Supplementary Materials

Selective Laser-assisted Direct Synthesis of MoS_2 for Graphene/MoS_2 Schottky Junction

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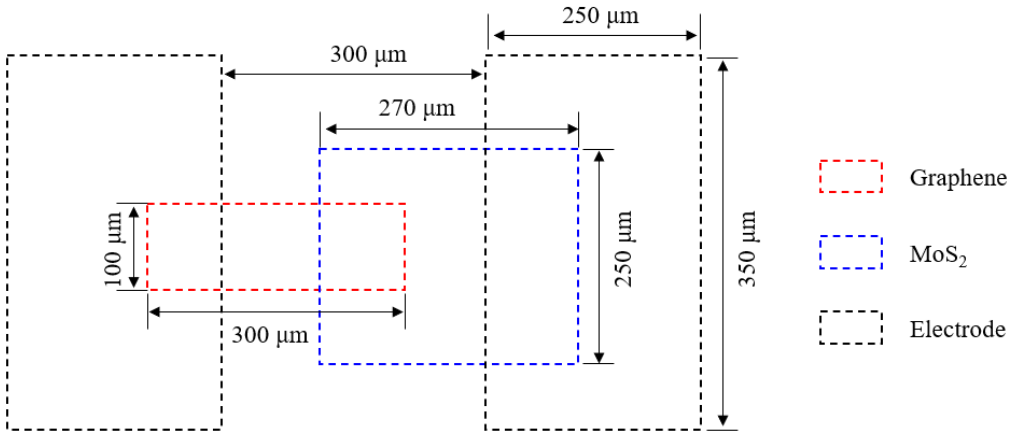
Figure S1. Schematic diagram of Graphene/MoS_2 based optoelectronic device.



Graphene pattern: The graphene layer was patterned into dimensions of 100 µm by 300 µm to serve as the base for our heterostructure.

MoS_2 pattern: The MoS_2 layer was synthesized and patterned simultaneously by laser annealing to dimensions of 250 µm by 270 µm. The MoS_2 pattern was partially overlapped with the graphene pattern to form the Schottky barrier.

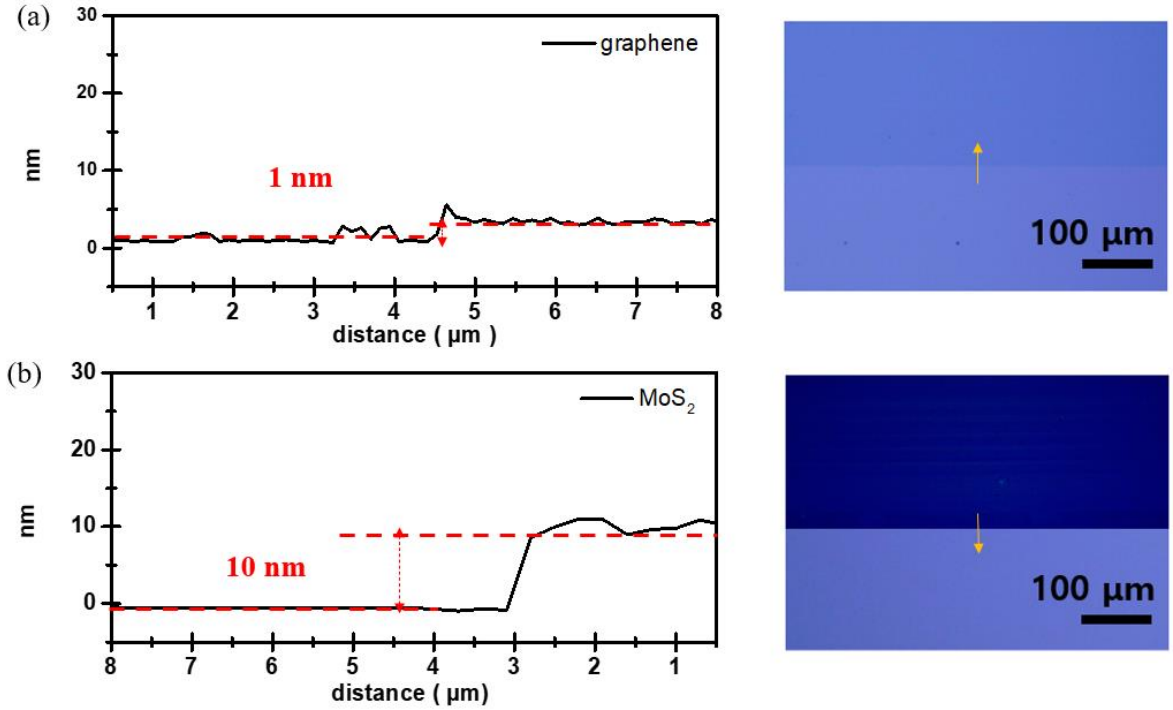
Electrode pattern size: Each electrode pattern was designed with dimensions of 250 µm by 350 µm to provide adequate contact area for electrical measurements without significantly overshadowing the active channel area. The distance between electrodes is 300 µm

