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$_2$S 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$_2$S 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


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.