Supplementary Information

Surface functionalization-induced photoresponse characteristics of monolayer MoS$_2$ for fast flexible photodetectors

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The photoresponsivity $R = \frac{I_{ph}}{P}$ was calculated for the pristine, ODTS-, and APTES-MoS$_2$ devices, and these values reached maximum values of 1500 A/W and 37.5 A/W at the lowest incident power for the APTES-MoS$_2$ and ODTS-MoS$_2$ devices, respectively. Photoresponsivity represents photocurrent generation respective to the incident illumination power. Therefore, the APTES-MoS$_2$ device with higher photoresponsivity suggests that more excitons were transported through the functionalized channel.
Fig. S2 Detectivity with respect to the incident illumination powers for the pristine, ODTS-, and APTES-MoS$_2$ devices.

The detectivity $D^*$ can be expressed as $D^* = \sqrt{AB}/NEP$, where $A$ is the device area, $B$ is the bandwidth, and NEP is noise-equivalent power which is the minimum detectable power when the signal-to-noise is equal to unity and bandwidth is limited to 1 Hz. The detectivity takes account the noise of a device, device area, and bandwidth. Highest detectivity of $10^{11}$ cmHz$^{-1/2}$/W was measured for the ODTS-MoS$_2$ device under the lowest illumination intensity, and it can be attributed to the lowering of the dark level by effectively withdrawing electrons from the channel.
Fig. S3 Time-dependent photocurrent measurement of the flexible MoS$_2$ photodetector before and after ODTS-functionalization.
<table>
<thead>
<tr>
<th>Materials</th>
<th>Device Type</th>
<th>Operation</th>
<th>Photoresponsivity (A/W)</th>
<th>Detectivity (cmHz^{-1/2}W)</th>
<th>Rise Time (s)</th>
<th>Decay Time (s)</th>
<th>Ref</th>
</tr>
</thead>
<tbody>
<tr>
<td>1L-MoS2</td>
<td>Phototransistor</td>
<td>$V_{ph} = -70V$</td>
<td>880</td>
<td>-</td>
<td>4</td>
<td>9</td>
<td>Nat. Nanotech. 8, 2013 (Ref 1)</td>
</tr>
<tr>
<td>Multilayer MoS2</td>
<td>Phototransistor</td>
<td>$V_{ph} = -3V$</td>
<td>0.05-0.12</td>
<td>$10^6$-$10^{11}$</td>
<td>-</td>
<td>-</td>
<td>Adv. Mater. 24, 2012 (Ref 2)</td>
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<tr>
<td>1L-MoS2</td>
<td>Phototransistor</td>
<td>$V_{ph} = +50V$</td>
<td>2200</td>
<td>-</td>
<td>10-100</td>
<td>-</td>
<td>Adv. Mater. 25, 2013 (Ref 3)</td>
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<tr>
<td>1L-MoS2</td>
<td>Phototransistor</td>
<td>$V_{ph} = +60V$</td>
<td>415-1750</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>Nat. Commun. 8, 2017 (Ref 4)</td>
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<tr>
<td>Multilayer MoS2</td>
<td>Photodetector</td>
<td>$V_{in} = 10V$</td>
<td>0.057</td>
<td>$1.55 \times 10^8$</td>
<td>-</td>
<td>-</td>
<td>Adv. Mater. 29, 2017 (Ref 5)</td>
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<tr>
<td>1L-MoS2</td>
<td>Photodetector</td>
<td>$V_{in} = 3V$</td>
<td>178</td>
<td>&gt;30</td>
<td>1.6</td>
<td>0.7</td>
<td>Adv. Mater. 29, 2017 (Ref 6)</td>
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<tr>
<td>1L-MoS2</td>
<td>Photodetector</td>
<td>$V_{ds} = 0.1-1V$</td>
<td>37-1500</td>
<td>$10^8$-$10^{11}$</td>
<td>-</td>
<td>-</td>
<td>This work</td>
</tr>
</tbody>
</table>

**Table S1.** Summary and comparison of the MoS$_2$ photodetectors.
Supplementary References

(1) O. Lopez-Sanchez, D. Lembke, M. Kayci, A. Radenovic, A. Kis, Nat. Nanotechnol. 2013, 8, 497.


