

Supporting Information

Rectifying optoelectronic memory based on WSe₂/graphene heterostructure

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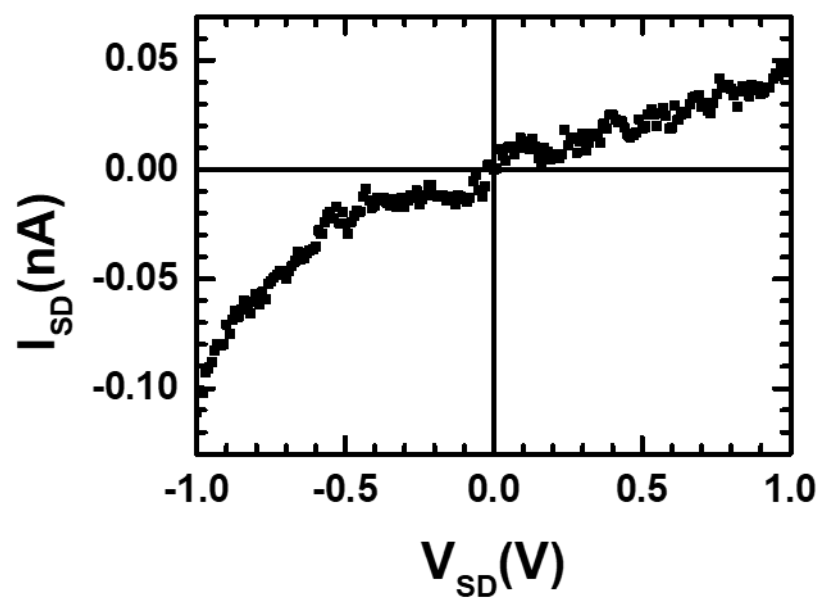


Figure S1. I_{SD} - V_{SD} curve measured before applying V_G .

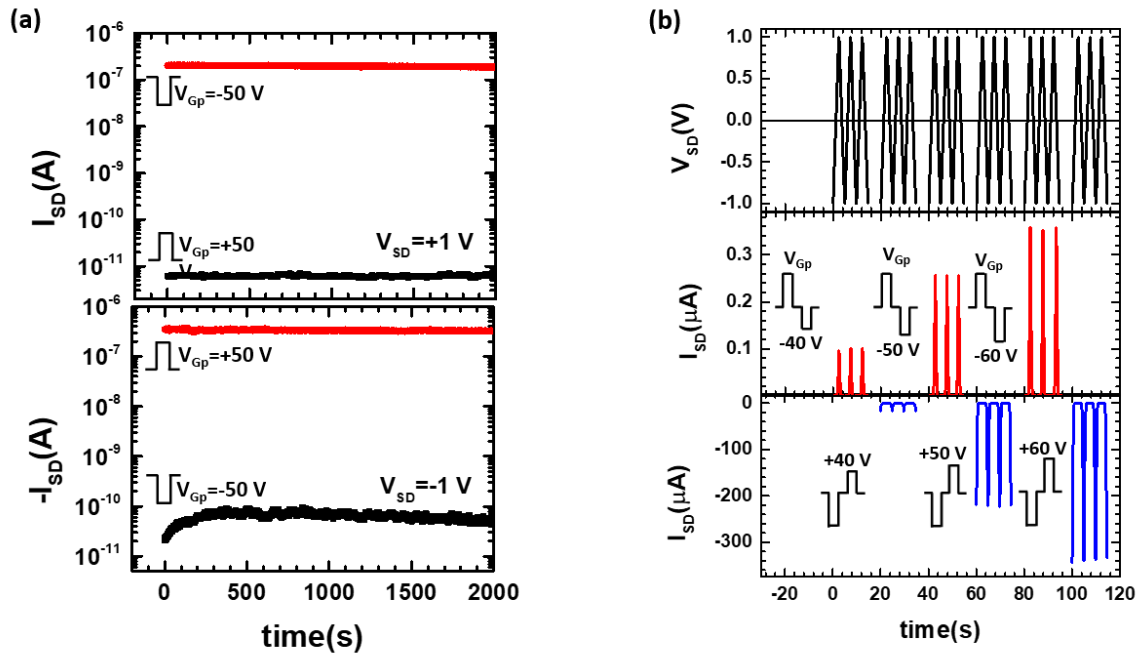


Figure S2. (a) Real-time I_{SD} measured at $V_{SD} = +1$ V (top) and $V_{SD} = -1$ V (bottom) after $V_{Gp} = -50$ V or $+50$ V was applied. (b) I_{SD} measured at V_{SD} of triangular waves with a frequency of 5 Hz (top) after applying various V_{Gp} . Before each measurement, the device was reset by applying $V_{Gp} = +60$ V (middle) or $V_{Gp} = -60$ V (bottom).

