Electronic Supplementary Information

Thickness-Dependent Schottky Barrier of MoS_2 Field-Effect Transistors

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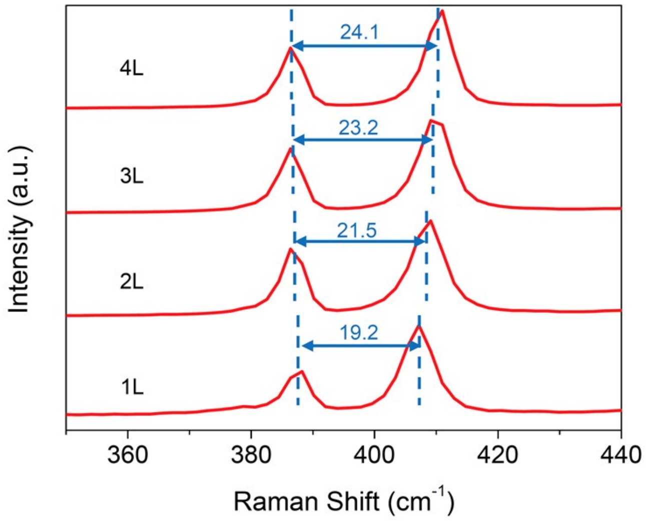

Fig. S1. Layer dependent Raman spectrum of MoS_2 for verification of each layer thickness. There are two representative peaks for MoS_2. Thickness of MoS_2 can be confirmed by space between two peaks. When MoS_2 is monolayer, it shows space about 19cm^{-1} and be widened gradually as thickness increases. Space between two representative peaks of 1L, 2L, 3L, and 4L are 19.2, 21.5, 23.2, 24.1 cm^{-1}, respectively. They are corresponding to previously reported literature values.

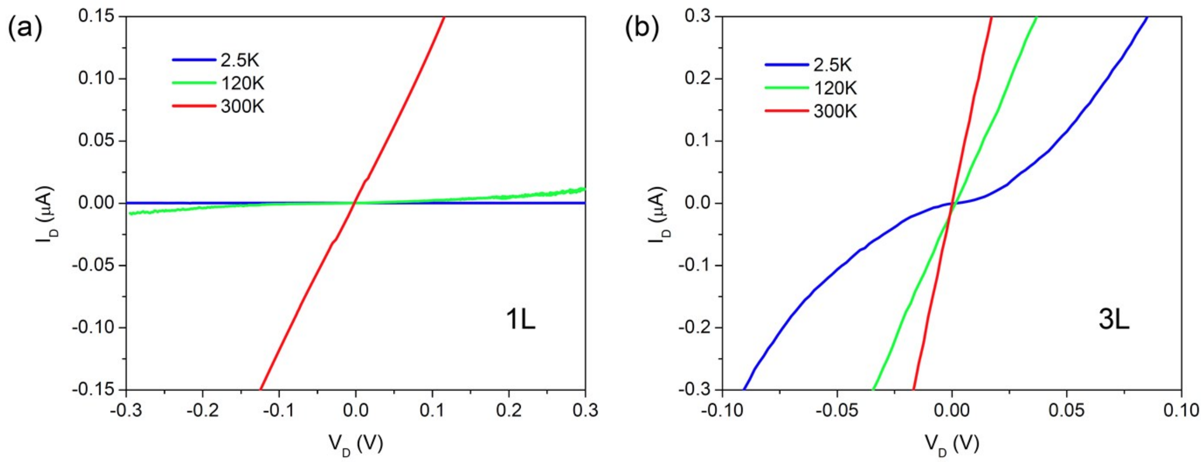

Fig. S2. Output characteristics of (a) 1L and (b) 3L MoS_2 FETs at different temperature. As temperature decreases, output curves of both 1L and 3L devices become non-linear, indicating that there is a Schottky barrier for both devices, which cannot be neglected. In most of previous reports, it was said that metal can form Ohmic contacts to MoS_2 regardless of their work functions. However, it just seems like that because thermal energy allows carriers to overcome the contact barrier at high temperature. From low temperature measurement, we realized that more systematic studies are needed, especially for thinner MoS_2 like 1-3L.

