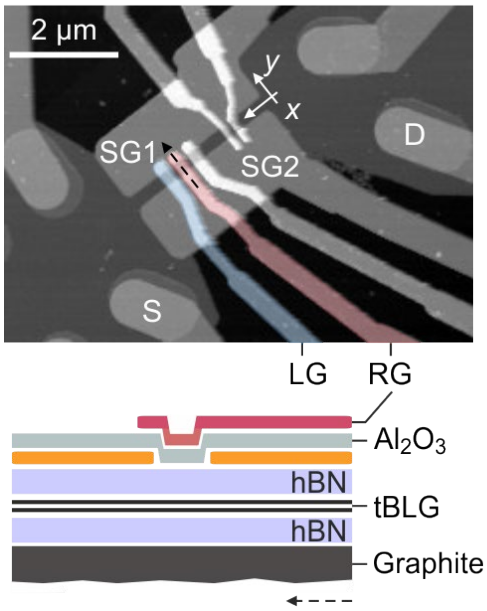
Aachen Graphene & 2D Materials Center

2D Materials and Quantum Device Group | RWTH AACHEN UNIVERSITY

Master Thesis:

Electrostatically defined quantum dots in magic-angle twisted bilayer graphene



Motivation: Two-dimensional (2D) materials offer an interesting and unique platform to study fundamental solid-state physics. Recently, the idea of twisting individual 2D materials against each other lead to the discovery of an unknown plethora of correlated quantum phases in graphene-based systems. By twisting two layers of single-layer graphene against each other, we are able to create a geometric effect (called moiré pattern) which leads at certain twist angles to gate-tunable superconductivity in this system. This allows the fabrication of nanostructures where we can start to use the gate-tunable superconductivity to realize advanced quantum devices like Josephson junctions with tunable weak links, quantum point contacts or quantum dots.

Aim of this thesis: The aim of this thesis is to realize a superconducting quantum dot in magic-angle twisted bilayer graphene. Depending on your interest, this can include the assembly of the moiré pattern, further nanofabrication under cleanroom conditions as well as pre-characterization methods like atomic-force and scanning electron microscopy during the fabrication steps. Finally, we will perform electrical measurements on the fabricated devices in one of our dilution refrigerators at temperatures in the low mK regime.

Your task: The task includes the fabrication of quantum devices and their characterization. In this project, you can broaden your knowledge in:

- Work with modern semiconductor fabrication technology
- Manipulation and readout of quantum devices
- Low temperature experimental setups
- Deeper understanding of basic quantum physics, electronic band structures, 2D materials and quantum devices.

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

Contact us: For further information, pleases contact Alexander Rothstein (alexander.rothstein@rwth-aachen.de) or Christoph Stampfer (stampfer@physik.rwth-aachen.de). More information about our work you can find at www.stampferlab.org and www.graphene.ac.

Reference:

1. Cao et al., *Nature* **556**. 43-50 (2018)
2. Zheng et al., Phys. Rev. Research **6**, L012051 (2024)