Raman spectroscopy study of atomically thin molybdenum ditelluride

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We exfoliate atomically thin crystals of $MoTe_2$ and investigate their phonon properties by Raman spectroscopy. $MoTe_2$ were synthesized through chemical vapor transport. Atomically thin $MoTe_2$ films were exfoliated mechanically from the bulk crystals onto SiO_2 (Fig. 1A). The Raman spectroscopy was performed at room temperature with an excitation of 532 nm. The Raman spectra of atomically thin $MoTe_2$ show prominent peaks of the in-plane E^1_{2g} mode at ~ 234 cm^{-1} and the out-of-plane A_{1g} mode at 171 cm^{-1} (Fig.1B). Similar to the other dichalcogenides, the E^1_{2g} mode upshifts while the A_{1g} mode downshifts with decreasing thickness. Additionally, we observe a strong peak in atomically thin $MoTe_2$, which is unobservable for bulk. The peak intensity becomes significant with decreasing thickness, but the peak vanishes in a single-layer crystal (Fig. 1B). Our density functional theory calculations reveal that the peak can be assigned as a Raman inactive mode of the out-of-plane B^1_{2g} mode. The activation of the B^1_{2g} mode in the atomic layers is likely due to translation symmetry breaking along the c-axis direction.

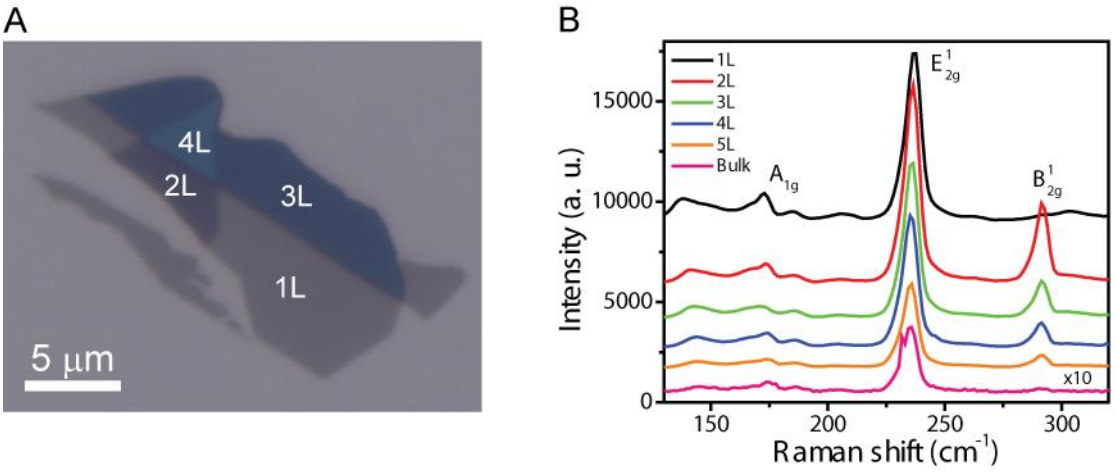

Figure 1: (A) A typical optical image of atomically thin $MoTe_2$ on SiO_2. (B) Raman spectra of atomically thin $MoTe_2$.