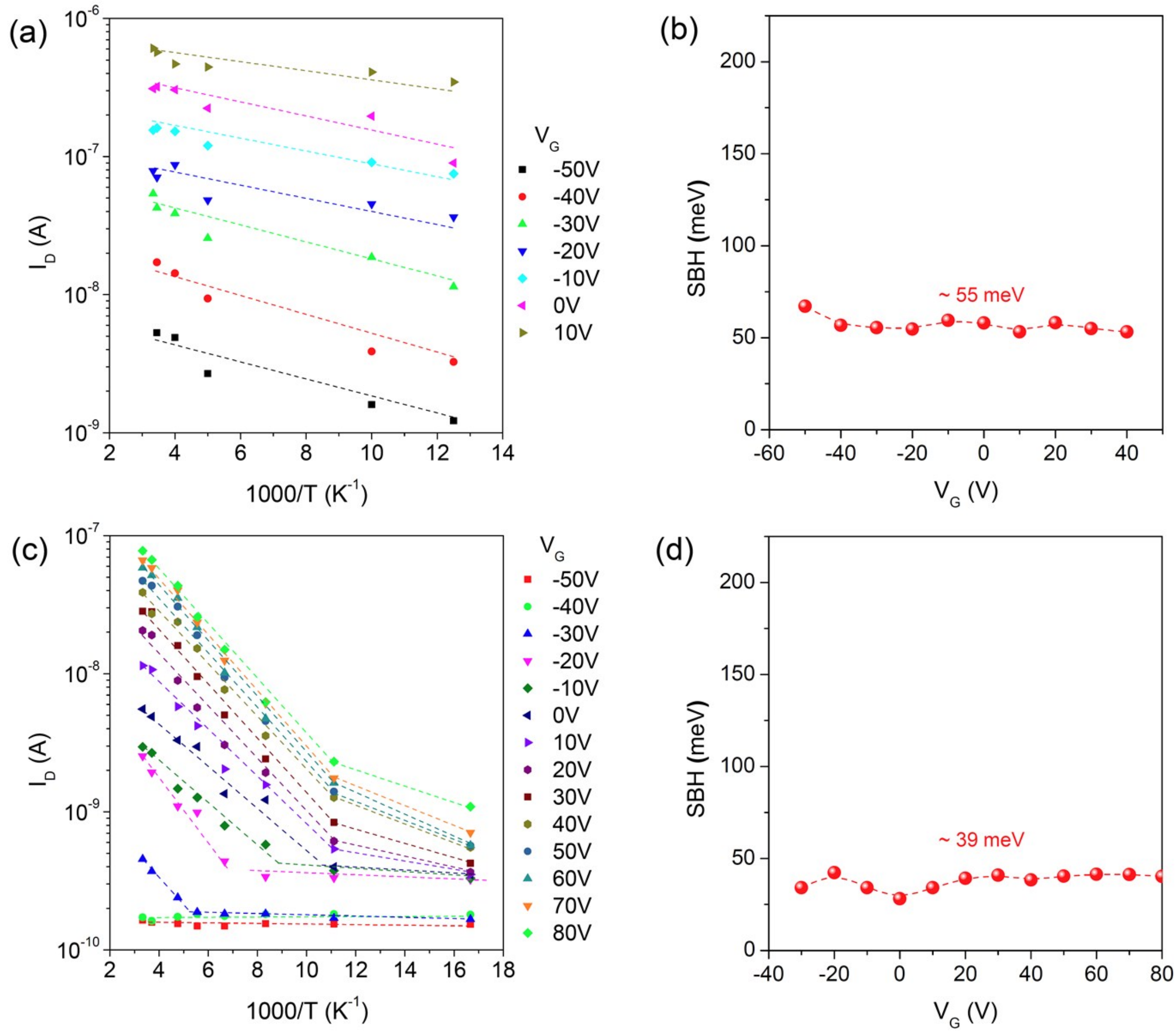

Fig. S3. (a) Temperature dependence of drain current (I_D) of 1L MoS_2 FET with Al contacts. Due to the higher Schottky barrier of monolayer device, thermionic emission region was not observed even at high temperature. Measurements at higher temperature destroy monolayer device. (b) SBH of 1L MoS_2 FET at different gate voltage. SBH for a flat band condition could not be extracted due to difficulty in high temperature measurement. (c) Temperature dependence of drain current (I_D) of 2L MoS_2 FET with Al contacts. (b) SBH of 2L MoS_2 FET at different gate voltage. It should be noted that lowest limit of SBH increases with decreasing thickness of MoS_2 at high gate voltage.

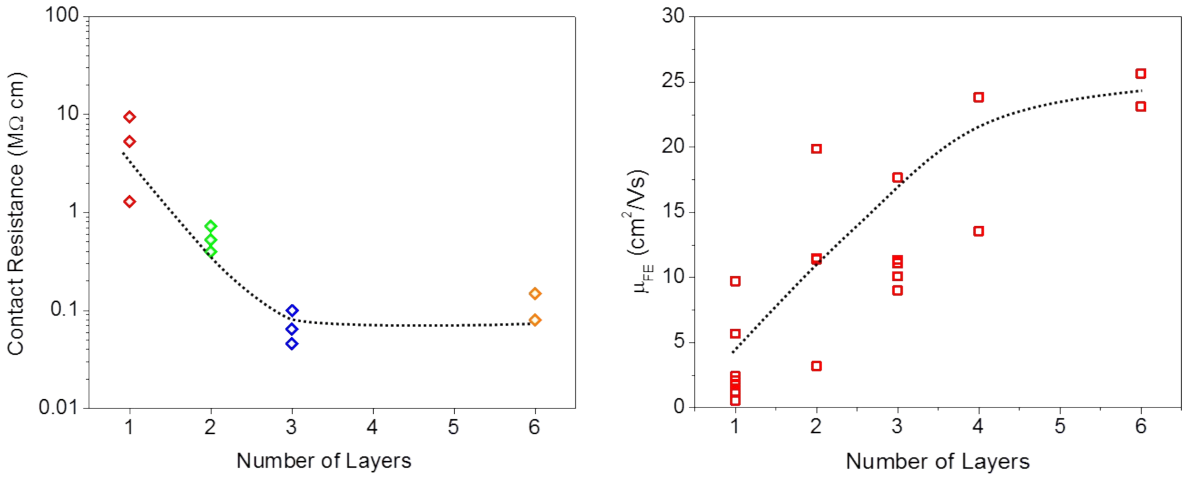

Fig. S4. (a) Contact resistance and field-effect mobility of MoS_2 with 1L to 6L.