Interlayer coupling in twisted MoS2/WS2 Van der Waals heterostructures

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Van der Waals (VdW) heterostructures have attracted considerable attention recently for exploring fundamental physics and demonstrating next generation optoelectronic devices. Amongst various van der Waals structures those based on transition metal dichalcogenides (TMDs) are especially interesting due to the tunability of the bandgap from infrared to visible range and enhanced light matter interaction. In addition, many of these types of heterostructures have type II alignment. As a result, photoexcited electrons and holes naturally separate into the adjacent layers through charge transfer process. The understanding of this charge-transfer process and optical properties of VdW heterostructures with different twisted angles between layers is an important issue for the design of new optoelectronics devices. Here, we report on the fabrication and optical characterization of Van der Waals heterostructures having different twist angles. The heterostructures were grown by vapor phase deposition using two-step process: flakes of MoS2 were first grown by conventional chemical vapor deposition (CVD) on SiO2/Si substrates followed by a second growth of large-scale WS2 monolayer using Van der Waals epitaxy (VdWE) technique. Micro-Raman and micro-photoluminescence measurements were performed in the regions of twisted MoS2/WS2 heterostructures and WS2 monolayers. The interlayer coupling in MoS2/WS2 heterostructures was probed by low frequency Raman measurements. Two Raman peaks in the range of 20-40cm-1 are observed for bilayers corresponding to the in-plane shear mode (SM) and the out plane layer breathing mode (LBM) which depends on the twist angle between the layers. Our results demonstrate an important dependence of low frequency Raman peaks and emission peaks with the twisted angle between MoS2 and WS2 layers due to different interlayer couplings.