Thickness of electrode materials: The electrodes are designed as a bilayer structure, consisting of a chromium adhesion layer of 5 nm, immediately followed by an 80 nm layer of gold. The chromium underlayer is essential for enhancing the adhesion of gold to the substrate. Nonetheless, the precise thickness of this chromium layer is critical to minimize contact resistance between MoS_2 and the metal contacts [S1]. Our experimental results indicate that a chromium layer thinner than 5 nm ($t < 5$ nm) is insufficient as an adhesion layer, whereas a thickness in excess of 10 nm adversely affects the uniformity of device performance. This non-uniformity is attributed to variable contact resistance between the MoS_2 and electrodes, likely a consequence of partial delamination of the electrode from MoS_2.[S1]

Reference

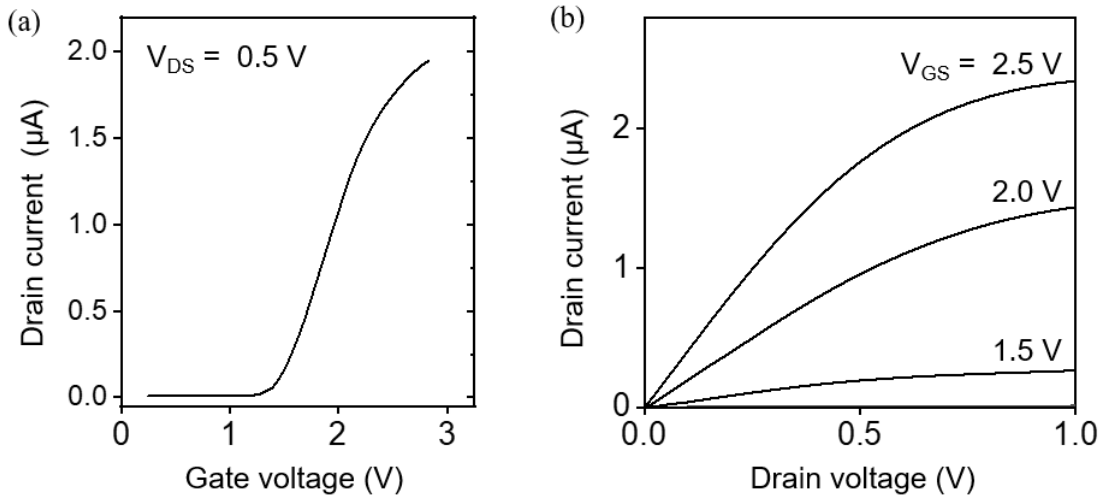
S1. Sano, K.; Takahashi, T.; Uchida, K. Large variability of contact resistance in Au/Cr/MoS2 system and its suppression by Cr thinning. Japanese journal of applied physics 2016, 55 (3), 036501.

Figure S2. AFM measurement



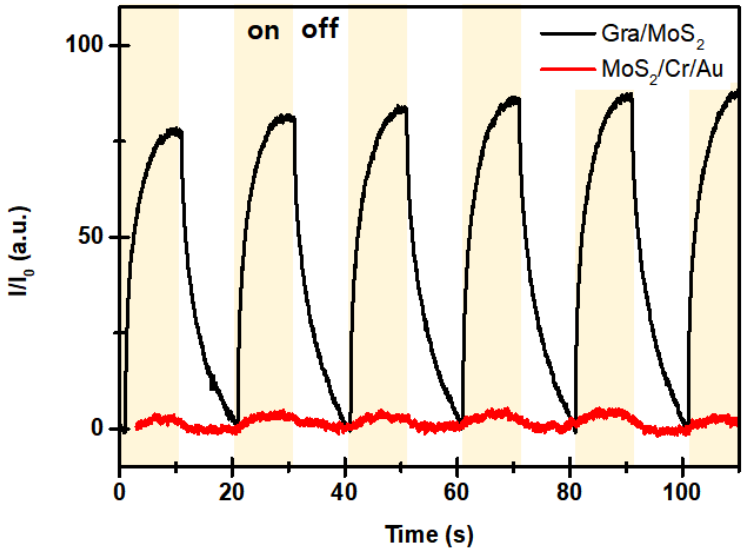
(a) Atomic force microscopy (AFM) height profile of the graphene (left) and optical microscope image (right) (b) height profile of the MoS_2 (left) and optical microscope image (right)

Figure S3. Transfer/output characteristics of MoS_2 FET



(a) Transfer characteristic and (b) output characteristic of Ion liquid gated MoS_2 FET.