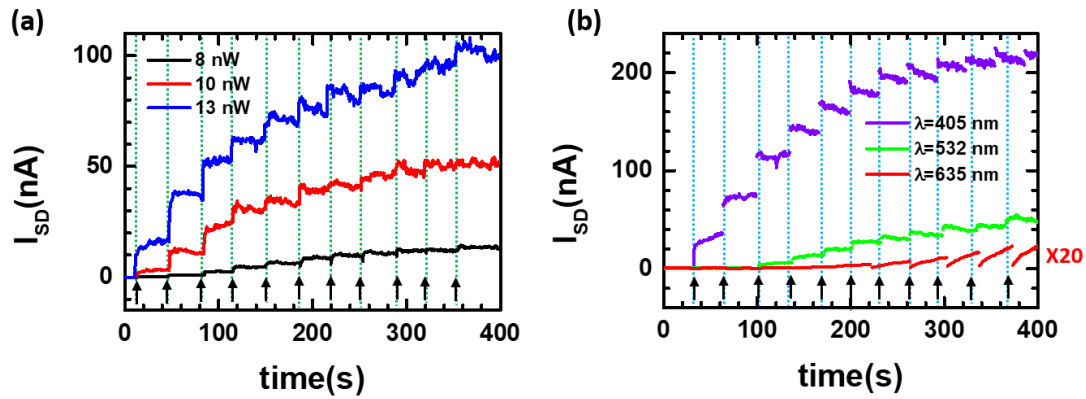


Figure S3. (a) I_{SD} measured at $V_{SD} = +1$ V when $V_{Gp} = +50$ V was applied to switch the device to the off state and then, $V_{Gp} = -15$ V and 532-nm laser pulses with different powers were simultaneously applied. (b) I_{SD} measured at $V_{SD} = +1$ V when $V_{Gp} = +50$ V was applied to switch to the off state and then, $V_{Gp} = -10$ V and laser pulses with different wavelengths and a power of 2 nW were simultaneously applied. The dotted lines indicate when the laser pulses were applied, while the arrows indicate the time at which V_{Gp} was applied.

