Kana Kojima

Hong En Lim, Zheng Liu, Wenjin Zhang, Tetsuki Saito, Yusuke Nakanishi, Takahiko Endo, Yu Kobayashi, Kenji Watanabe, Takashi Taniguchi, Kazunari Matsuda, Yutaka Maniwa, Yuhei Miyauchi, Yasumitsu Miyata

Department of Physics, Tokyo Metropolitan University, Hachioji, 192-0397, Japan
Inorganic Functional Materials Research Institute, AIST, Nagoya, 463-8560, Japan
Institute of Advanced Energy, Kyoto University, Uji, 611-0011, Japan
National Institute for Materials Science, 1-1 Namiki, Tsukuba, Japan

Corresponding Author: Y. Miyata, Tel: 042-677-2508, E-mail: ymiyata@tmu.ac.jp

Restoring intrinsic optical properties of CVD-grown MoS_2 monolayers and their heterostructures

The van der Waals (vdW) heterostructures of two-dimensional materials have attracted much attention for their superior electrical and optical properties. The superconductivity illustrated in bilayer graphene and the formation of interlayer excitons in the TMDC-based vdW heterostructures for instance, are promising for optoelectronic applications [1-3]. Recently, large-area vdW heterostructures with clean interface have been successfully prepared on Si substrates using chemical vapor deposition (CVD) method. However, for such CVD-grown heterostructures on SiO_2 surface, the lattice strain caused by the substrate has resulted in a weakened interlayer coupling and PL broadening. Herein, by removing the underlying SiO_2/Si substrate used, we demonstrate an improved interlayer coupling in CVD-grown MoS_2/WS_2 heterostructures [4].

MoS_2/WS_2 heterostructures grown on SiO_2 surface by CVD were transferred onto a TEM grid to form the suspended structure. This process can suppress tensile strain induced by the supporting substrate, as confirmed by the blue shift in the PL peak of monolayer TMDCs. For the suspended MoS_2/WS_2 heterostructures fabricated, an interlayer exciton peak appears at 1.63 eV, which is not observed on the substrate supported one. This implies an enhanced interlayer coupling in the free-standing sample, highlighting the importance of studying these atomically thin vdW heterostructures without the substrate influence. Our results provide a simple method for understanding the intrinsic physical properties of TMDCs and the development of sophisticated optoelectronic devices.

References

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Figure

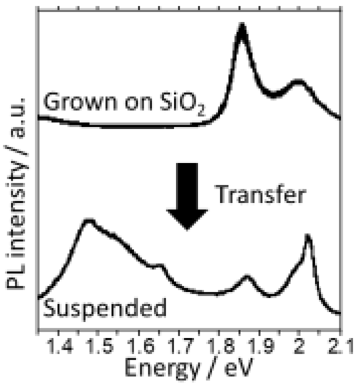

Figure 1: PL spectra of MoS_2/WS_2 vertical heterostructures grown on SiO_2 and after the transfer on a TEM grid.