Alkali metal-assisted growth in metal-organic chemical vapor deposition of two-dimensional layered chalcogenides

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Metal organic chemical vapor deposition (MOCVD) is one of the most powerful ways to prepare large-scale and uniform transition metal dichalcogenide (TMDC) atomic-layers and their heterostructures[1-3]. So far, the progress in vapor phase growth have been achieved by the use of metal organic precursors and additional growth promoters such as alkali metal halides. Although several works have been reported, the roles of the promoter remain unclear. It is therefore crucial to understand and control the effects of promoter to achieve better growth.

Here, by using alkali metal compounds as promoters, we report a high-quality TMDC growth with MOCVD. We found that the introduction of alkali metals improves various parameters, which includes grain size, uniformity of layer number, nucleation density, and defect density of TMDCs such as MoS_2, WS_2, $MoSe_2$, and WSe_2 monolayers. Besides, the alkali metal promoters work also on the exfoliated graphite and hexagonal boron nitride, the van der Waals surfaces, in addition to SiO_2 and sapphire. Our results suggest that the alkali metals may play a role in aiding the formation of intermediate products composed of alkali metals and transition metals rather than dehydration and/or substrate surface modification. The present findings pave way for the simple and rapid preparation of large scale, high quality TMDCs, and TMDC-based heterostructures.

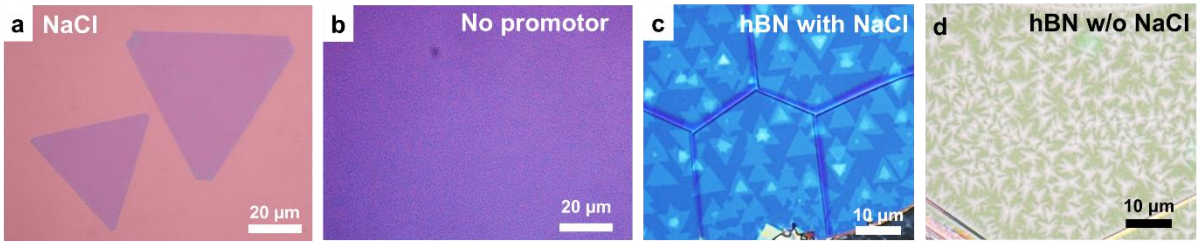

Figure 1. Optical images of MOCVD grown WS_2 (a) with and (b) without NaCl on SiO_2/Si, and (c) with and (d) without NaCl on hBN.

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[3] S. Xie *et al.* Science, **359**, 1131–1136 (2018)

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