

Chemical vapor growth and delamination of 2D honeycomb MX_3 transition metal halide nanosheets down to the monolayer limit

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Transition metal trihalides (TMTH) of stoichiometry MX_3 (M = transition metal, X = Cl, Br or I) are a remarkable class of two-dimensional materials. MX_3 compounds consist of stacked layers that are only coupled weakly by van-der-Waals forces. Each individual layer consists of honeycomb pattern, similar to graphene. Nowadays, TMTH compounds are well established as bulk catalysts in organic synthesis procedures ($TiCl_3$, $RuCl_3$ and $CrCl_3$). Yet, the investigations of novel structure to property relations of many TMTHs by downscaling to promising monolayer are still outstanding. Interestingly, the incorporation of magnetism in MX_3 sheets, e.g. by chromium, is the key for potential applications from sensing elements to information storage by spintronics based on ultrathin magnetic devices. However, the production of high crystalline two-dimensional MX_3 nanosheets down to the monolayer limit is still an experimental challenge and synthesis approaches like common exfoliation techniques of bulk flakes lack due to non-reproducibility.

We focused on synthesis of thin MX_3 nanosheets ($h \leq 100$ nm) on suitable substrates by chemical vapor transport (CVT) in sealed silica glass (quartz) ampoules and the characterization of structures by several analytical techniques. CVT of nanosheets directly on substrates benefits of low timescales and material consumption as well as less rate of distortions (stacking faults) in as-grown structures.

References

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- [2] M. Grönke, P. Schmidt, M. Valldor, S. Oswald, D. Wolf, A. Lubk, B. Büchner, S. Hampel, Chemical vapor growth and delamination of α - $RuCl_3$ nanosheets down to the monolayer limit, *Nanoscale* **2018**, 10, 19014.)

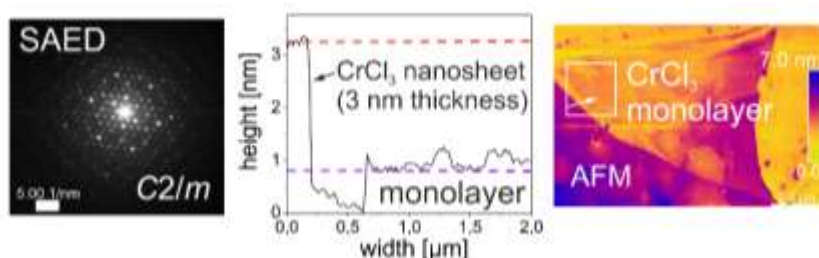


Fig. 1: SAED pattern and AFM measurement of a $CrCl_3$ monolayer and corresponding microscope image of measurement (the white line is indicating the measurement).