Thermal-Assisted Vertical Electron Injections in Few-Layer Pyramidal-Structured MoS_2 Crystals

Mei Er Pam
Lay Kee Ang, Hui Ying Yang
Pillar of Engineering Product Development, Singapore University of Technology and Design, 8 Somapah Road, Singapore 487372, Singapore,

yanghuiying@sutd.edu.sg

Abstract

The interlayer screening effects and charge conduction mechanisms in atomically-thin two-dimensional (2D) materials are crucial for electronics and optoelectronics applications. [1, 2-4] However, such effects remain largely unexplored in chemical-vapor-deposition (CVD) grown molybdenum disulfide (MoS_2) crystals. Here, we report a controllable CVD-grown of monolayer MoS_2 and layer-by-layer pyramidal-structured MoS_2 crystals with an oxidized Mo foil precursor. The interlayer screening effects and charge conduction mechanisms in the pyramidal-structured MoS_2 crystals are studied. Although *Fowler-Nordheim (FN)* tunneling model is widely adopted to describe the vertical charge transport mechanism at the 2D-semiconductor/bulk-metal interface [5-6], we found that such mechanism cannot satisfactorily explain the electrical measurement obtained from our CVD-grown MoS_2 samples. Instead, our analysis reveals that *Richardson-Schottky (RS)* emission is the dominant transport mechanism when V_{bias} < 1 V. Our findings provide a fundamental understanding on the charge conduction mechanism in CVD-grown MoS_2 crystals, which is crucial for development of MoS_2 electronics and optoelectronics devices.

References

[1] Zheng, J.; Yan, X.; Lu, Z.; Qiu, H.; Xu, G.; Zhou, X.; Wang, P.; Pan, X.; Liu, K.; Jiao, L. Adv. Mater., 29 (13) (2017), 1604540.

[2] Xu, Y.; Cheng, C.; Du, S.; Yang, J.; Yu, B.; Luo, J.; Yin, W.; Li, E.; Dong, S.; Ye, P.; Duan, X. ACS Nano, 10 (5) (2016), 4895-4919.

[3] Allain, A.; Kang, J.; Banerjee, K.; Kis, A. Nat. Mater., 14(2015), 1195.

[4] Das, S.; Appenzeller, J. Nano Lett., **2013**, 13 (7), 3396-3402.

[5] Son, Y.; Wang, Q. H.; Paulson, J. A.; Shih, C. J.; Rajan, A. G.; Tvrdy, K.; Kim, S.; Alfeeli, B.; Braatz, R. D.; Strano, M. S. ACS Nano, 9 (3) (2015), 2843-2855.

[6] Son, Y.; Li, M. Y.; Cheng, C. C.; Wei, K. H.; Liu, P.; Wang, Q. H.; Li, L. J.; Strano, M. S. Nano Lett.,16 (6) (2016), 3571-3577.

Figures

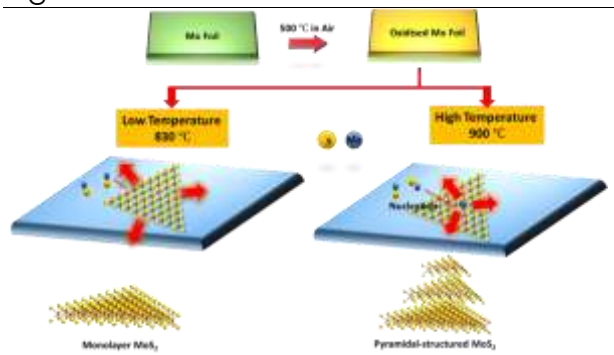

Figure 1: Schematic diagram for the growth of monolayer and pyramidal-structured MoS_2 crystals under low temperature (830 ℃) and high temperature (900 ℃), respectively.

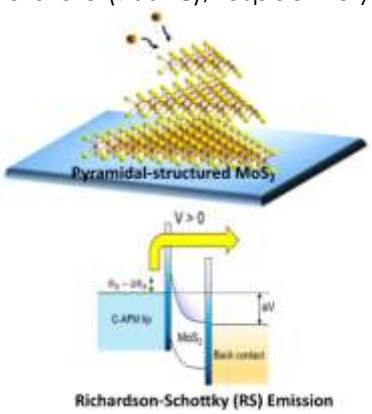

Figure 2: Thermal-Assisted Vertical Electron Injections by Richarson-Schottky emission in Few-Layer Pyramidal-Structured MoS2 Crystals.