Optical and Optoelectronic Properties in 2D Homo- and Hetero-junctions

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It is well-known that the optical and electronic structures of two-dimensional transition metal dichalcogenide (2D TMD) materials and perovskites often show very strong layer-dependent properties[1]. It is less well-known however is that the properties can also be tuned by stacking order, which allows us to build electro and optical devices with the same material and the same thickness. Detailed understanding of the inter-layer interaction will help greatly in tailoring the properties of 2D TMD materials for applications, e.g. in p-n junction, transistors, solar cells and LEDs. Raman/Photoluminescence (PL) spectroscopy and imaging have been extensively used in the study of nano-materials and nano-devices. They provide critical information for the characterization of the materials such as electronic structure, optical property, phonon structure, defects, doping and stacking sequence[2].

In this talk, we use Raman and PL techniques and electric measurements, as well as simulation to study TMD samples (Figure 1). The Raman and PL spectra also show clear correlation with layer-thickness and stacking sequence. Electrical experiments and ab initio calculations reveal that difference in the electronic structures mainly arises from competition between spin-orbit coupling and interlayer coupling in different structural configurations[3]. Similar phenomena could also be found in TMD heterostructures.

References

[1] Tan, P. H.; Han, W. P.; Zhao, W. J.; Wu, Z. H.; Chang, K.; Wang, H.; Wang, Y. F.; Bonini, N.; Marzari, N.; Pugno, N.; Savini, G.; Lombardo, A.; Ferrari, A. C. Nat Mater 2012, 11, (4), 294-300.

[2] Yan, J.; Xia, J.; Wang, X.; Liu, L.; Kuo, J. L.; Tay, B. K.; Chen, S.; Zhou, W.; Liu, Z.; Shen, Z. X. Nano letters 2015, 15, (12), 8155-61.

[3] Xia, J.; Yan, J.; Shen, Z. X. FlatChem 2017, 4, 1-19.

Figures

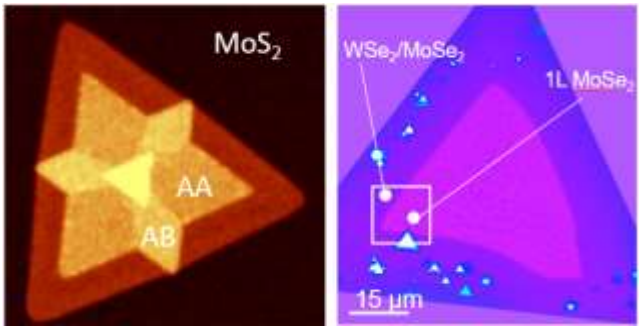

Figure 1: 2D homo-(left) and hetero-junction grown by CVD method.