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Title of the Presentation: Monolayer in-plane heterojunction light-emitting devices with tunable composition distribution

First Name: Jiang

Last Name: Pu

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

Email: jiang.pu@nagoya-u.jp

Short Biography:

Dr. Jiang Pu is an assistant professor in Department of Applied Physics at Nagoya University, Japan. He received his B.E and M.E degrees in Applied Physics from Waseda University, Japan. He completed his Ph.D. in the Leading Graduate Program in Science and Engineering at Waseda University in 2017, supported by Ministry of Education, Culture, Sports, Science and Technology (MEXT). During his Ph.D., he also was selected as the Research Fellowship for Young Scientists from Japan Society of Science.

Abstract:

Atomically thin transition metal dichalcogenides (TMDCs) are an attractive material for functional optoelectronic applications because of their diverse bandgaps, robust exitonic emission/absorption, and unique quantum (spin-valley) properties [1]. In particular, the in-plane heterojunctions based on TMDC monolayers provide opportunities to directly modulate band structures and lattice strains by the spatial distribution of constituent elements, leading to further control of light-emitting capability. However, it is still challenging to create light-emitting devices and to explore the electroluminescence (EL) properties using in-plane heterostructures with tunable composition distribution. Here, we demonstrate the EL influenced by composition distribution in monolayer in-plane heterojunctions through by adopting electrolyte-based light-emitting device structures, as shown in Fig. 1 [2,3].

In this talk, we focus on two types of monolayer in-plane heterojunction light-emitting devices. One is the realization of light-emitting devices with atomically sharp heterojunction interfaces that is grown by chemical vapor deposition (CVD). We directly observed interfacial EL in various TMDC heterojunctions (Fig. 1: Left), in which their EL was significantly affected by interfacial strains. As a result of strain effects, we can generate room temperature chiral EL at steep heterojunction interfaces. The other is the demonstration of light-emitting devices using the composition graded monolayer TMDC alloys synthesized by CVD. The spatial composition gradient directly reflect the light-emitting energy varied from 2.1 eV to 1.7 eV (Fig. 1: Right). In this device, we utilized the spatial control of recombination zone in the electrolyte-based devices [4]. As a consequence, we can achieve continuous and reversible color-tunable light-emitting devices (Fig. 1: Bottom). Our results provide a new approach for exploring quantum light sources and developing broadband optical applications based on monolayer semiconductors.

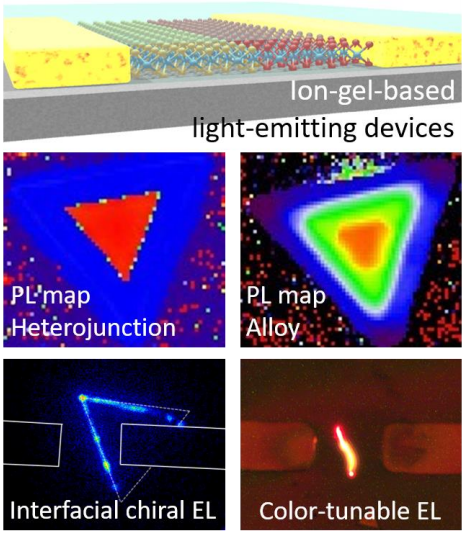

Fig. 1 Functional in-plane hetero-device

[1] J. Pu and T. Takenobu Adv. Mater. 30, 1707627 (2018).
[2] J. Pu, et al., Adv. Mater. 29, 1606918 (2017).
[3] J. Pu, et al., Adv. Mater. 33, 2100601 (2021).
[4] H. Ou, J. Pu, et al., ACS Nano 15, 12911 (2021).