Bandgap tunability of CVD monolayer WSe_2 flakes by atomic force microscopy

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Abstract

Two-dimensional transition metal dichalcogenides have emerged as a new class of semiconductor materials with novel electronic and optical properties of interest to future nanoelectronics technology. Monolayer tungsten diselenide (WSe_2), which represents a prototype two-dimensional transition metal dichalcogenide, has an electronic bandgap that increases with decreasing tensile strain [1]. Recently, large-size monolayer WSe_2 has been produced by chemical vapour deposition [2-3], but has not yet been fully explored. Here we systematically characterize chemical vapour deposition-grown WSe_2 by high-resolution atomic force microscopy (AFM), photoluminescence (PL) spectroscopy and mapping and demonstrate non-uniform strain in single-crystalline monolayer WSe_2 and strain-induced bandgap engineering. AFM method is used to perform two-dimensional materials of strain releasing. The PL peak position of WSe_2 decreases significantly with the addition of AFM scanning numbers. The growth parameters of monolayer WSe_2 were directly grown on a sapphire substrate by chemical vapour deposition method, which have been optimized to achieve the as-grown bandgap as low as 1.611 eV. More interestingly, the monolayer WSe_2 bandgap to be 1.631 eV by AFM probe scanning to release intrinsic stain. This work opens up new possibilities for flexible electronic and optoelectronic devices with tunable bandgaps that utilize exactly the control of two-dimensional materials stain engineering.

References

[1] Desai SB, Seol G, Kang JS, Fang H, Battaglia C, Kapadia R, et al., Nano Letters, **14** (2014) 4592-7.
[2] Chen C-H, Wu C-L, Pu J, Chiu M-H, Kumar P, Takenobu T, et al., 2D Materials, **1** (2014) 034001.
[3] Huang J-K, Pu J, Hsu C-L, Chiu M-H, Juang Z-Y, Chang Y-H, et al., ACS Nano, **8** (2013) 923-30.

Figures

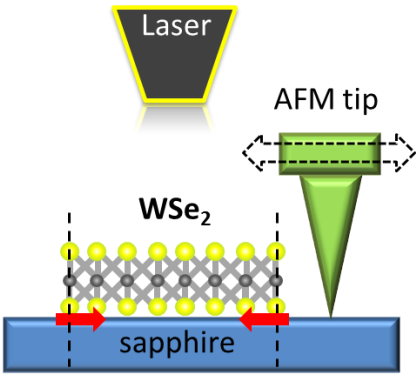

Figure 1: The schematic for the PL and AFM measurement of the triangular WSe_2 monolayer flakes.