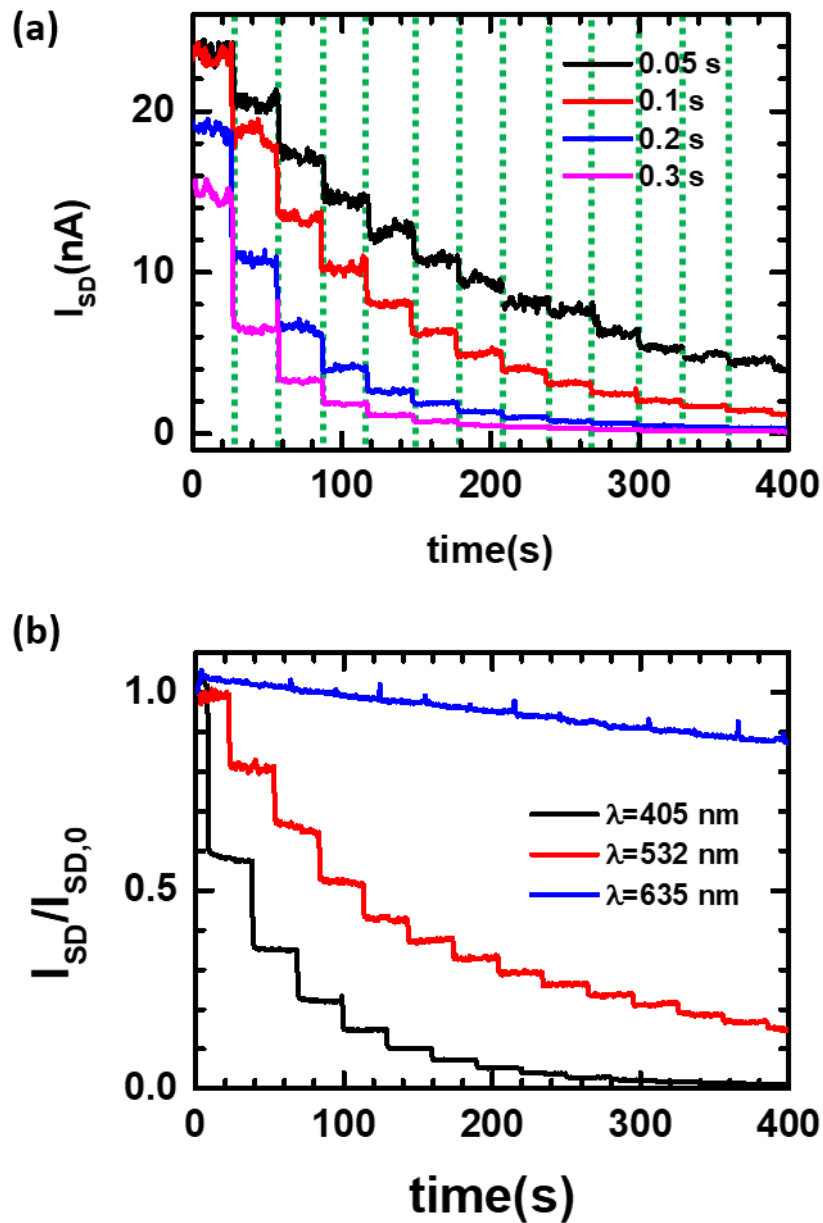


Figure S4. (a) I_{SD} measured at $V_{SD} = +1$ V after $V_{Gp} = -50$ V was applied and then, 532-nm laser pulses with different exposure times and a power of 2 nW were repeatedly applied. The dotted lines indicate the time when the laser pulses were applied. (b) Normalized I_{SD} measured at $V_{SD} = +1$ V when laser pulses with different wavelengths and a power of 3 nW were applied after applying $V_{Gp} = -50$ V. $I_{SD,0}$ indicates the current level before illumination with laser pulses.

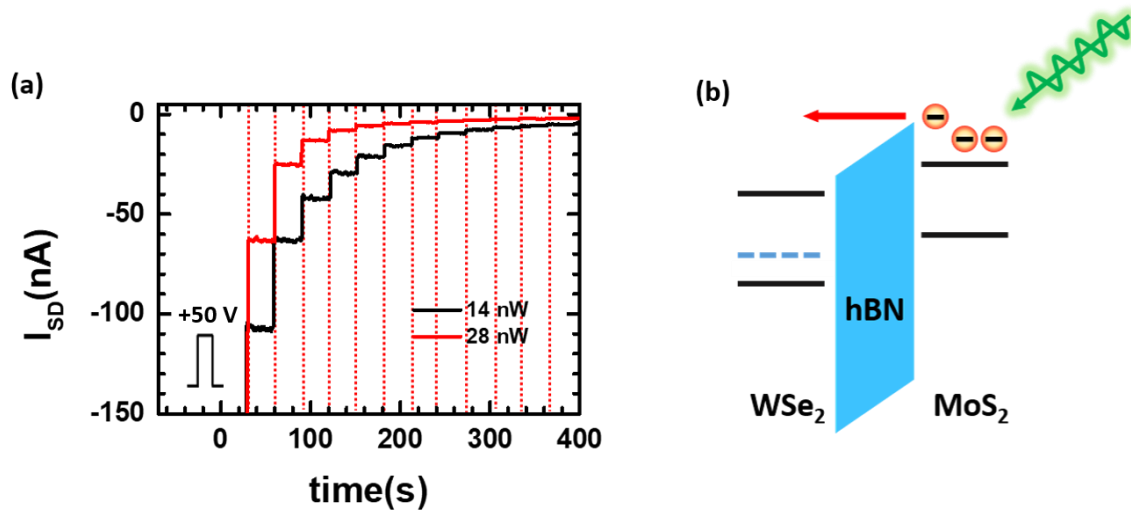


Figure S5. (a) I_{SD} measured at $V_{SD} = -1$ V when $V_{Gp} = +50$ V was applied to switch the device to the on state and then, 635-nm laser pulses with different powers were repeatedly applied. (b) Energy band diagram proposed to explain the negative stepwise photoconductance at $V_{SD} = -1$ V.

