

Supporting Information:

Direct Bilayer Growth: a New Growth Fundamental for Novel WSe₂

Homo-junction and Bilayer WSe₂ Growth

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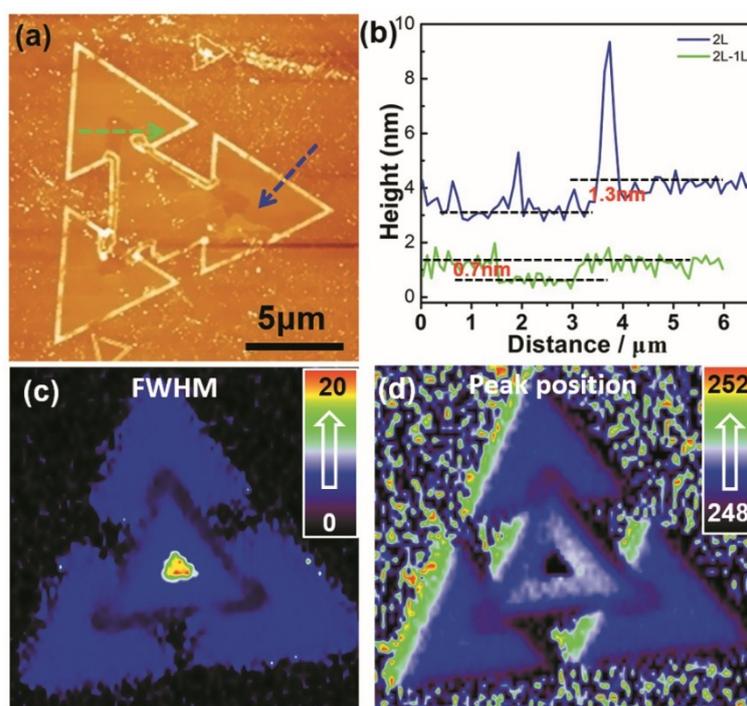


Figure S1 (a-b) AFM image of the WSe₂ homo-junction and the corresponding height profiles. (c) The FWHM intensity maps of WSe₂ Raman characteristic peak. The fitting range is 200-300cm⁻¹. (d) Raman peak position mapping of E_{12g} mode for the WSe₂ homo-junction sample.

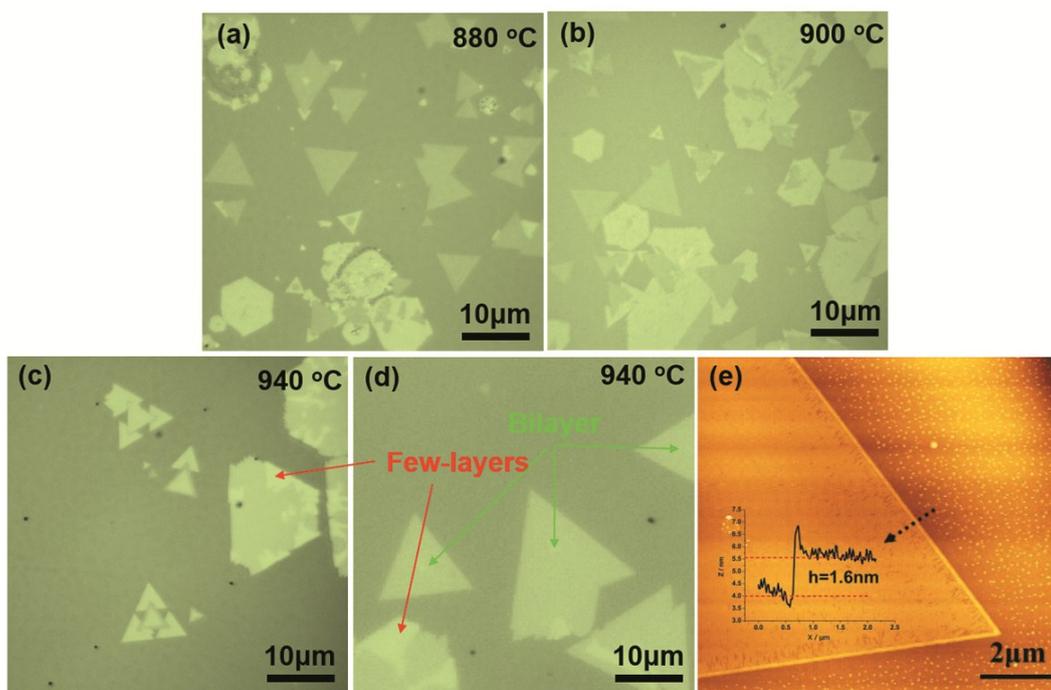


Figure S2 More optical images of WSe₂ samples grown on sapphire substrates: (a) 880 °C, (b) 900 °C, (c) 940 °C and (d) 940 °C. (e) AFM image of the CVD-grown bilayer WSe₂ at 940 °C.

