7th International Workshop on 2D Materials

Title of the Presentation: Spatial Control of Dynamic *p-i-n* Junctions in Large-area Transition Metal Dichalcogenide Light-Emitting Devices

First Name: Hao

Last Name: Ou

Affiliation: Dept. of Applied Physics, Nagoya University, Nagoya, Japan

Email: ou.hao@g.mbox.nagoya-u.ac.jp

Short Biography:

Mr. Ou is a Ph.D. student of the Department of Applied Physics at Nagoya University, Japan. He received B.E. and M.E. degrees in Huazhong University of Science and Technology, China. He now is a first-grade doctoral student of Nagoya University, studying the transport and opto-electronic properties of two-dimensional TMDC, under the supervision of Prof. Taishi Takenobu.

Abstract:

Diverse functionalized light-emitting devices based on monolayer transition metal dichalcogenides (TMDCs) have showed exotic properties, such as flexible light-emitting devices [1], chiral light-emitting devices [2], and cavity-integrated photonic devices [3]. However, most reported researches have used exfoliated or CVD-grown single-crystalline monolayers. To further widen applications, the devices fabricated with large-area monolayers are necessary. Recently, we established a simple electrolyte-based light-emitting structure, which is suitable to generate electroluminescence (EL) using large-area TMDCs (Fig. 1a) [4]. Based on this method, here, we demonstrate various large-area light-emitting devices with WSe_2, $MoSe_2$, and WS_2 monolayers to evaluate their EL properties.

Two-terminal light-emitting devices were fabricated on CVD-grown polycrystalline monolayers with spin-coated electrolyte films (Fig. 1a). With applied voltage, the ions redistribute to form the electric double layers on the surfaces of electrodes and TMDC channel. Electrons (holes) are then injected from anode (cathode), and recombine to emit light. Figures 1b-1c indicates the spatial EL images of WSe_2, $MoSe_2$, and WS_2 devices, respectively. We achieved direct observations of EL in various monolayers, and interestingly, we noticed that each device has its own light-emitting position within channel region (Figs. 1b-1c). To investigate the mechanism behind these phenomena, we measured the electron and hole mobilities in each device. As a result, we found out a proportional relationship between relative light-emitting positions and carrier mobilities. We will discuss the detail light-emitting mechanism by comparing with conventional organic light-emitting transistors. Our results offer possible ability for precise control of EL positions in large-area TMDC devices.

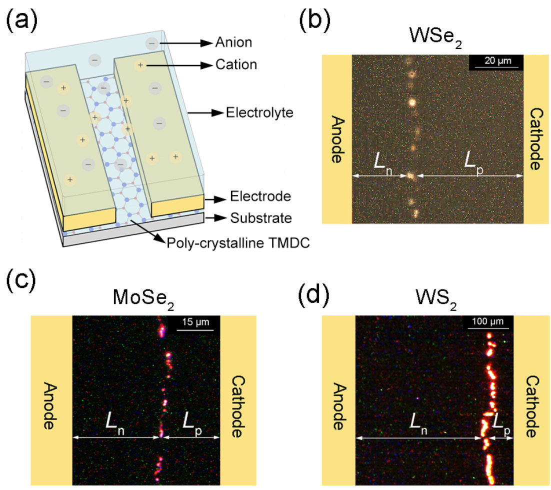

Fig. 1. Large-area TMDC light-emitting devices

[1] J. Pu et al., Nano. Lett. 12, 4013-4017 (2012).
[2] Y. Zhang et al., Science 344, 725-728 (2014).
[3] Y. Bie et al., Nat. Nanotechnol. 12, 1124-1129 (2017).
[4] J.Pu et al., Adv. Mater. 29, 1606918 (2017)