Electronic Supplementary Information

Gas adsorbates are Coulomb scatterers, rather than neutral ones, in monolayer MoS_2 field effect transistor

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S1. XPS data for CVD-grown monolayer MoS_2 on a SiO_2 substrate

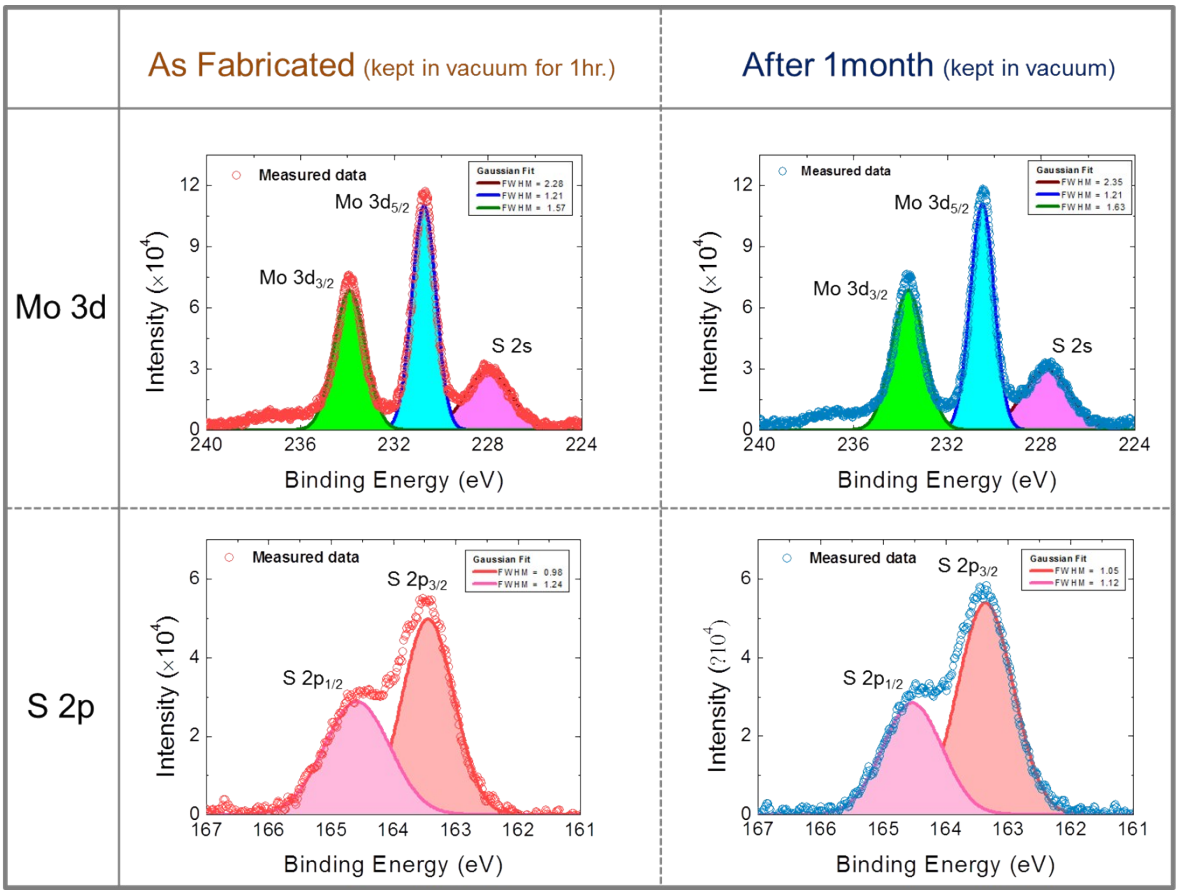

Figure S 1. Comparison of XPS data in monolayer MoS_2 as fabricated and after 1 month, both in vacuum

To check if the oxidation of Mo or sulfur loss plays as major causes to change the electrical properties or not in CVD-grown monolayer MoS_2 FET on a Si/SiO_2 substrate, we compared XPS data as fabricated and after 1month in vacuum for MoS_2 on a Si/SiO_2 substrate. The sample was kept in a high vacuum chamber of XPS measurement system (PREVAC, XPS(ESCA)/UPS, 5×10^{-10} mbar) for 1 month. First, after 1 hour loading the sample in vacuum, the measurement for "As Fabricated" in Figure S1 was implemented. The measurement of "After 1 month" was to compare the change of molecules in MoS_2. Not only the shapes of data for Mo 3d and S 2p regions, but also the analysis of the full-width-half-maximum (FWHM) values for peaks describe the ratio of Mo:S is almost not changed after keeping the sample in vacuum for one month as shown in Figure S1.

S2. The effect of light and gate sweep range in a transfer curve

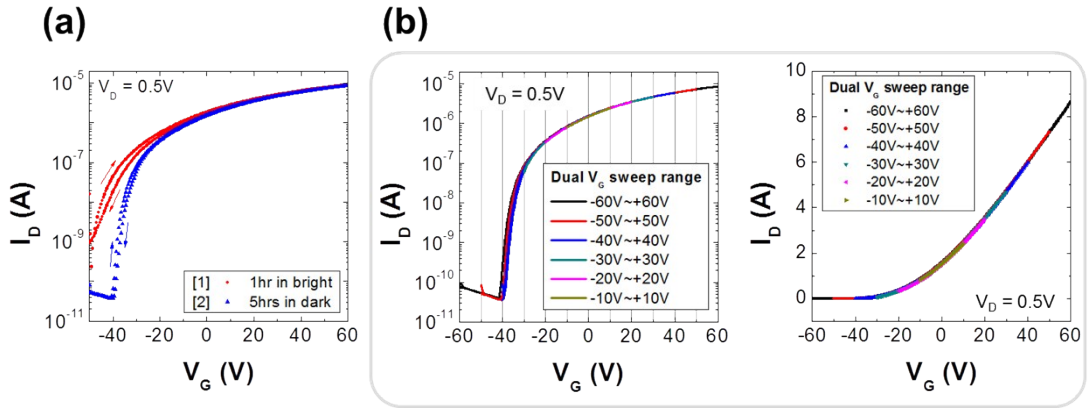

Figure S 2. Comparison of dual-gate swept transfer curves for a MoS_2 device (a)in bright and in dark, and (b) with the different gate sweep ranges (left: log-scaled, right: linear-scaled)

As mentioned in the manuscript, we did not consider the effect of light and gate sweep range or sweep direction as the causes to occur the electrical instability in the experiment. By showing the negligible electrical hysteresis in vacuum and consistent current values under various V_G ranges, we confirmed this assumption is reasonable. In Figure S2(a), we compared the transfer curves for the device, which was kept in vacuum more than 1 year, in bright environment (normal laboratory environment of fluorescent light) and in dark. After exposing the sample to the light for one hour, I_D-V_G was measured with V_D = 0.5V. And then, the window view port of a vacuum probe station was covered to block the light completely. After keeping the device in dark for 5 hours, I_D-V_G curve under the same V_D was obtained. In dark and in vacuum, the negligible electrical hysteresis was shown and the addition of the parameter, that is the dual V_G sweep under the different ranges, surely dispelled the V_{TH} shift problem depending on a V_G sweep range as shown in Figure S2(b). The maximum V_G value for a dual sweep varies from 60 V to 10 V with the increment of 10V, where the V_G was swept from the negative maximum value to the positive maximum and then again to the negative. From both of log-scaled and linear-scale plots of comparison, we concluded the electrical hysteresis, by the light and the range of V_G sweep, are not need to be considered in this study.