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hBN-encapsulated Group-VI TMDC van der Waals Heterostructures : Fabrication and Optical properties

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1. Introduction

Two-dimensional (2D) semiconductors, including MoS_2, WS_2, $MoSe_2$, etc., have provided a fascinating opportunity to explore optical properties in 2 dimensions. In particular, van der Waals (vdW) heterostructures composed of these 2D semiconductors, such as WS_2/MoS_2, offer a novel platform for optical physics, where strong inter-layer interaction drastically alters optical transitions. To explore the intrinsic properties of TMDC vdW heterostructures, high-quality samples are indispensable. Here, we report preparation and optical properties of high-quality vdW heterostructure (WS_2/MoS_2) which are fully encapsulated by hexagonal boron nitride (hBN) (Fig. 1).

2.Results and discussion

We synthesized monolayer MoS_2 and WS_2 by chemical vapor deposition method and prepared thin hBN flakes by mechanical exfoliation method. hBN-encapusulated heterostuructures (hBN/WS_2/MoS_2/hBN) were prepared with the polymer-assisted dry-transfer method. Figure 2 shows PL spectrum of a (hBN/WS_2/MoS_2/hBN) sample measured at room temperature under ambient condition. As clearly seen, PL peaks arising from A-exciton of WS_2 and MoS_2 appear at 1.98 and 1.87 eV, respectively. In addition to the A-exciton peaks, new emissions can be seen at 1.4-1.7 eV. This new feature, which is decomposed to three peaks, is observed in heterostructure samples, being assigned to interlayer excitons. The interlayer excitons in WS_2/MoS_2 vdW heterostructures were observed in previous papers, giving a single broad peak at around 1.4 eV. [1] In contrast, the observed interlayer PL peak gives more detailed spectral features, which might originate from high-quality (clean interface and surface flatness) of our sample.

3. Conclusions

We have successfully fabricated hBN-encapsulated WS_2/MoS_2 vdW heterostructure by the dry transfer method. Appearance of the sharp interlayer exciton peak clearly demonstrates that the quality of the fabricated is high. The results obtained in this work indicate the importance of hBN encapsulation in investigation of intrinsic physical properties of TMDC and its vdW heterostructures.

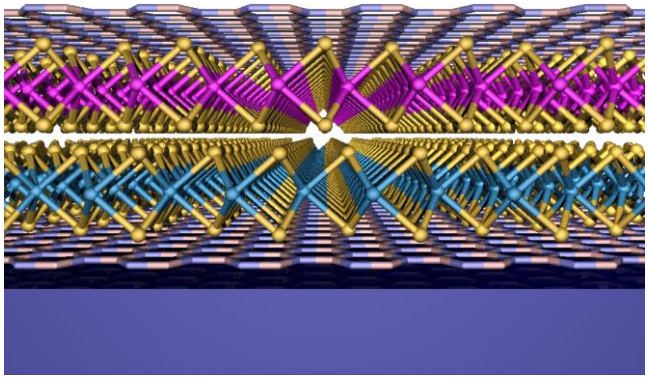

Fig. 1 A structure model of the fabricated heterostructure.

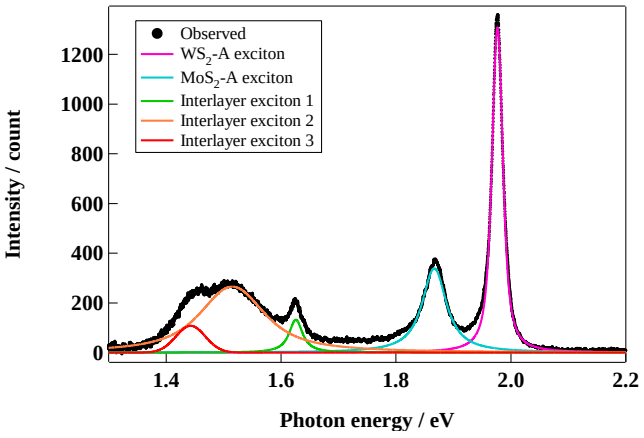

Fig.2 PL spectrum of hBN-encapsulated WS_2/MoS_2 vdW heterostructure.

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References

[1] Y.gong *et al.*, ***Nature Materials,*** **13** (2014) 1135.