td>
<td>~42 ms</td>
<td>S2</td>
</tr>
<tr>
<td>Multi-layered GeSe</td>
<td>IR</td>
<td>57 nm/10 μm</td>
<td>V_d = 4 V</td>
<td>283 mW/cm²</td>
<td>3.5       (808 nm)</td>
<td>~9.4×10²</td>
<td>530</td>
<td>NR</td>
<td>100 ms</td>
<td>S3</td>
</tr>
<tr>
<td>GeS nanoribbon</td>
<td>Visible</td>
<td>41 nm/5 μm</td>
<td>V_d = 5 V</td>
<td>0.25 μW/cm²</td>
<td>139.9     (530 nm)</td>
<td>~8.0×10³</td>
<td>3.37×10⁴</td>
<td>NR</td>
<td>850 ms</td>
<td>S4</td>
</tr>
<tr>
<td>Multi-layered GeS</td>
<td>Visible</td>
<td>~28 nm/13 μm</td>
<td>V_g = 0 V V_d = 10 V</td>
<td>1.5 μW/cm²</td>
<td>206       (633 nm)</td>
<td>~1.4×10⁴</td>
<td>4×10⁴</td>
<td>2.35×10¹³</td>
<td>~7 ms</td>
<td>This work</td>
</tr>
<tr>
<td></td>
<td></td>
<td>V_g = -80 V V_d = 10 V</td>
<td>10 μW/cm²</td>
<td>655 (633 nm)</td>
<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

V_g: back gate voltage; V_d: source-drain voltage; R_λ: photoresponsivity; τ_l/τ_t: ratio of carrier lifetime (τ_l) to transit time (τ_t); EQE: external quantum efficiency; D*: specific detectivity; NR: not reported.
**Fig. S1** (a) Elemental mapping of the as-synthesized bulk GeS crystal. (b) EDS spectrum of the bulk GeS crystal. (c) Analysis of the weight and atomic percentages of the GeS crystal reveals the stoichiometric ratio of Ge:S of ~ 1:1.
Fig. S2 The measured $I_{ds} - V_g$ curve of a multi-layered GeS-FET indicates the on/off current ratio of $\sim 10^5$. 
**Fig. S3** An absorption spectrum of bulk GeS crystal was observed. In the inset, the band gap of the bulk GeS crystal is estimated to be \(~1.63\) eV by fitting the measured data to a Tauc’s plot.
Fig. S4 D* of a multi-layered GeS photodetector as a function of $V_g$ was measured at $V_{ds} = 10 \, \text{V}$ and $P = 10 \, \mu\text{W/cm}^2$ at 633 nm.
**Fig. S5** Photoswitching stability of a GeS photodetector in response to a long train (~100 cycles) of pulsed illumination at $P = 12.7 \text{ mW/cm}^2$ ($\lambda = 633 \text{ nm}$), $V_g = 0 \text{ V}$, and $V_{ds} = 1 \text{ V}$. 
REFERENCES


