Supporting information on

Interplay between many body effects and Coulomb screening in optical bandgap of atomically thin MoS_2

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The PL intensity in the bi-layer of MoS_2 is larger than that in the mono-layer at 4.2 K, and this feature is what is measured in our MoS_2 sample. However, at 300 K (room temperature) the PL intensity in the monolayer of MoS_2 becomes larger, as expected. We confirmed this behavior for different 1L and 2L MoS_2 flakes (Fig. S1). Presently, we do not fully understand why the A exciton of 2L-MoS_2 becomes stronger than that of 1L-MoS_2 at low temperatures. We have not found relevant literature which deals with this phenomenon. It is known that the PL curve and intensity of atomically thin MoS_2 are affected by defects, substrate as well as layer number. Thus, we presume that complex temperature-dependent interplay between these factors is linked to this observation. But, we cannot exclude the possibility of inherent material properties of atomically thin MoS_2. Currently we are working on this issue and will be reported elsewhere.

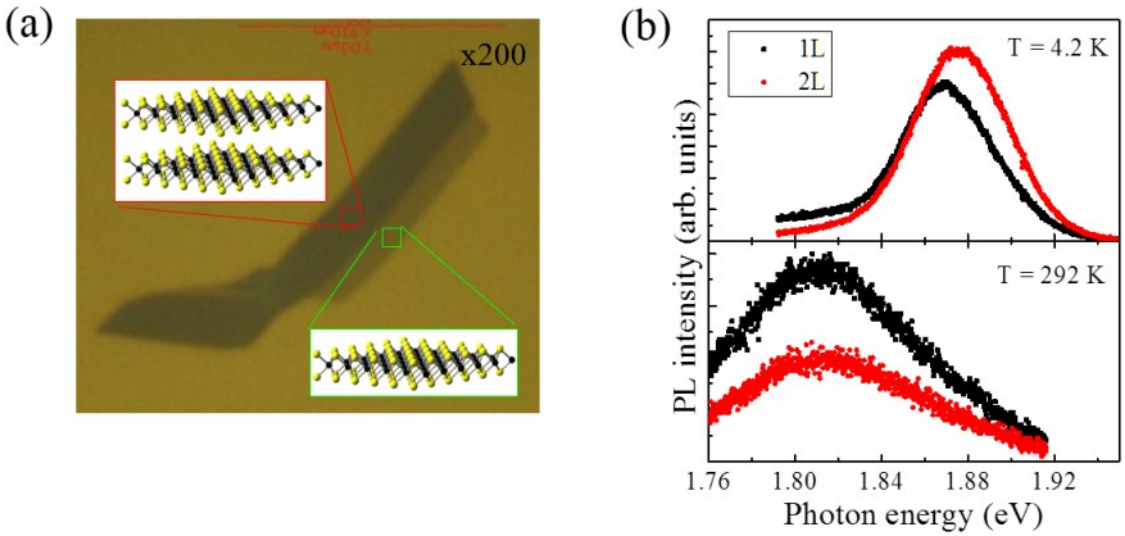

Fig. S1. (a) Optical microscopy image of 1L and 2L MoS_2 on a SiO_2/Si substrate and (b) temperature dependent PL spectra of 1L and 2L MoS_2.

Indeed, in order to assure the minor effect of localized heating (due to the excitation laser) on the PL peak shift in 1L MoS_2, we measured temperature-dependent PL peak at a low excitation power (Fig. S2). As the temperature increases the PL peak remains unchanged

below ~ 100 K. The most noticeable feature in the temperature-dependent PL characteristics is its dramatic decrease in peak's height. On the contrary, the observed PL peak's height increases linearly with the excitation power. Thus, considering the excitation power dependent PL peak's height and unchanged PL peak's position below 100 K, it is quite reasonable to presume that the influence of localized heating due to the excitation laser is insignificant.

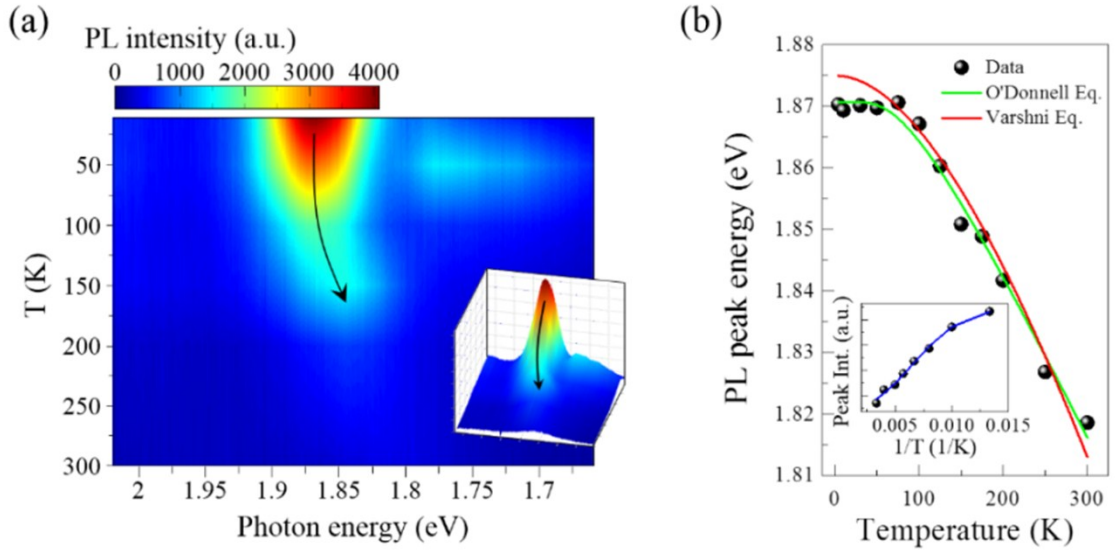

Fig. S2. (a) Intensity map of the temperature dependent PL spectrum of 1L MoS_2 and (b) temperature dependent PL peak energy together with fitting curves.