Resonance effect on low frequency Raman spectrum of few-layer WS_2

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We investigated the Raman spectrum of few-layer WS_2 using seven different excitation energies in the range of 1.96 eV to 3.82 eV. Because of complicated excitonic band structures, transition metal dichalcogenides show anomalous resonance Raman behaviors. [1][2] Some peaks, including some second-order peaks, are enhanced when the excitation energy matches with exciton states. We found that the A_{1g} and 2LA modes of WS_2 are enhanced near resonance with the A, B and C exciton states whereas the E_{2g}^1 mode is enhanced only near the C exciton state.

Especially, in the low frequency region (<50 cm^{-1}), several new peaks appeared in addition to the breathing and shear modes. We observed a broad central peak and new peaks at 28 cm^{-1} and 46 cm^{-1} when the excitation energy matches the A and B exciton states. Also, a shear mode peak shows the Breit-Wagner-Fano (BWF) line shape at resonance with the A exciton.

References

[1] Kim, K et al., ACS Nano, 10 (2016) 8113-8120
[2] Lee, J.-U. et al., Nanoscale, 7 (2015), 3229-3236

Figures

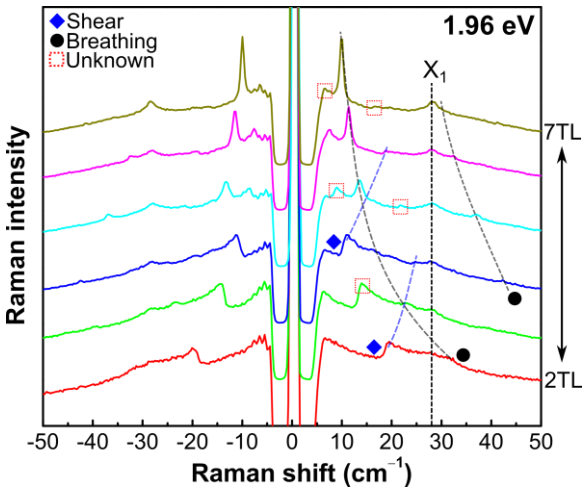

Figure 1: Raman spectra of 1.96 eV incident laser.

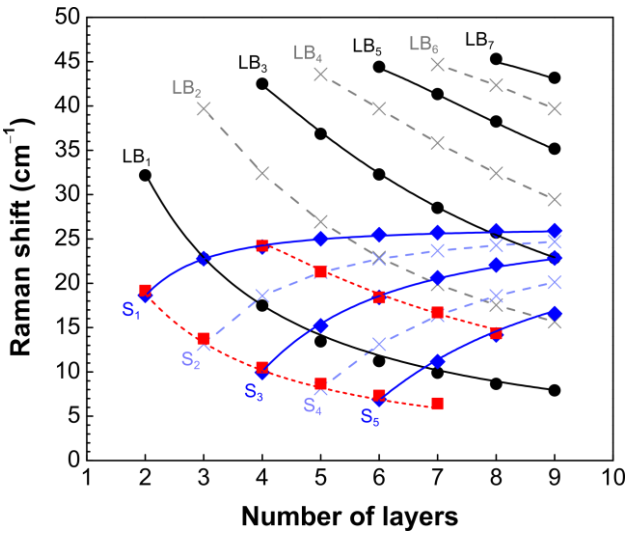

Figure 2: Peak position in low frequency region of few-layer WS_2.