JARA|FIT
Fundamentals of Future Information Technology

2nd Institute of Physics A

RWTH AACHEN UNIVERSITY

Open Bachelor-Thesis Project

Impact of vacuum annealing on the properties of 2D materials

(Supervision of thesis can be done in either German or English language)

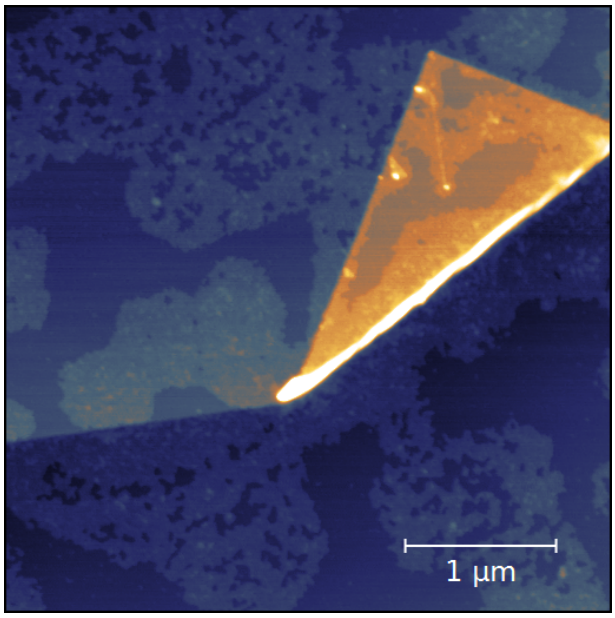
Each individual member within the large family of 2-dimensional (2D) materials, like graphene or monolayers of transition metal dichalcogenides, is interesting on its own. Some have unique physical properties due to their pronounced spin-orbit coupling, others are ferromagnetic or superconducting, and yet others show quantum phenomena even at room temperature. But the technological potential of each individual 2D material may be nothing compared to the one which unfolds as soon as different 2D materials are combined in so-called heterostructures. Preliminary experiments with such heterostructures demonstrated interesting physical phenomena and created the dream of a completely new class of artificial solids with tailored physical properties [1].

Nevertheless, there is one fundamental challenge which must be overcome for this dream to become true: The avoidance of contamination at the interfaces of the stacked 2D materials. Due to their fabrication process or even their mere exposure to ambient conditions, the 2D materials are covered with contaminations. Such contaminations on atomically thin materials will significantly contribute to the overall heterostructure and degrade its properties [2]. But if even the "dirty" heterostructures nowadays show intriguing physics, what will be revealed as soon as clean interface are accomplished?

Therefore, we aim to improve the fabrication process of the heterostructures by cleaning the 2D materials at high temperatures in a high-vacuum system. For this, the Bachelor-thesis should answer the following two questions:

1) What temperatures are needed to remove different kind of contaminations under vacuum conditions?

2) Does the annealing step change the physical properties of the 2D materials?



The Bachelor-student will learn to fabricate stacks consisting of 2D materials, which are then annealed under varying temperatures and high-vacuum conditions. To investigate the impact of the cleaning, the student will learn how to characterize the properties of 2D materials by different, non-invasive methods. These include Raman spectroscopy, photoluminescence, and atomic force microscopy.

[1] A. K. Geim & I. V. Grigorieva, Nature 499, 419 (2013) (freely accessible within the RWTH net)
[2] A. V. Kretinin et al., Nano Lett. 14, 3270 (2014) (freely accessible within the RWTH net)