# Supplementary material

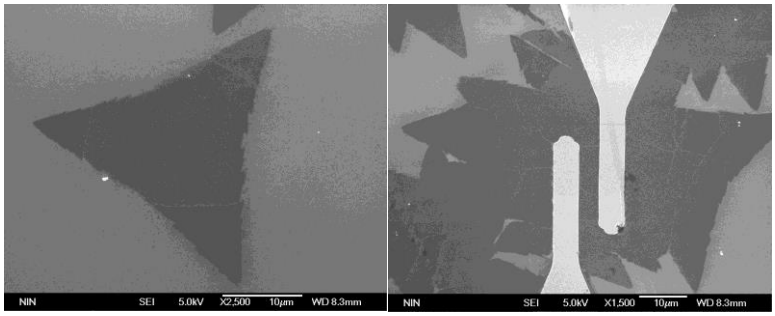


**Figure S1.** The SEM images of monolayer $MoS_2$ and transistor.

Table S1. Comparison of the performance of device with literature.

| Ref. | Materials | Ion/Ioff Ratio | On-state Current(A) | Dielectric | Structure | Process complexity |
|---|---|---|---|---|---|---|
| Our result | $MoS_2$ | ~$1\times10^4$ | $2\times10^{-7}$ | 300nm $SiO_2$ | Horizontal-gate | I |
| [1] | $MoS_2$ | ~$1\times10^4$ | $3\times10^{-6}$ | 90nm $SiO_2$ | Back-gate | II |
| [2] | $MoS_2$ | ~$1\times10^4$ | $3\times10^{-7}$ | $SiO_2$ | Back-gate | II |
| [3] | $MoS_2$ | ~$10^6$ | $1\times10^{-6}$ | $Al_2O_3/HfO_2$ | Dual-gate | IV |
| [4] | $MoS_2$/BP | ~$10^4$ | $1\times10^{-7}$ | Ion gel(top) | Top-gate | III |
| [5] | $WSe_2/SnSe_2$ | ~$10^5$ | $9\times10^{-7}$ | 40nm $Al_2O_3$ (bottom) | Back-gate | II |

Process complexity progressively increases from I to IV.

Table S2. Typical values of parameters in equations.

| parameters | | Value |
|---|---|---|
| L(μm) | Length of channel | 8 |
| W(μm) | Width of channel | 40 |
| $t_{ox}$(nm) | Thickness of oxide | 300 |
| $g_m$(S) | Trans-conductance | $di_{ds}/dv_{gs}$ |
| $C_{ox}$(F/μm$^2$) | Gate capacitance per unit area | $1.15\times10^{-4}$ |
| $\mu_0$(cm$^2$/V・s) | Mobility | 2.06 |
| $V_{th}$(V) | Threshold voltage | -16 |
| $R_{total}$(Ω) | Total resistance | $v_{ds}/i_{ds}$ |
| $A^*$ (A/(cm$^2$・K$^2$)) | Richardson's coefficient | 120 |
| k(J/K) | Boltzmann constant | $1.380649\times10^{-23}$ |
| T(K) | Temperature | 300 |

## References


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