Electronic Supplementary Material (ESI) for Nanoscale.

Supporting Information

1. The transfer curve and output curve of a Ti/Au supported device

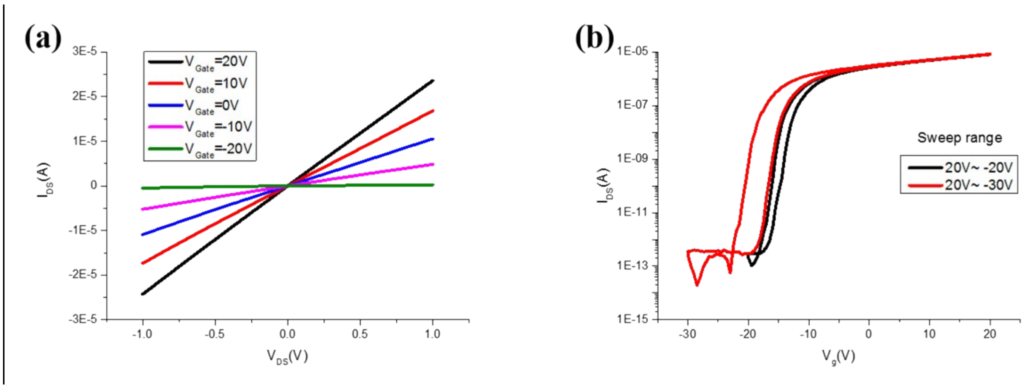

Fig. S1 (a) the output curves of a supported device with Ti/Au contact. (b) The transfer curves of the device measured with different gate sweep range, showing similar hysteresis as the device with Cr/Au contact.

2. The SiO_2 in the suspended devices

To test whether the SiO_2 has all been removed in the suspended devices, we perform the following measurements on a suspended FET. We sweep the gate bias from a positive voltage +30V to the left to about -45V, and measure the source-drain current I_{ds} and gate leakage current I_{gate}. The results are shown in Figure S2. It can be seen that when the gate bias is larger than about -40V, the I_{ds} changes as in a normal FET and the gate leakage current I_{gate} is very small at the noise level. (The large noise of the gate leakage current comes from the large noise of the substrate of the probe-station.) When the gate bias reaches about -40V, the gate leakage current suddenly rises more than 5 order of magnitudes to the current limiting value we set to protect the circuit, and at the same time, I_{ds} also rises to the current limiting value we set. The suddenly increased I_{gate} indicates the suspended MoS_2 channel touches the gate electrode, which is the Si substrate in the FET, therefore confirms the SiO_2 covering the Si substrate has been removed completely beneath the suspended MoS_2 channel.

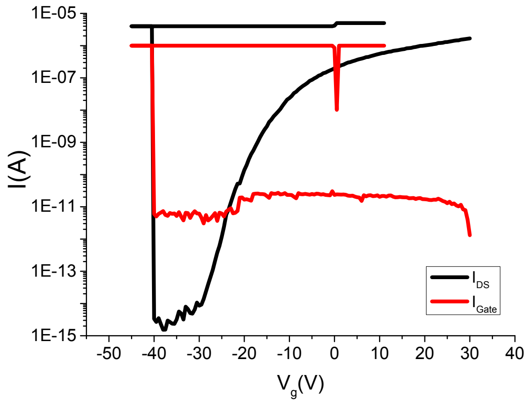

Fig S2. The leak current for suspended device.