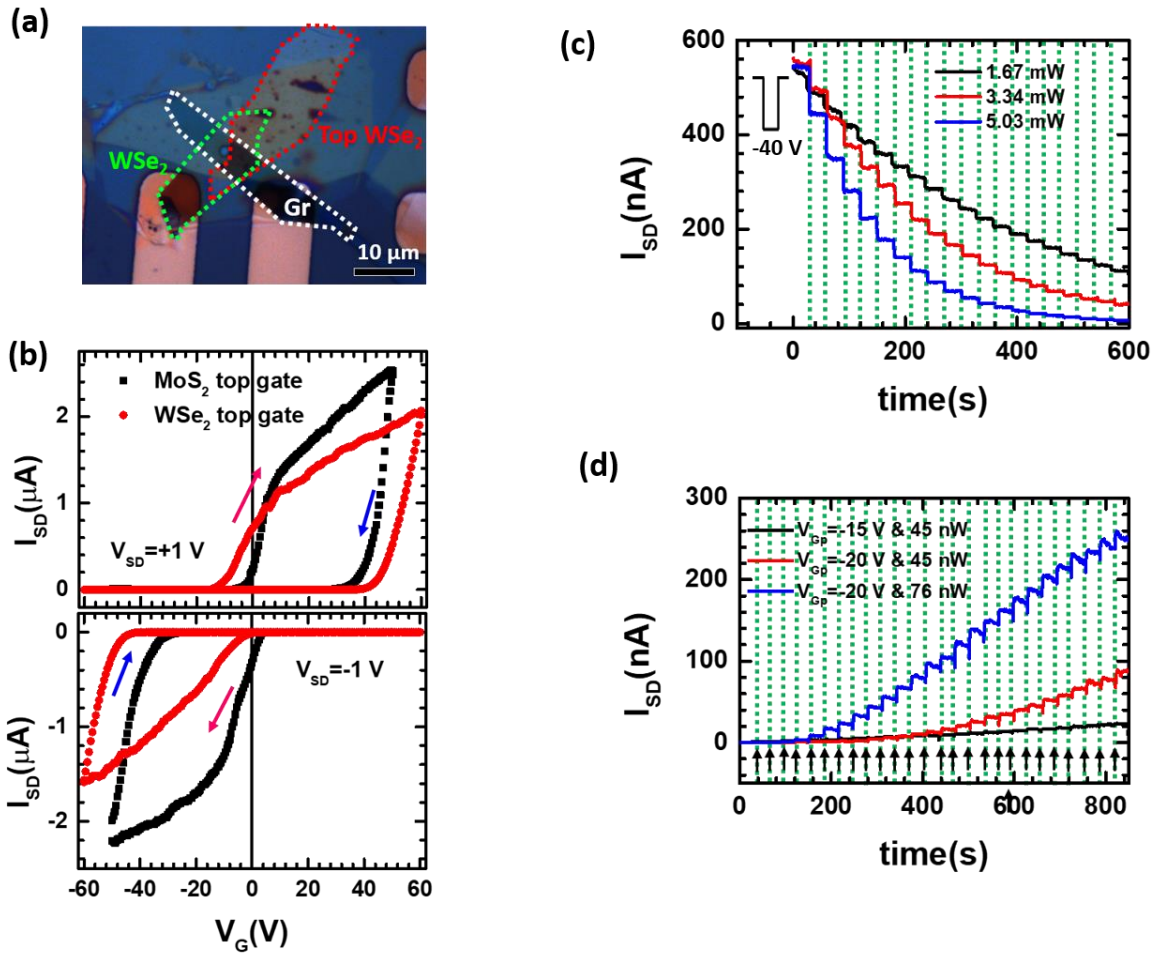


Figure S6. (a) Optical microscopy image of the WSe₂ - based device with the WSe₂ top layer. (b) I_{SD} - V_G transfer curves for the WSe₂ devices with the MoS₂ (black symbols) or WSe₂ top layer (red symbols) measured at $V_{SD} = +1$ V and $V_{SD} = -1$ V by sweeping V_G from -60 to $+60$ V and back to -60 V. (c) I_{SD} measured at $V_{SD} = +1$ V when $V_{GP} = -40$ V was applied to switch to the on state and then, 532-nm laser pulses with different powers were repeatedly applied. (d) I_{SD} measured at $V_{SD} = +1$ V when $V_{GP} = +40$ V was applied to switch the device to the off state and then, $V_{GP} = -15$ or 20 V and 532-nm laser pulses with different powers were repeatedly applied. The dotted lines indicate the time when the laser pulses were applied, while the arrows indicate the time at which V_{GP} was applied.

