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An Innovative Approach for Wafer Scale High Optical Quality TMDs Atomic Layers Growth by MOCVD Technique

Abstract
The successful growth of Two-Dimensional (2D) TMDs materials is one of the prerequisites in order to take advantage of their remarkable electronic and optoelectronic properties in real applications. This requires the systematic study of the growth mechanism of such atomic films. Here, I will present the results on the growth of WS_2 and WSe_2, via the metal-organic chemical vapor deposition (MOCVD) approach. One of the major advantages of MOCVD is the use of volatile precursors for both, the metal and the chalcogen sources, in contrast to the more common metal oxide powder-based CVD approach [1], where the control over the precursor supply is limited. Although the MOCVD method results in large-scale growth, it might include intrinsic carbon contamination [2] arising from the volatile organic-based precursors themselves. This, together with the high rate of precursor decomposition at the growth temperature, leads to the formation of nano-crystalline films.
Here, a Growth-Etch cycle technique is developed, in which the precursors are sequentially delivered while a small amount of water vapor is introduced to the growth chamber. This causes the re-evaporation of small and defective domains as well as the carbon contaminants from the growth substrate, allowing the highly crystalline domains to expand, resulting in high-optical quality large domains or continuous atomic layers, depending on growth conditions [4]. This methodology could be further extended to other 2D materials in general and TMDs in particular. Finally, I will describe how the MOCVD approach can be used to study the van der Waals epitaxy of TMDs on different substrates.

References

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Figures

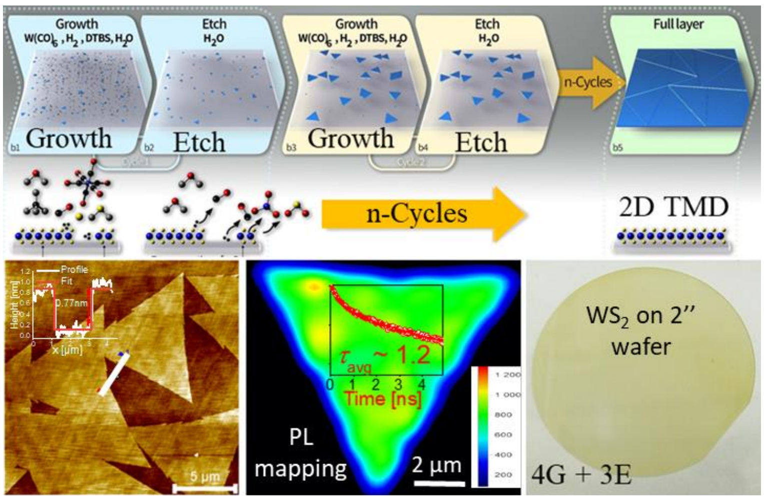

Figure 1: Schematic model of the growth-etch method, Topography map with the corresponding height profile of a monolayer WS_2, PL intensity map and TRPL decay measurement on a single crystal WS_2, a full coverage monolayer WS_2 on a 2" sapphire substrate.