

• Supplementary File •

## Layer-by-Layer Epitaxy Growth of Thickness-Controllable Two-Dimensional Tungsten Disulfide

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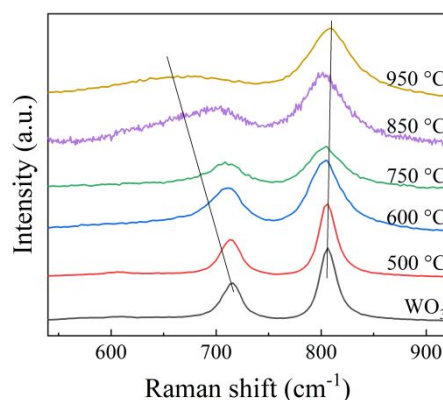
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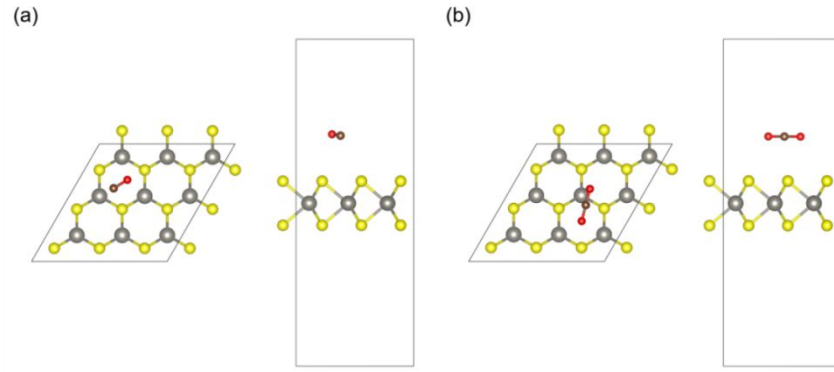
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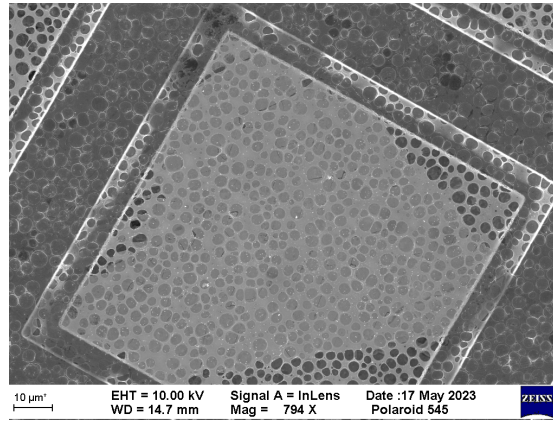
**Figure S1.** The low to high magnification of optical images of obtained bilayer WS<sub>2</sub> sheets with the assisted of carbon. (a) Low magnification of optical images of obtained bilayer WS<sub>2</sub>. (b) Higher magnification of optical images of obtained bilayer WS<sub>2</sub>. (c) High magnification of optical images of obtained bilayer WS<sub>2</sub>.



**Figure S2.** Raman spectra of WO<sub>3</sub> precursors collected at different temperature.



**Figure S3.** Top and side views of the gas molecules (a) CO , (b) CO<sub>2</sub> adsorbed on the most stable adsorption site of WS<sub>2</sub> monolayer.



**Figure S4.** Low magnification SEM image of transferred bilayer WS<sub>2</sub> flake on Copper grid.

Table S1 A summary table of the devices structures and measurement conditions

material	mobility	on/off ratio	measurement conditions	device structures	Ref.
MoS <sub>2</sub>	36	/	Room temperature vacuum	Back-gate HfLaO substrate	8
MoS <sub>2</sub>	21	$1.1 \times 10^7$	Room temperature vacuum	Back-gate SiO <sub>2</sub> substrate	15
MoS <sub>2</sub>	74.8	$10^4$	Room temperature vacuum	Back-gate SiO <sub>2</sub> substrate	18
WS <sub>2</sub>	31	$10^9$	Room temperature vacuum	Back-gate HfLaO substrate	9
WS <sub>2</sub>	2.1	/	Room temperature vacuum	Back-gate HfLaO substrate	10
WS <sub>2</sub>	2.5	$1.8 \times 10^6$	Room temperature vacuum	Back-gate SiO <sub>2</sub> substrate	20
WS <sub>2</sub>	34	$6 \times 10^8$	Room temperature vacuum	Back-gate SiO <sub>2</sub> substrate	21
WS <sub>2</sub>	58	$10^8$	Room temperature vacuum	Back-gate h-BN substrate	(this work)
WS <sub>2</sub>	40.5	$10^8$	Room temperature vacuum	Back-gate SiO <sub>2</sub> substrate	(this work, Fig. R1)