NaCl-assisted, low pressure MOCVD growth of mono- to few layer MoS_2

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This work aims at developing a homogeneous and large-scale deposition of polycrystalline mono- to few layer MoS_2 films with high electronic quality for transistor applications. Metal-organic vapour deposition (MOCVD) has shown to produce continuous films of transition metal dichalcogenides with high spatial uniformity [1][2]. Compared to conventional CVD using chalcogenide and metal oxide powders as precursors, MOCVD is superior in terms of controlled supply of volatile precursors and the high potential for process upscaling and wafer-scale deposition. However, challenges in the MOCVD field are the control of nucleation density and the coalescence of films with large crystal domain size, reaching micrometer scale. Carbon contamination related to the used organic precursors is also a major issue of MOCVD.

In this work, we demonstrate the growth of MoS_2 films on Si/SiO_2 substrates by MOCVD in a home-built, vertical hot-wall reactor using molybdenumhexacarbonyl $Mo(CO)_6$ and diethylsulfide $(C_2H_5)_2S$. The precursors were transported without carrier gas into the low pressure reactor chamber (≈10^{-2} torr working pressure), with flow control achieved by metering needle valves. Optimal growth parameters (temperature, time, precursor flow) were explored and samples were characterized by Raman/PL spectroscopy, SEM and XPS.

Between 550°C and 700°C coalesced films with only few nanometer domain size were grown. When NaCl was evaporated in situ from a crucible inside the reactor chamber at 700°C, typical MoS_2 triangles with edge length of several hundreds of nanometers were obtained homogeneously distributed over the whole substrate. We will discuss how this NaCl-assisted growth can help to increase the crystal domain size of MoS_2 films grown by MOCVD. [3] [4]

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References

[1] Kang, K., et al., Nature, 520(7549): 656-660, (2015)
[2] Lin, Y. C., et al., *Acs Nano, 12*(2), 965-975. (2018)
[3] Kim, H., et al., Nano Letters, 17(8): 5056-5063, (2017)
[4] Song, J. G., et al., Nanotechnology, 28(46): 8, (2017)

Figures

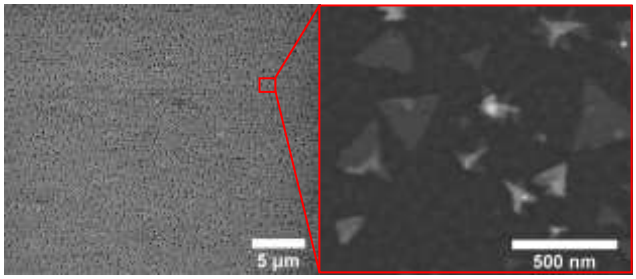

Figure 1: MoS_2 triangular crystals grown on Si/SiO_2 @ 700°C (NaCl-assisted).

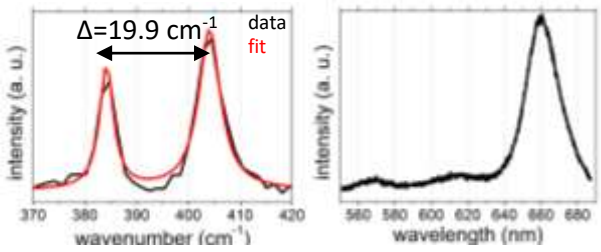

Figure 2: Raman (left) and PL spectra (right).