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Wafer-Scale and Homogeneous Growth of High Quailty Tungsten Dichalcogenides Using MOCVD

Two-dimensional (2D) transition metal dichalcogenides (TMDs) as emerging semiconductors have a great potential for next-generation electronics and optoelectronics because of their exceptional properties. For practical applications in a wide range of industries, the development of wafer-scale growth techniques of high-quality TMDs is surely required. A variety of thin film deposition processes, including metal-organic chemical vapor deposition (MOCVD), CVD, atomic layer deposition, and molecular beam epitaxy, have been utilized for large-scale growth. Among them, the MOCVD is one of the most promising approaches for high-quality growth with the wafer-scale uniformity[1].

In this research, we present the wafer-scale growth of monolayer tungsten dichalcogenides using vertical and cold-wall-type MOCVD. By precisely controlling nucleation density under the optimized growth condition, first of all, monolayer WSe_2 and WS_2 films were uniformly grown on a 2-inch sized SiO_2/Si substrate. We investigated the optical properties using PL, Raman and absorption spectroscopy, and found that MOCVD-grown films exhibit high optical quality comparable to those of the exfoliated single crystal counterparts. To further improve the film quality, the sodium chloride (NaCl) uniformly dispersed on the substrate by spin coating was employed as a surfactant during the MOCVD growth. We found that the surfactant-mediated grown films have much larger grain sizes and improved electrical and optical characteristics than those of normally-grown films without NaCl. This could be understood by the suppressed nucleation and the promoted lateral crystal growth mediated as introducing a surfactant. The detailed growth mechanism and the role of NaCl will be further discussed.

References

[1] Kibum Kang *et al.*, Nature, 520 (15) 656