Figure S4. Photocurrent Comparison between Graphene/MoS_2 and MoS_2/Cr/Au Junctions



The incident laser used for the measurement possesses a wavelength of 473 nm, power of 3.5 mW, a pulse repetition rate of 50 mHz, and a variable spot size ranging from 50 to 200 μm.

Figure S5. Schematic diagram for manufacturing a CVD type device array

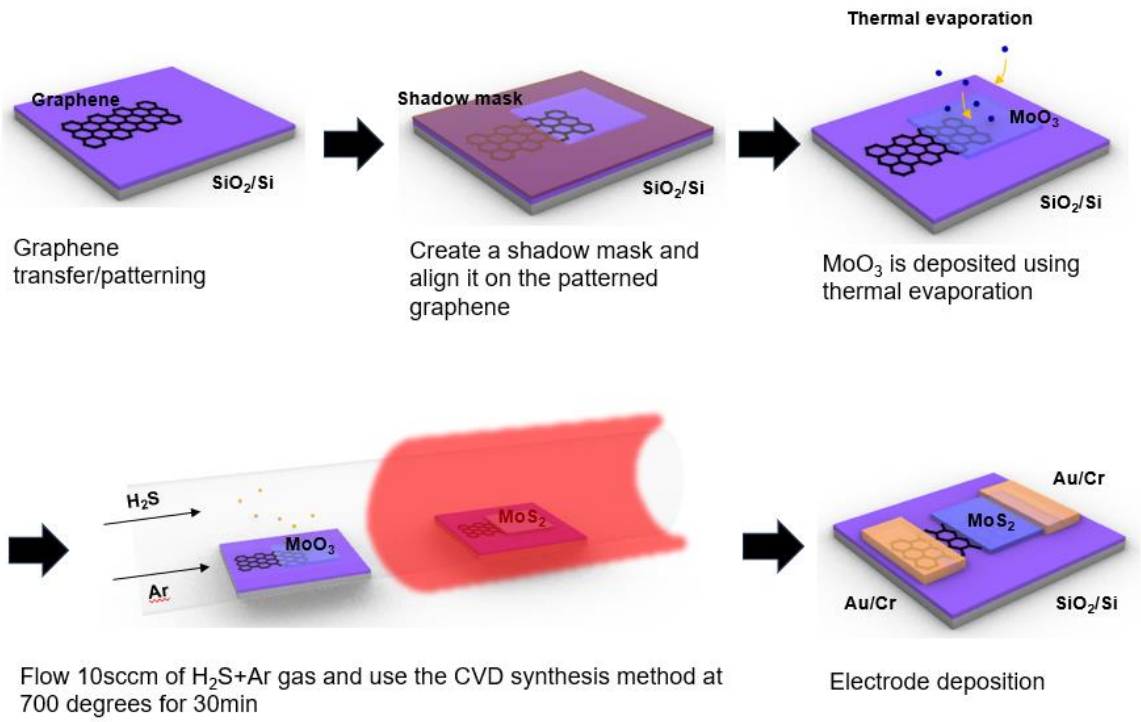
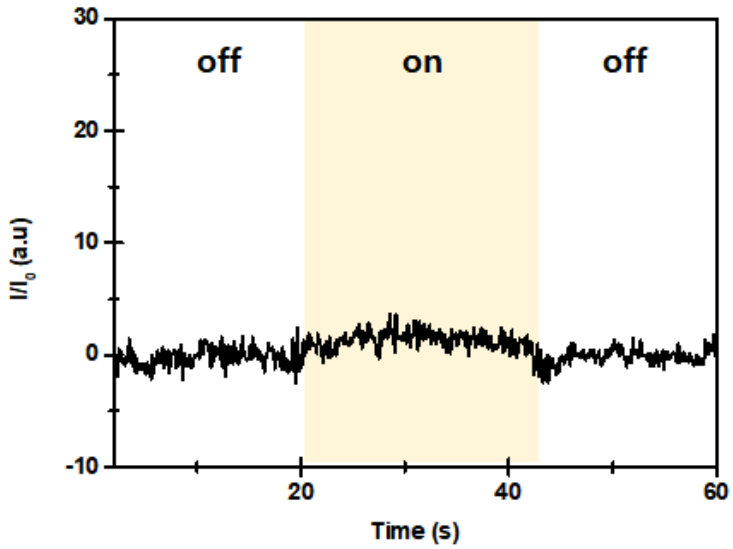


Figure S6. Photo-responsiveness of CVD type device



The CVD-type device has significantly lower reactivity to light than the laser photothermal-based device we used. In addition, damage to the lower layer graphene occurred due to the high temperature of 700 ºC.

