Engineering optoelectronic properties of $MoSe_2$/graphene van der Waals heterostructure

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Vertical heterostructures composed of 2D transition metal dichalcogenides (TMDs) and graphene have demonstrated promising physical properties for the spintronics and optoelectronics. Unlike 3D heterostructures prepared via heteroepitaxial crystal growth, TMDs/graphene van der Waals (vdW) heterostructures possess advantages of interface engineering. Herein, we compare a few different vdW heterostructures composed of TMDs and graphene and show that their optoelectronic properties are controllable with their stacking sequences. Vertical heterostructures of chemical vapor deposition (CVD) $MoSe_2$ and graphene are prepared using a conventional wet-transfer technique. We compare $MoSe_2$/graphene/graphene/SiO_2 (MGGS) and graphene/$MoSe_2$/graphene/SiO_2 (GMGS) structure using photoluminescence (PL) spectroscopy. We confirm that the PL quenching is significant for GMGS compared to MGGS, indicating the quenching is dependent on the heterostructure geometry. This result paves the way for the rational design of vdW heterostructures for various optoelectronic applications.