3. The optical image and the thickness of the single layer devices.

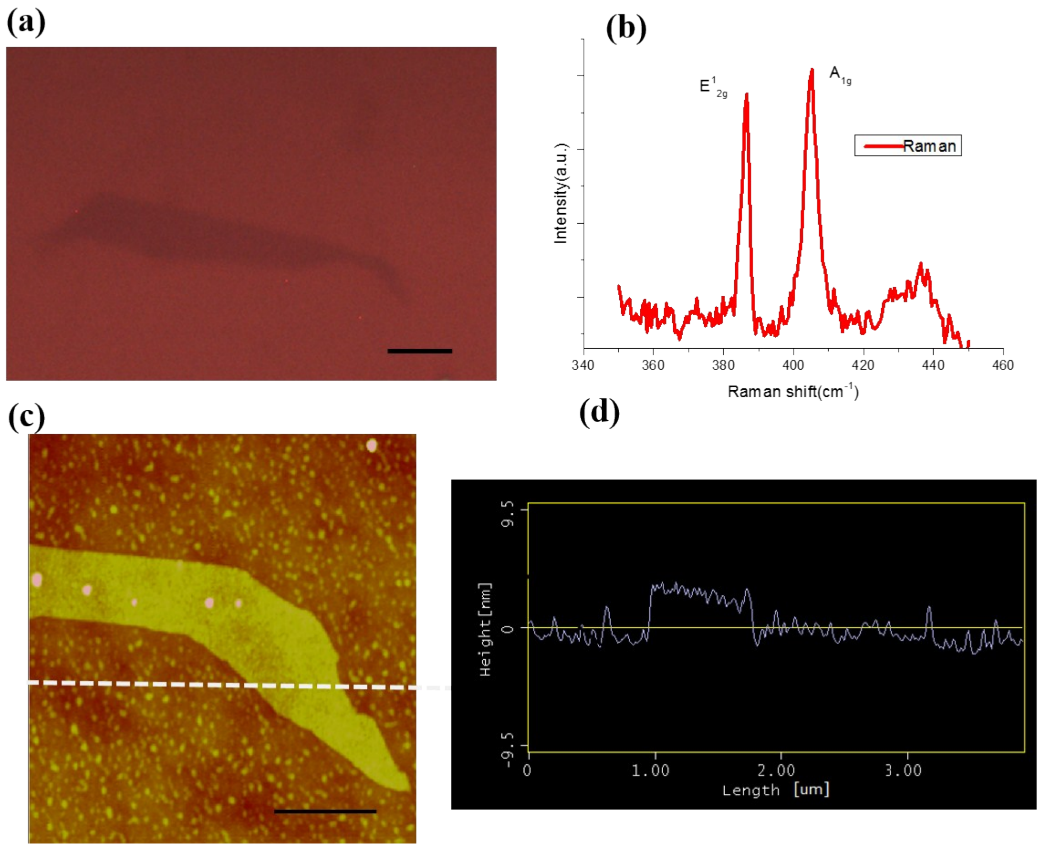

Fig S3. (a) The optical image of a single layer MoS_2 sheet in the device shown in Figure 5 and Figure 6. The scale bar is 3μm. (b) The Raman spectrum of the MoS_2 sheet. (c) The AFM image of the part of the sheet. The scale bar is 1μm. (d) The line-scale along the dotted line in (c) showing the height of the MoS_2 is 1.5nm. Note, as the AFM image was obtained after our experimental measurement, there are some contamination dots on the substrate.

