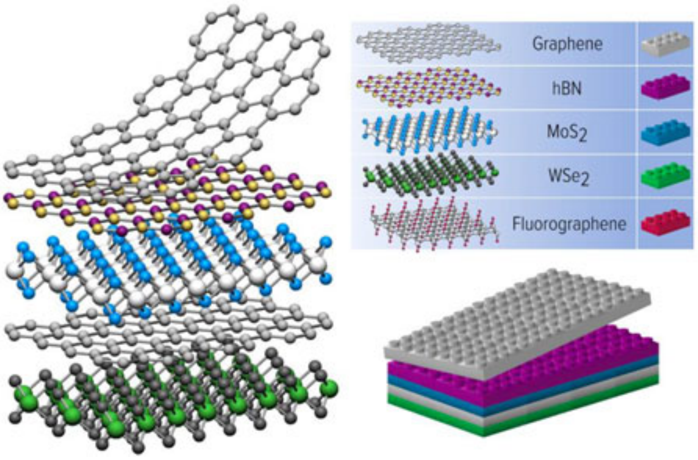
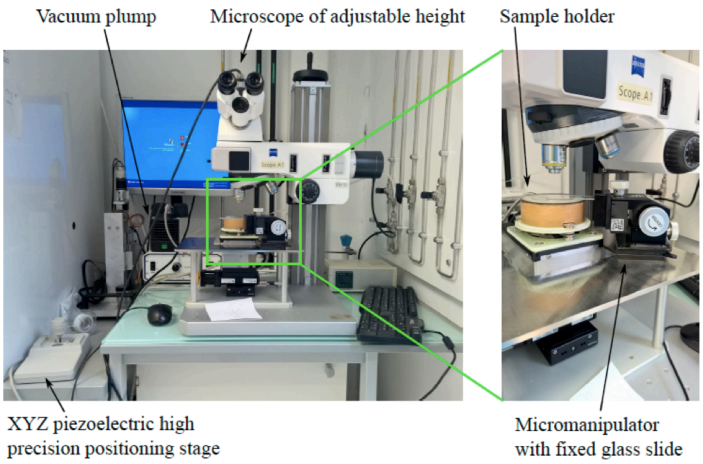
Masterarbeit: Transfer microscope for nanostructures





Two dimensional electronic systems have been of major interest for both fundamental and applied physics since the discovery of graphene in 2004 [1]. Studying the large variety of fundamental properties displayed by graphene (Dirac physics, quantum Hall effect, quantum spin Hall effect, etc.) and other 2D materials (exciton physics in transition metal dichalcogenides, superconductivity and Moiré physics in bilayer graphene, etc.) has generated an increasing need for extremely clean and controlled material growth and nanostructure fabrication.

In 2013, the discovery of the van-der-Waals dry transfer technique has triggered a small revolution in the field of 2D materials [2]. By allowing the precise mechanical stacking of single exfoliated nanostructures, artificial multilayers can be designed at will like LEGOS, with a high degree of control on the relative thicknesses, angular mismatch, and cleanliness of the structures. The range of potentially stackable materials is vast, ranging from metallic (graphene, graphite…) to semiconducting (WSe_2, WTe_2, etc.) materials, encapsulated in-between insulating (boron nitride hBN, etc.) layers. This encapsulation between insulating protective layers is of particular interest for materials that are not stable in air and has led – among others – to the discovery of superconductivity in bilayer graphene and the quantum spin Hall effect in WTe_2 monolayers.

A recent addition to the 2D materials family is Bismuthene on SiC [3] (discovered at EP4 in Würzburg), a honeycomb lattice analogue of graphene, except with Bismuth rather than carbon atoms. Unlike in graphene, the quantum spin Hall effect is predicted in Bismuthene for temperatures up to room temperature. Due to the instability of Bismuthene in air, capping it is an absolutely vital first step to investigate its transport properties. For this purpose, the master candidate will set up a new nanostructure transfer setup, develop the first stacks of graphene and boron nitride, and characterize those by electrical transport. Intermediate goal is to realize a hBN-graphene stack on $SrTiO_3$ substrate, where a quantum spin-Hall phase has recently been demonstrated [4]. The final goal is to prepare the setup in a glove box environment for the encapsulation of Bismuthene with hBN and the possible measurement of the first room temperature quantum spin Hall system.

Contact person: Louis Veyrat (louis.veyrat@physik.uni-wuerzburg.de, Büro F171, EP4)

[1] Geim, A. K., & Grigorieva, I. V. (2013). Van der Waals heterostructures. *Nature*, *499*(7459), 419-425.
[2] Wang, L. *et al.,* (2013). One-dimensional electrical contact to a two-dimensional material. *Science*, *342*(6158), 614-617.
[3] Reis, F. *et al.*, (2017). Bismuthene on a SiC substrate: A candidate for a high-temperature quantum spin Hall material. *Science*, *357*(6348), 287-290.
[4] Veyrat et al., Helical quantum Hall phase in graphene on $SrTiO_3$, arXiv1907.02299