Aachen Graphene & 2D Materials Center

2D Materials and Quantum Device Group

RWTH AACHEN UNIVERSITY

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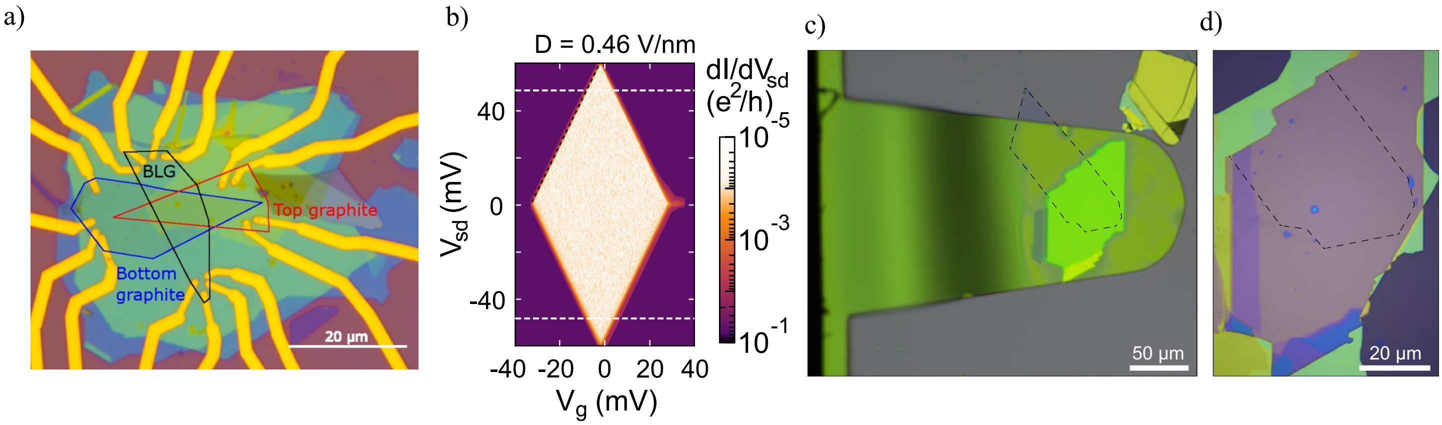
Master Thesis:

Polymer free assembly and characterization of bilayer graphene heterostructures

Motivation: Two dimensional (2D) materials have established themselves as an exceptionally active and broad field of research over the past two decades. Their most exceptional properties reveal themselves in so-called heterostructures, which combines several different 2D materials [1].
These structures face one common challenge, namely contamination during assembly [2].
Only recently, a new polymer-free stacking method has been developed that significantly reduces the amount of residual contamination and paving the way for further improvement of heterostructures [3].



a) Completed high quality BLG device, assembled with a polymer stamp. b) Bias spectroscopy diamond showing the clean band gap opening for the device in a). c) Pick up of an hBN flake with a polymer free cantilever. d) Completed heterostructure, assembled with the polymer free cantilever in c). Figures c) and d) are taken from [3].

Aim of this thesis: The goal of this project is to establish the novel polymer-free stacking procedure and produce high-quality heterostructures in the process.
These heterostructures are then going to be characterized by means of atomic force microscopy (AFM), Raman spectroscopy, photoluminescence and electrical transport measurements. In order to determine their quality and compare them to samples fabricated with state of the art polymer-based techniques.

Your tasks: You will be involved in the fabrication process, beginning with the exfoliation of 2D materials, and proceeding to assemble the heterostructure. You will then characterize the finished stacks and carry out further processing using advanced fabrication techniques, including electron-beam lithography, reactive ion etching, and metal evaporation.
Lastly, you will participate in measurements conducted at cryogenic temperatures as low as 20 mK and analyze the resulting data.

You will gain experience in the following topics:

- Quantum physics, 2D materials, transport and optical measurements
- Fabrication of state-of-the-art quantum devices
- Performing measurements in a dilution refrigerator
- Data evaluation using a preferred programming language (e.g., Python).

Furthermore, you participate in group seminars and journal clubs where you follow current developments in this field of research and discuss recent experiments.

Contact: For further information, please contact David Emmerich (david.emmerich@rwth-aachen.de).
More information about our work can be found at stampferlab.org and www.graphene.ac.

[1] „Van der Waals heterostructures“, Nature 499, 419 (2013)
[2] „The composition and structure of the ubiquitous hydrocarbon contamination on van der Waals materials“ Nat. Commun. 13, 1 (2022)
[3] „Clean assembly of van der Waals heterostructures using silicon nitride membranes“, Nat. Electron. 6, 981 (2023)