Aachen Graphene & 2D Materials Center

2D Materials and Quantum Device Group | RWTH AACHEN UNIVERSITY

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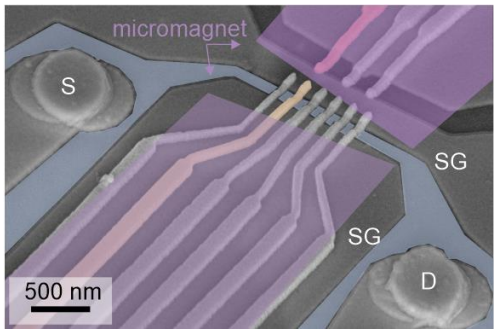
Bachelor Thesis:

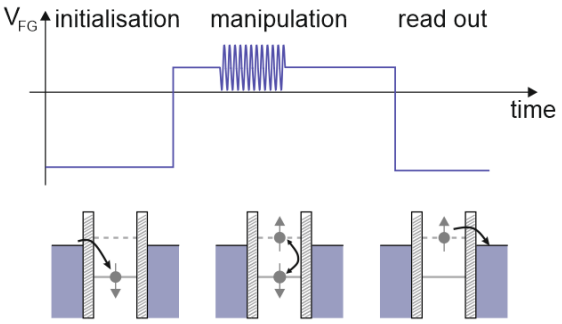
Conceptualization and fabrication of a micromagnet for spin manipulation in graphene quantum dots

Motivation: Research in the field of two-dimensional (2D) materials such as graphene and hexagonal boron nitride (hBN) is because of their extraordinary properties among the most exciting and fastest growing fields in modern solid state physics. Bilayer graphene (BLG) offers the possibility to create nanostructures like quantum dots purely electrostatic due to an electric field tunable band gap. Moreover, material quality and fabrication technology have been improved in recent years, which allows exploring the potential of BLG as a material for quantum devices. Today's technology allows the fabrication of high-quality quantum dot devices in bilayer graphene, which is due to its properties promising for quantum computation. Our team is working on the realization of quantum bits such as spin or valley qubits, which might be implemented in BLG quantum dots. On the way to realize a spin qubit, the manipulation of a spin state in the field gradient of a micromagnet (electric dipole spin resonance) is an important step.

(a)



(b)



(a) Device with gates to control quantum dots by DC and AC voltages. A schematic of a possible micromagnet design is depicted in violet. (b) Pulse sequence for manipulation of a spin state in a quantum dot. [PhD thesis of L. Banszerus (2022)].

Aim of this thesis: This thesis aims at the fabrication of a micromagnet and its characterization. The conceptualization of the magnets shape is backed up with a python-based simulation. This will be followed by electrical transport measurements at temperatures below 20mK, where high frequency voltage pulses will be used to manipulate spin states in the field gradient of the micromagnet in BLG quantum dots.

Your task: Your task includes the fabrication of a micromagnet. You can broaden your knowledge in:

- Low temperature experimental setups and high frequency electronics
- Manipulation and readout of charge and spin states in quantum dots
- Work with modern semiconductor fabrication technology
- 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 and you will be part of a vivid and large team with a strong sense of collaboration.

Contact us: For further information, pleases contact Katrin Hecker (katrin.hecker@rwth-aachen.de), Christian Volk (volk@physik.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.