Growth and characterization of transition metal dichalcogenides using halide-assisted MOCVD

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Chemical vapor deposition (CVD) is one of the most powerful techniques for growth of large-area transition metal dichalcogenide (TMDC) atomic layers and their heterostructures. In particular, Kang et al. recently reported the growth of large-area and uniform TMDC films using organic compound-based precursors with high vapor pressure [1]. Because of their high controllability of supply rate, this progress motivates us to fabricate TMDC-based heterostructures through multi-step metal-organic CVD (MOCVD) processes. In this work, we have developed a simple and effective way to produce uniform and high-quality monolayer MoS_2 and WS_2 films using halide-assisted MOCVD.

Monolayer MoS_2 (WS_2) are grown by using organic sulfide and molybdenum (tungsten) compounds. To improve the sample quality, we have investigated the effect of alkali metal halides (AMHs) such as NaCl as the growth promoters. The effects of AMHs are suggested to be the removal of water, the formation of volatile oxyhalides, and the surface modification previously [1-3]. Figure 1 shows atomic force microscope (AFM) and scanning tunneling microscope (STM) images of samples grown with and without AMHs in MOCVD. We found that the use of AMHs improves various parameters including grain size, uniformity of layer number, nucleation density, and defect density of MOCVD-grown TMDCs. Unlike the previous studies [1,2], no oxygen atoms are included in the present precursors, and thus, the different mechanism is required to explain the halide-assisted growth in the present case. In the presentation, we will discuss the role of AMHs in MOCVD growth and show the details of optical and electrical properties of samples.

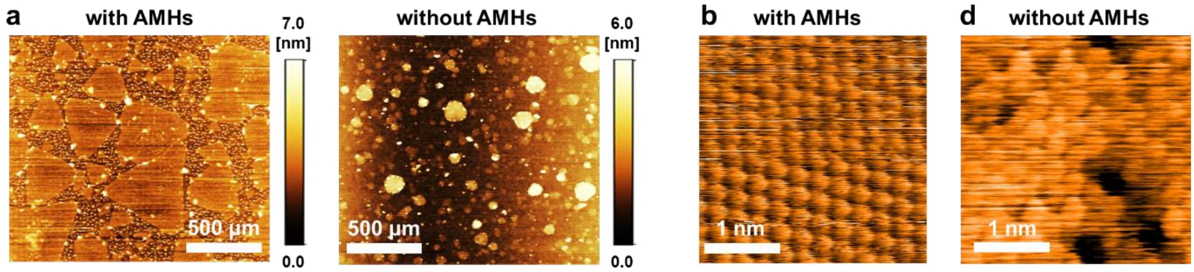

Fig.1 (a) AFM and (b) STM images of MoS_2 grown by MOCVD with and without alkali metal halide (AMHs).

[1] K. Kang et al., Nature, **520**, 626 (2015)., [2] S. Li, et al. Appl. Mater. Today, **1**, 60 (2015),
[3] H. Kim et al., Nano Lett., in press.

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