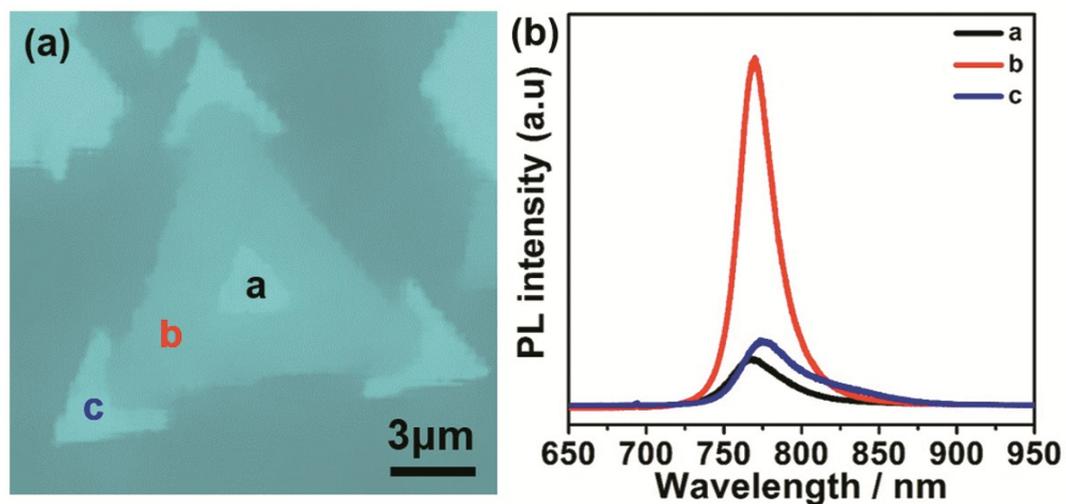


Figure S3 (a) Typical optical image of the CVD-grown WSe₂ samples at 880 °C. (b) PL spectra at the different regions of WSe₂ homo-junction.

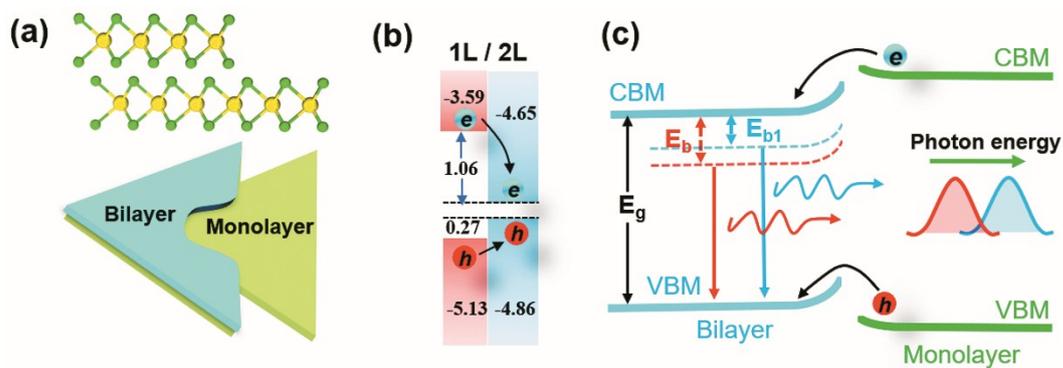


Figure S4 (a) The side view model of the atomic structures for AA stacking WSe₂ homo-junction. (b) Band alignments of monolayer/bilayer WSe₂ homo-junction with respect to the vacuum level.¹ (c) Schematic diagram of the mechanism for emission energy shift induced by charge transfer from monolayer to bilayer WSe₂.²