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Figure S7. MoS_2 quality variation as a function of laser scanning speed

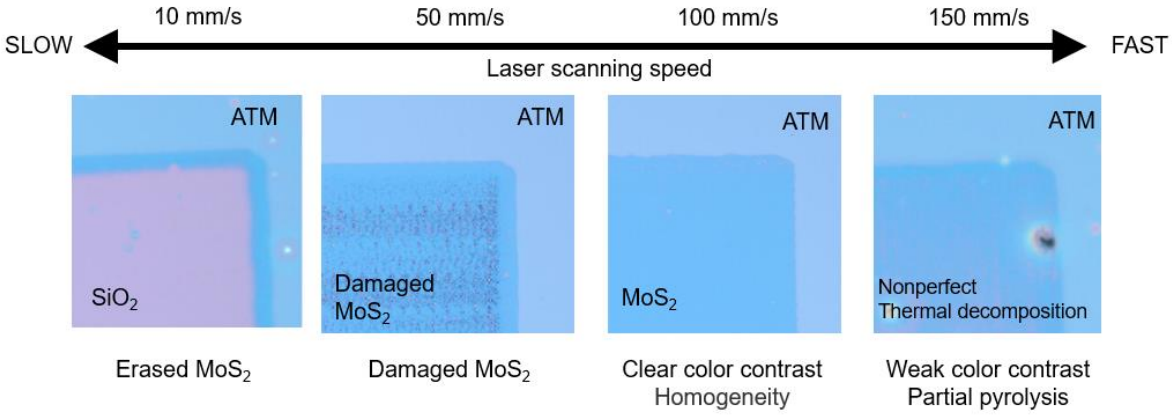
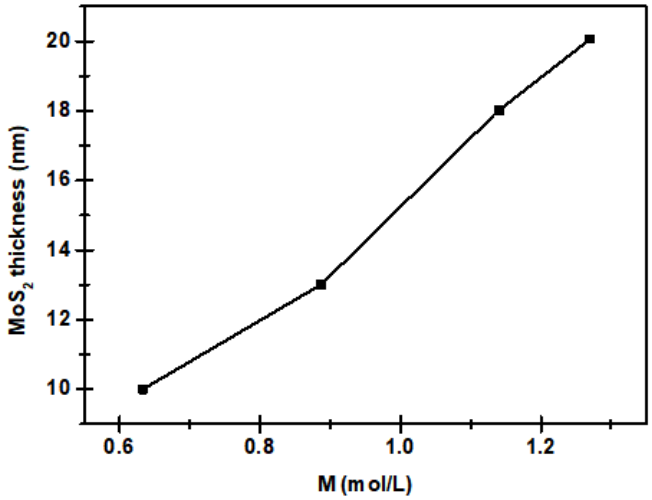


Figure S8. MoS_2 quality variation as a function of laser scanning speed

(a)

ATM amount (g)	M (mol/L)
1.0	0.633
1.4	0.887
1.8	1.140
2.0	1.270

(b)



(a) Molal concentration according to mixed ATM mass (b) thickness of synthesized MoS_2 according to ATM precursor molal concentration

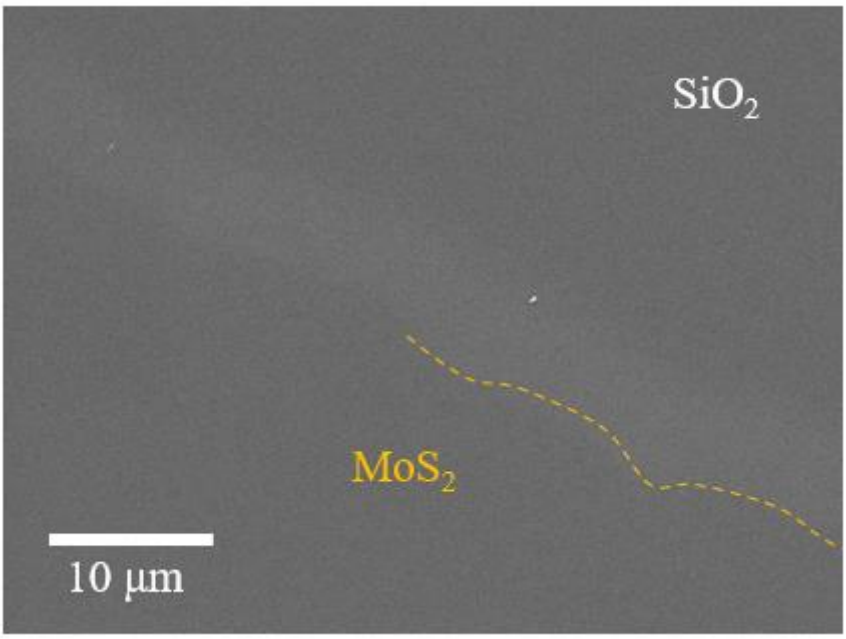



Figure S9. SEM image of MoS_2 boundary