Large-Area CVD Growth of Two-Dimensional Semiconductor Using Sublimation of Metal Films

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Several two dimensional (2D) transition metal dichalcogenides (TMDs), especially MoS_2, have emerged as promising layered semiconducting materials for advanced electronic materials. [1] For fabrication of high-performance 2D-based device, large area 2D materials are highly required. In the conventional chemical vapor deposition (CVD) synthesis of TMD materials, solid powders (such as MoO_3, WO_3, and S, Se) are employed as precursor. [2] Because of random deposition of powder on the target substrate, uniform growth of layered materials cannot be easily achieved. Proximity supply of MoO_3 powder [3] or direct sulfurization of ALD Mo film [4] can be applied as an effort to solve these limitations.

In this work, thin transition metal film is employed as uniform metal precursor and sulfur was supplied by flowing H_2S gas. Transition metal is sputtered onto a source substrate. A target substrate is placed upside down above the source substrate with distance. Both substrates are heated with a flow of H_2S gas for sulfurization.

As a result, high-quality 2D TMD films were obtained in large scale. This method shows a great potential for large-area growth of variable 2D semiconductors such as MoS_2, WS_2, and WSe_2, etc.

References

[1] B. Radisavljevic *et al.*, Nat. Nanotechnol., 6 (2011) 147
[2] R. Gatensby *et al.*, Appl. Surf. Sci., 297 (2014) 139
[3] M. O'Brien *et al.*, Sci. Rep., 4 (2014) 7374
[4] Y. Lee *et al.*, Nanoscale, 6 (2014) 2821

Figures

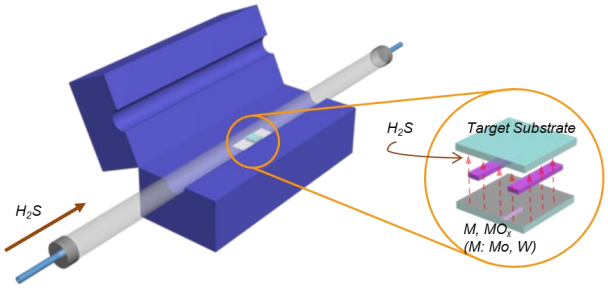

Figure 1: Schematic diagram of the proximity CVD growth of MoS_2. Target substrate is put upside down above source substrate with distance.

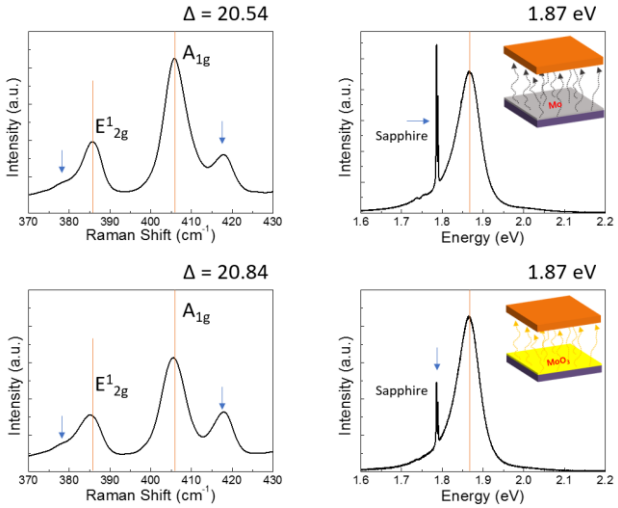

Figure 2: Raman and PL spectra of synthesized MoS_2 using Mo film and drop-casted MoO_3 powder as metal precursor.