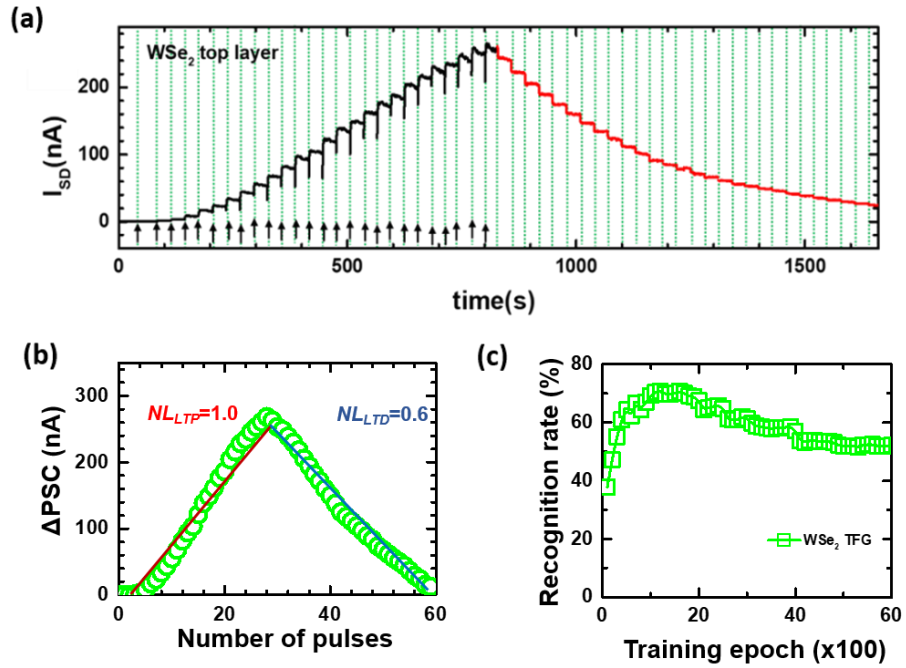


Figure S7. (a) Optoelectronic memory states of WSe₂ top layer/WSe₂/graphene memory. I_{SD} was measured at $V_{SD} = +1$ V when $V_{GP} = -20$ V and 532-nm laser pulses (0.1 s, 54 nW) repeatedly applied from off state and 532-nm laser pulses (0.1 s, 10 nW) were applied without V_G from on state. (b) PSC measured according to number of pulses applied. The nonlinearity (NL) was estimated to be 1.0 and 0.6 for potentiation and depression, respectively. (c) Recognition rate of WSe₂ top layer device according to the number of training.

