Exciton tuning in monolayer WSe_2 via substrate induced electron doping

Yang Pan[1]
Mahfujur Rahaman[2], Lu He[1], Ilya Milekhin[1,3] and Dietrich R. T. Zahn[1,3]
[1]*Semiconductor Physics, Chemnitz University of Technology, 09107 Chemnitz, Germany*
[2]*Department of Electrical and Systems Engineering, University of Pennsylvania,19104 Philadelphia, USA.*
[3]*Center for Materials, Architectures and Integration of Nanomembranes (MAIN), Chemnitz University of Technology, 09107 Chemnitz, Germany*
yang.pan@physik.tu-chemnitz.de

Abstract

Exciton and bandgap tuning currently is one of the hottest research topics for two-dimensional (2D) transition metal dichalcogenides (TMDCs) since the birth of the new generation 2D semiconductors [1,2]. As shown in Figure 1a, we observe a ~100 meV redshift for the monolayer WSe_2 photoluminescence (PL) together with a PL quenching of 1-2 magnitudes and a drastic increase of the trion emission intensity when monolayer WSe_2 is brought in contact with highly oriented pyrolytic graphite (HOPG) compared to the monolayer WSe_2 deposited onto a dielectric substrate such as hBN. By a systematic study using PL and Kelvin probe force microscopy (KPFM) (Figure 1b) on WSe_2/HOPG, WSe_2/hBN, and WSe_2/graphene, we conclude that this phenomenon of exciton tuning is induced by electron doping via the substrate. Our results propose a simple yet efficient way for exciton tuning in monolayer WSe_2, which plays a central role in the fundamental understanding and for further device development.

References

[1] Chaves, A. *et al*. npj 2D Materials and Applications, 4 (2020) 1-21
[2] Raja, A. *et al*. Nature Communications, 8 (2017) 1-7

Figures

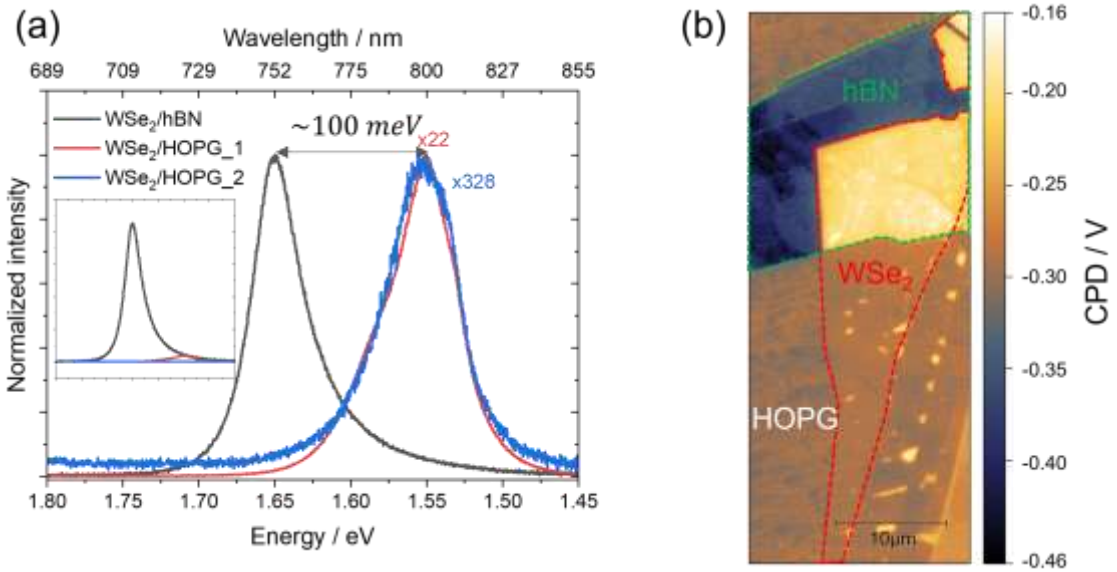

Figure 1: (a) Normalized PL spectra of monolayer WSe_2/hBN and WSe_2/HOPG. Inset: as-measured (not-normalized) PL spectra. (b) KFPM of a sample exhibiting WSe_2/hBN/HOPG and WSe_2/HOPG regions.