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Interlayer interaction in a van der Waals heterostructure of transition metal dichalcogenide and hexagonal boron nitride

Two dimensional (2D) van der Waals (vdW) heterostructures have attracted explosive interest because of their potential ability to exhibit novel quantum phenomena based on condensed matter physics.[1] The 2D vdW heterostructures are formed by stacking different types of 2D materials, including graphene, transition metal dichalcogenide (TMD) and hexagonal boron nitride (h-BN).[2,3] Each layers are dangling-bond-free and weakly bound to neighboring layers by vdW interactions. The 2D vdW heterostructures have exhibited novel quantum phenomena emerging from layer-layer interaction, such as electron-electron interaction and electron-phonon interaction. As a template for an application to electronic device, the layer-layer interaction between TMD and h-BN layer needs to be significantly investigated, because the TMD and h-BN exhibit a semiconducting and insulating characteristic, respectively. In this study, we investigate the interlayer interaction between TMD and h-BN by observing spectroscopic characteristics from the 2D vdW heterostructures. We fabricated the heterostructures by transferring a top-layer flake onto bottom-layer flake using a pick-up transfer technique based on polydimethylsiloxane (PDMS)/ polypropylene carbonate (PPC) stamp. The investigation of Raman scattering and photoluminescence (PL) reveals the nature of phonon vibration and excitonic transition of the heterostructures. We expect that the fundamental understanding of the layer-layer interaction in the 2D vdW heterostructures play a key role for future applications to electronic devices based on 2D materials.

References

[1] Geim, A., et al., Nature, 499 (2013) 419
[2] Novoselov, K. S., et al., Science, 353 (2016) aac9439
[3] Pizzocchero, F., et al., Nature Communications, 7 (2016) 11894

Figures

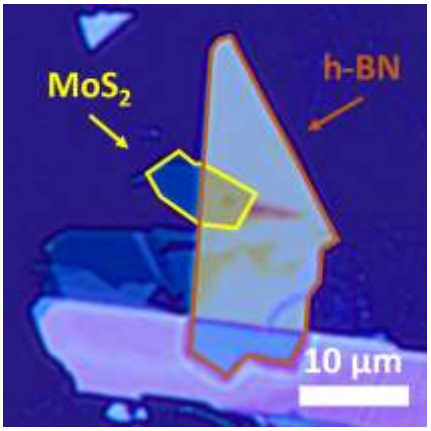

Figure 1: Optical image of heterostructure composed of molybdenum disulfide and hexagonal boron nitride.