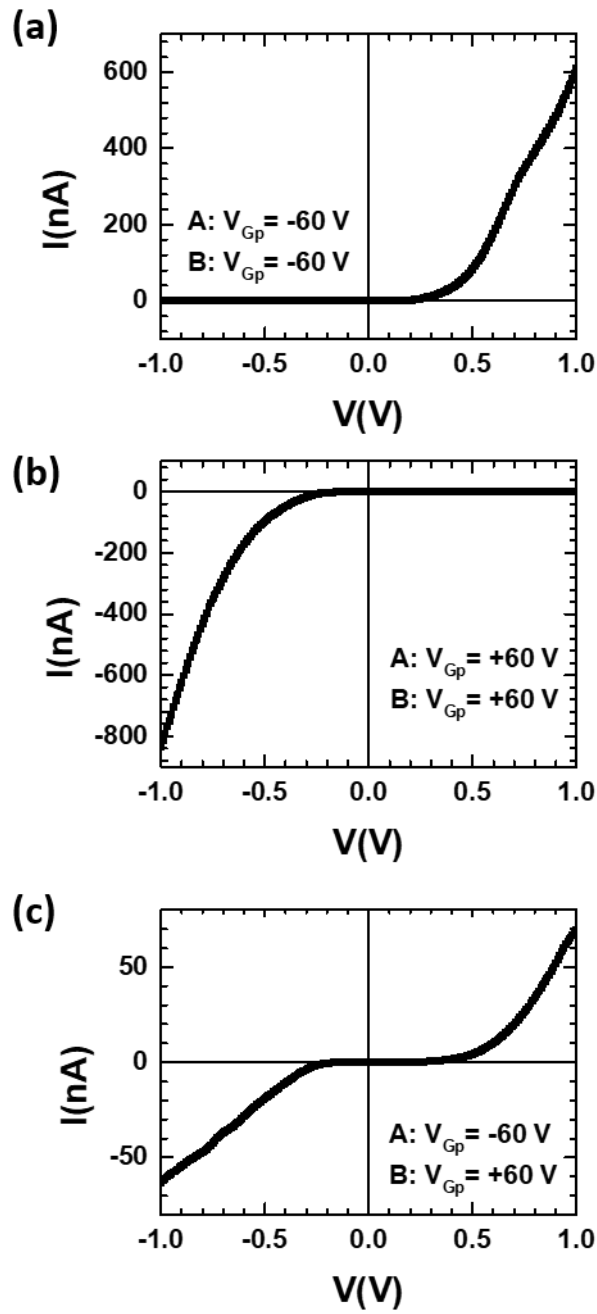


Figure S8. I - V curves measured after (a) $V_{Gp} = -60$ V or (b) $V_{Gp} = +60$ V were applied to both devices A and B. (c) I - V curves measured after $V_{Gp} = -60$ V and $V_{Gp} = +60$ V were applied to devices A and B, respectively.