4. The thickness of MoS_2 sheets in Figure 7

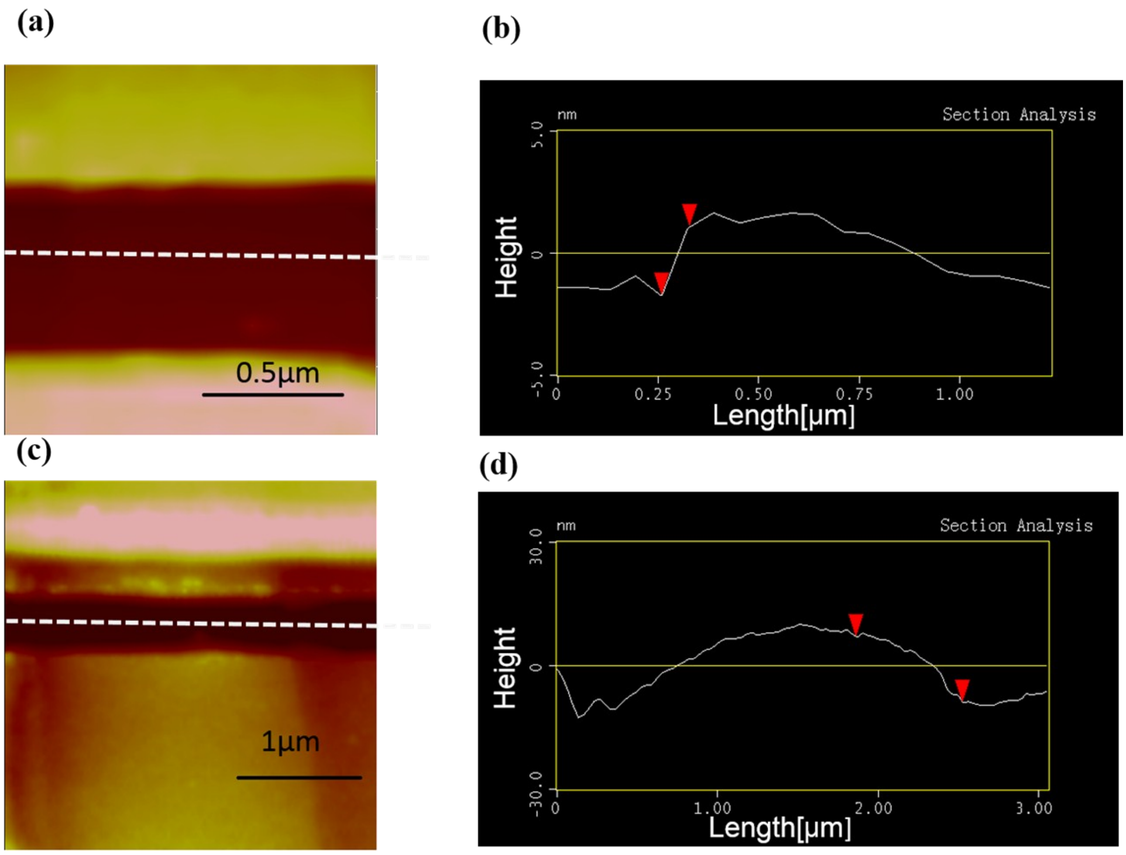

Fig S4 (a) and (b) the AFM image and line-scale of the thin sheet MoS_2 in Figure 7. The thickness is around 3 nm. (c) and (d) the AFM image and line-scale of the thick sheet MoS_2 in Figure 7.The thickness is around 15 nm.

5. The temperature of the devices during current annealing

Simulation:

The length of the channel is 1µm, the thickness for supported device is 5 nm, the thickness of the suspended devices is 0.7 nm. We choose the current as 100 µA for the supported Ti/Au contacted device and 10 µA for the Cr/Au contacted suspended device. Other parameters we used are from Ref 1 and 2. Comsol is used to simulate the thick layer device. Matlab is used to simulate the single layer suspended device, because program error occurs in the mesh process using Comsol when the layer is thin.

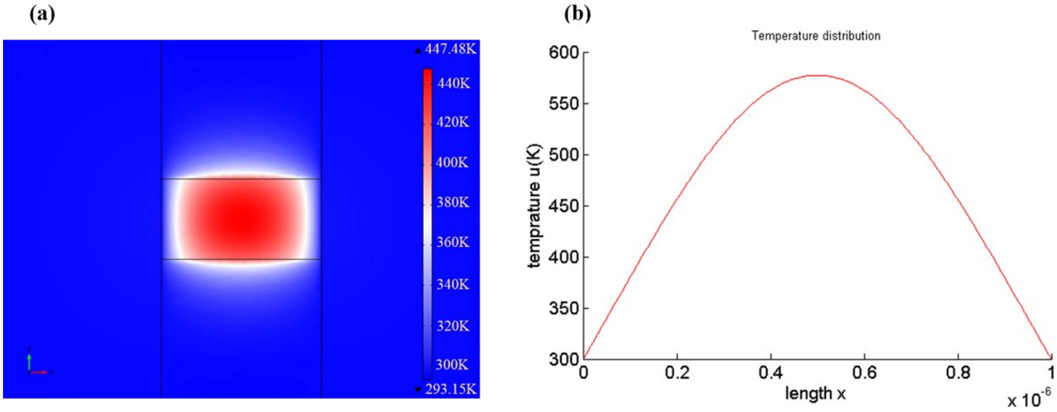

Figure S5 (a) The temperature distribution of the supported Ti/Au contacted device simulated with Comsol. (b) The temperature distribution of a suspended device simulated with Matlab.

Reference

1 Andrzej, T.; Jarosław, J.; Anna, Ł.; Mariusz, Z. Temperature-Dependent Thermal Properties of Supported MoS_2 Monolayers. *ACS Appl. Mater. Interfaces* 2015, 7, 5061−5065

2 Volovik, L. S., Fesenko, V. V., Bolgar, A. S., Drozdova, S. V., Klochkov, L. A., & Primachenko, V. F. (1978). Enthalpy and heat capacity of molybdenum disulfide. *Soviet Powder Metallurgy and Metal Ceramics*, *17*(9), 697-702.