Aachen Graphene & 2D Materials Center

2D Materials and Quantum Device Group | RWTH AACHEN UNIVERSITY

June 2019

Master Thesis:
Tunable double quantum dots in bilayer graphene

Motivation: The investigation of two-dimensional (2D) materials such as graphene, bilayer graphene (BLG) or hexagonal boron nitride (hBN) is certainly one of the most exciting and fastest developing areas of modern solid-state physics. Especially the interest in bilayer graphene has increased strongly in the last 2 years. This is partly due to the surprising discovery of superconductivity in twisted two-layer graphs. On the other hand, the material quality has improved to such an extent that it is now possible to use the electrostatically tunable band gap technologically. This opens the possibility to investigate the potential of bilayer graphene (BLG) for quantum technological applications. In particular, our latest technology improvements enable the fabrication of well controllable quantum dots, whose energy scales and dynamic behavior are currently being investigated in detail.
In combination with the intrinsic topological degrees of freedoms of bilayer graphene, the latest developments give great hope to make bilayer graphene usable for quantum information technology.

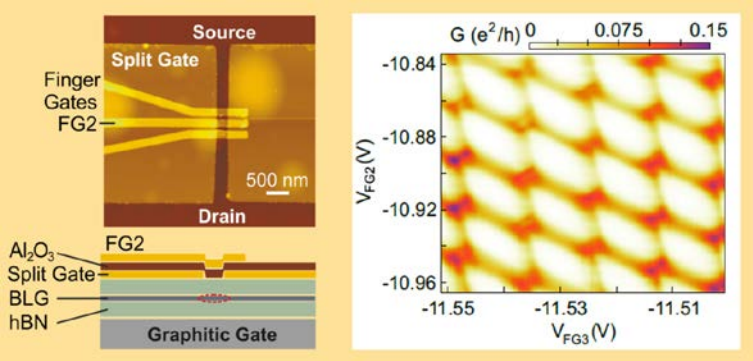

Figure 1: Top-gated bilayer graphene device with multiple finger gates, which allow realizing single and double quantum dots. On the right first conductance measurements in the multi-electron range are shown [L. Banszerus et al. Nano Lett. 18, 4785 (2018)].

Aim of the thesis: The aim of this master thesis is to realize double quantum dots in BLG based on the existing technology and to investigate them by means of transport measurements at low temperatures (< 20 mK). Special attention will be given to the understanding of (i) the possible quantum dot configurations (electron-electron, electron-hole, etc.) and (ii) the spin states and (iii) if possible the spin-Pauli blockade mechanism.

Your task: Your task includes the preparation of samples and characterization. This includes the practical improvement of manufacturing processes and electrical measurements in our dilution refrigerators. Within this project, you can expand your knowledge about these topics:
- Working with state-of-the-art semiconductor manufacturing technologies in cleanroom research facilities
- Operation and understanding of low temperature measuring setups (dilution fridges10 mK)
- Manipulation of quantum dot states with high-frequency control and readout electronics
- Deepening the understanding of basic quantum physics of electronic band structures, 2D materials and quantum devices.

You will also take part in group seminars and journal clubs to discuss current developments in this field of research.

Contact us: For further information and interest please contact Christoph Stampfer (stampfer@physik.rwth-aachen.de) or Luca Banszerus (luca.banszerus@rwth-aachen.de). More information about our work can also be found at www.stampferlab.org and www.graphene.ac.