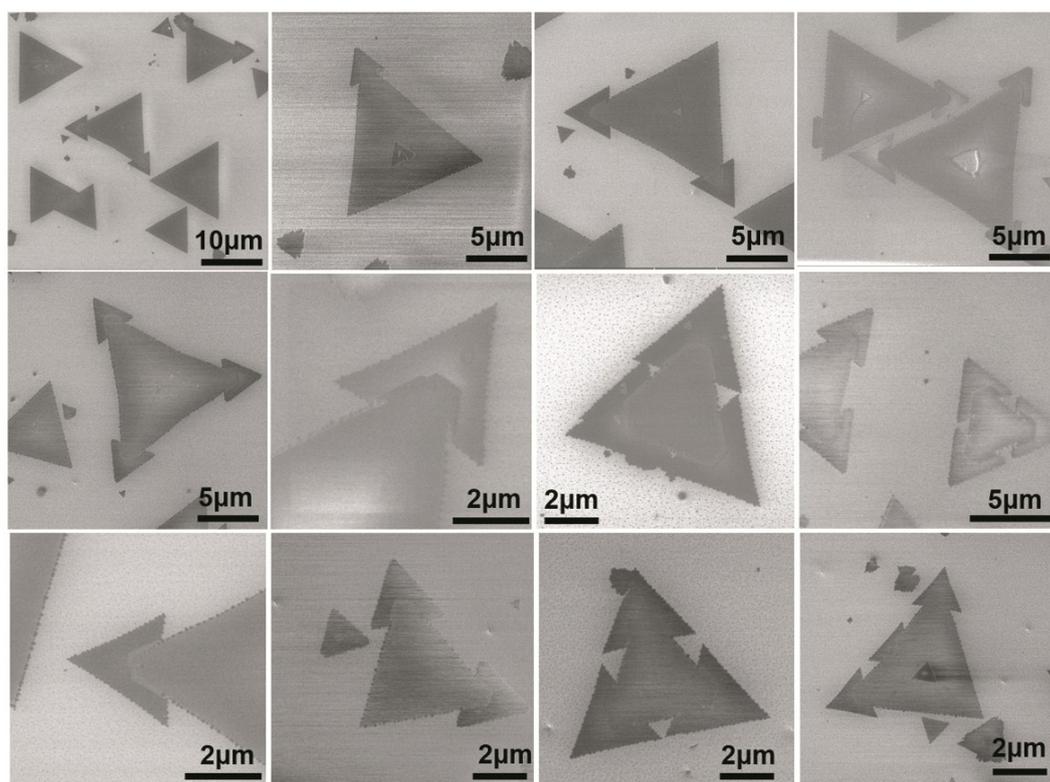


Figure S5 More typical SEM images of WSe₂ homo-junction at different morphology.

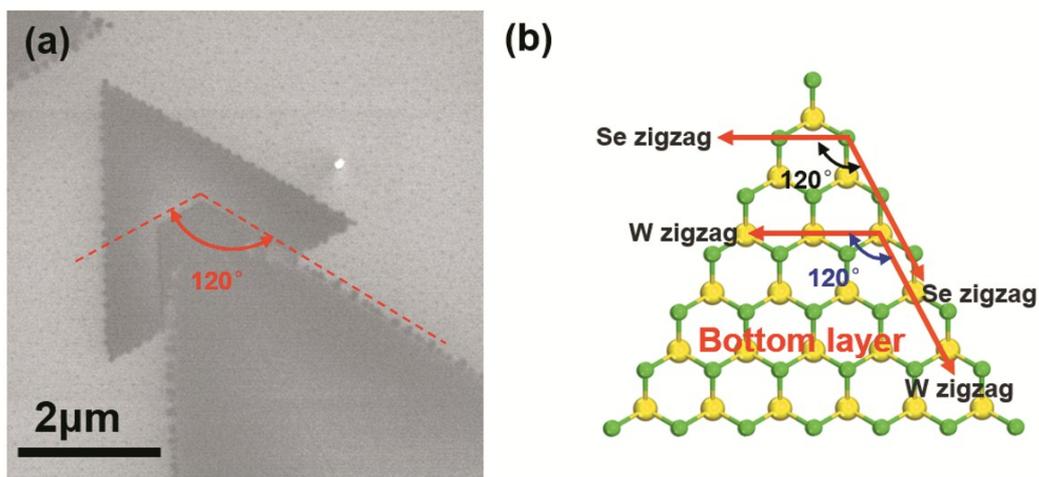


Figure S6 (a) Typical SEM image of vertex region of WSe₂ homo-junction. (b) Schematic illustration of bottom layer atomic structure of WSe₂ homo-junction.

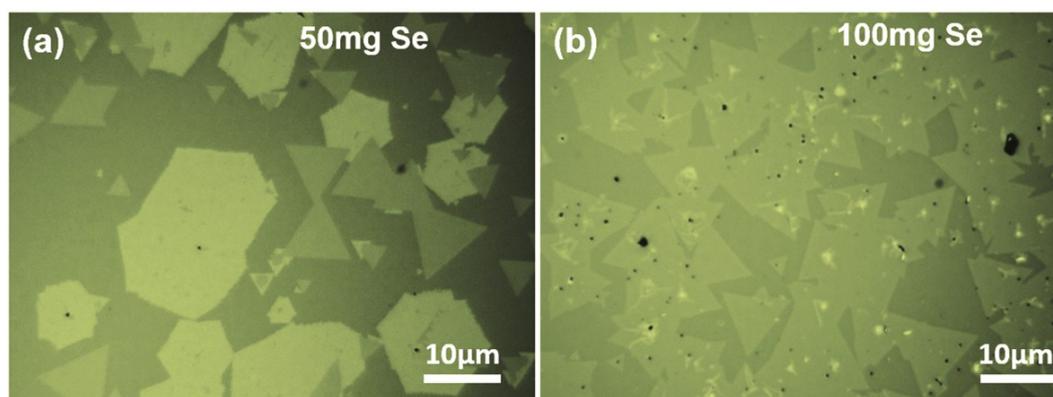


Figure S7 Typical optical image of the CVD-grown WSe₂ samples at 900°C. The growth time was 7 min and the WO₃ powder is 200mg.

References

- 1 C. Xia, W. Xiong, J. Du, T. Wang, Y. Peng, Z. Wei, J. Li and Y. Jia, *Small*, 2018, **14**, 1800365.
- 2 Z. Jia, J. Shi, Q. Shang, W. Du, X. Shan, B. Ge, J. Li, X. Sui, Y. Zhong and Q. Wang, *ACS Appl. Mater. Interfaces*, 2019, **11**, 20566-20573.