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Interface electroluminescence from WS_2/WSe_2 in-plane heterostructures

Heterostructures of transition metal dichalcogenides (TMDCs) are an attractive system to realize high-performance devices such as light-emitting diodes and tunnel field-effect transistors. To realize such devices, it is important to understand the electrical and optical properties of TMDC-based heterointerface. Recently, electroluminescence (EL) has been observed for MoS_2/WSe_2 in-plane heterostructures by using electric-double layer technique [1]. In the previous study, the samples show EL only from monolayer MoS2 due to strain-induced modulation of band alignment. However, little attention has been given to such strain effect on the optical spectra of TMDC-based heterointrerface.

In this study, we report the characteristic EL from the strained heterointerface of WS2/WSe2 in-plane heterostructures. WS_2/WSe_2 in-plane heterostructures were grown on SiO_2/Si substrates by salt-assisted chemical vapor deposition (CVD). To observe EL through carrier recombination at interface, we have fabricated the electric double layer light-emitting diodes (EDLEDs) with ion gel (Fig.1a). The devices show linear light emission from the interface by applying voltage (Fig.1b). The EL spectra show two peaks, which can be assigned to exciton peaks of WS_2 and WSe_2 (Fig.1c). Interestingly, the EL peaks are shifted compared with the photoluminescence (PL) peaks of WS_2 and WSe_2. The shift can be explained by lattice strain in WS_2/WSe_2 lattice mismatched interface. Furthermore, valley polarization was also observed for WS_2 exciton peak even at room temperature probably due to strain-assisted valley magnetoelectric effect [2]. The present results indicate that TMDC-based heterointerfaces provide a unique system to control and use their unique electrical and optical properties.

References

[1] J. Pu et al., Adv. Mater., 29, 1606918 (2017).
[2] J. Lee et al., Nat. Mater., 16, 887891 (2017).

Figures

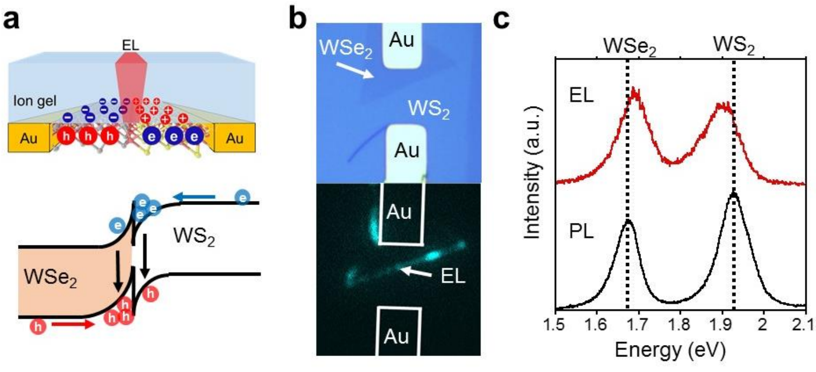

Figure 1: (a) Schematic of structure and energy band diagram of WS_2/WSe_2-based EDLED device after the formation of p-i-n junction by electric double layer doping. (b) Optical and electroluminescence (EL) images, and (c) EL and photoluminescence (PL) spectra of WS_2/WSe_2-based EDLED device.