

Controlled growth of transition metal dichalcogenide monolayers using Knudsen-type effusion cells for the precursors

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Abstract

Controlling the flow rate of precursors is essential for the growth of high quality monolayer single crystals of transition metal dichalcogenides (TMDs) by chemical vapor deposition (CVD). Thus, introduction of an excess amount of the precursors affects reproducibility of the growth process and results in the formation of TMD multilayers and other unwanted deposits. Here we present a simple method for controlling the precursor flow rates using the Knudsen-type effusion cells [1]. This method results in a highly reproducible growth of large area and high density TMD monolayers. The size of the grown crystals can be adjusted between 10 and 200 μm . We characterized the grown monolayers by optical, atomic force and transmission electron microscopies as well as by X-ray photoelectron, Raman and photoluminescence spectroscopies, and by electrical transport measurements showing their high optical and electronic quality based on the single crystalline nature. The quality of these CVD grown TMDs can be compared to the best quality exfoliated materials [2].

References

- [1] A. George, C. Neumann, D. Kaiser, R. Mupparapu, T. Lehnert, U. Hübner, Z. Tang, A. Winter, U. Kaiser, I. Staude and A. Turchanin, *J. Phys. Mater.* 2 (2019) 016001
- [2] S. Shree, A. George, T. Lehnert, C. Neumann, M. Benelajla, C. Robert, X. Marie, K. Watanabe, T. Taniguchi, U. Kaiser, B. Urbaszek and A. Turchanin, *2D Mater.* 7 (2020) 015011

Figures



Figure 1: a) Scheme of the CVD growth system. b) Optical microscopy image of monolayer crystals of MoS₂.