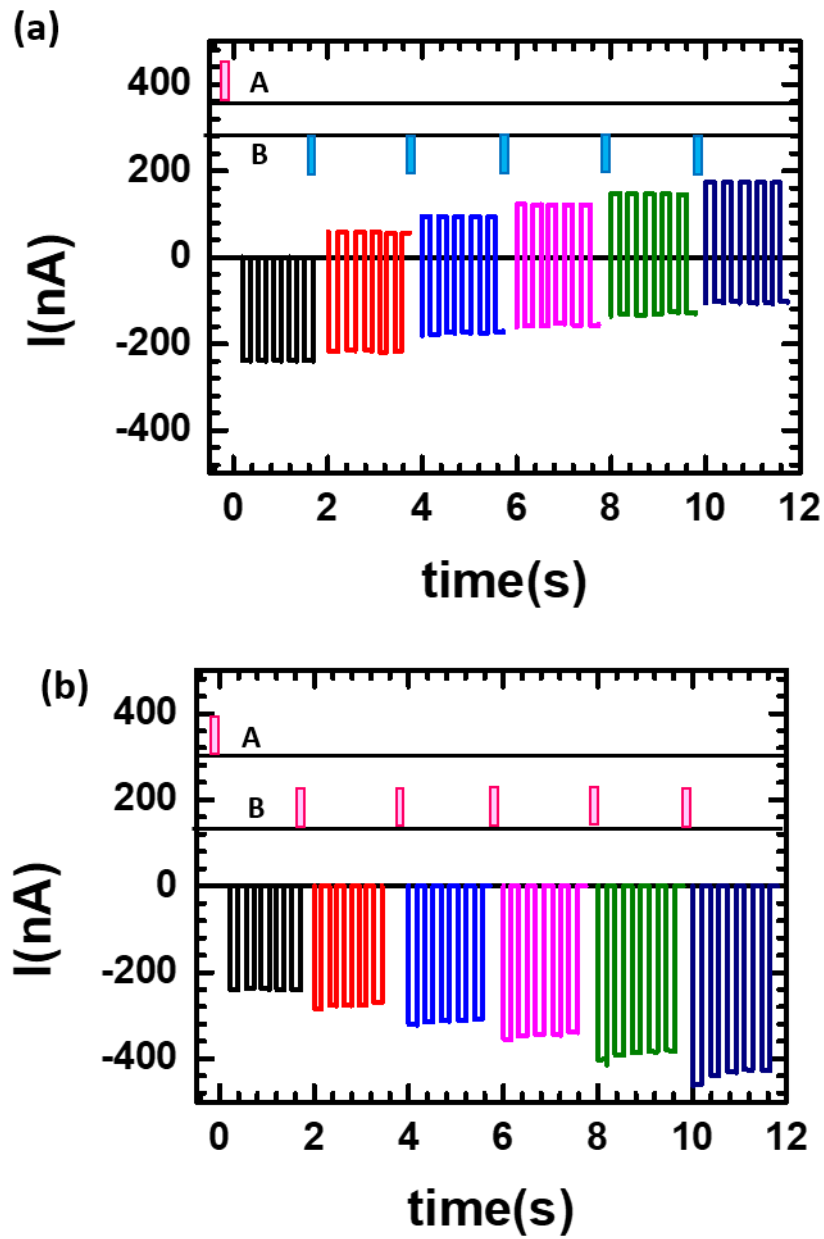


Figure S9. I measured at V of ± 1 V square waves with a frequency of 5 Hz when $V_{Gp} = +50$ V was applied to device A, followed by repeatedly applying (a) $V_{Gp} = -50$ V or (b) $V_{Gp} = +50$ V to device B.

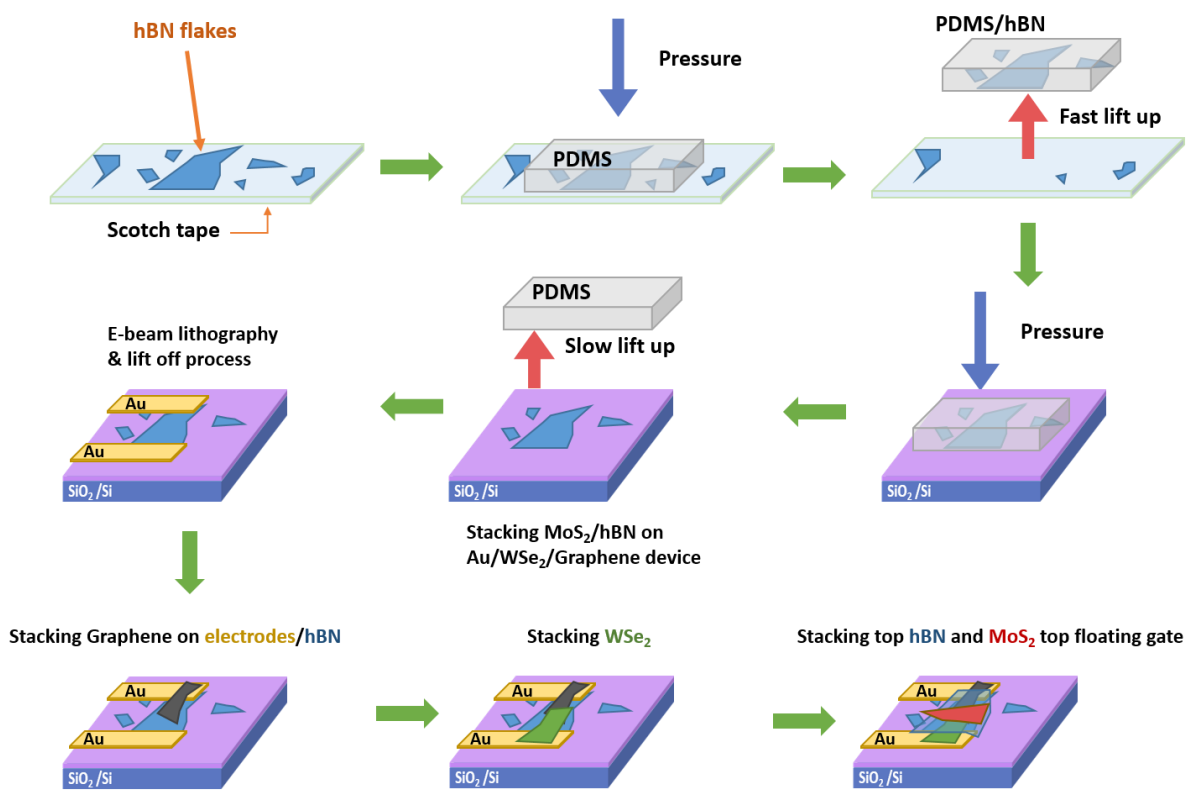


Figure S10. Schematic of the device fabrication process.