Aachen Graphene & 2D Materials Center

2D Materials and Quantum Device Group

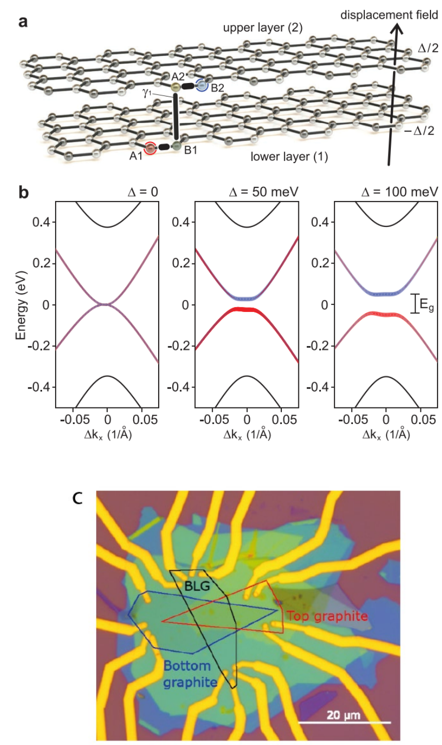
RWTH AACHEN UNIVERSITY

Master thesis:

Spin-Orbit Coupling and Magnetic Phases in Bilayer Graphene–SnS Heterostructures

Motivation: Bilayer graphene (BLG), when exposed to a perpendicular electric field, acquires a tunable bandgap and exhibits a cascade of correlated electronic and magnetic phases. Recent research has shown that proximity coupling to materials with strong spin–orbit coupling (SOC), like SnS, can significantly alter the spin structure and magnetic behavior of BLG. SnS not only induces a large SOC but also features gate-tunable ferroelectricity and a persistent spin helix (PSH) structure, making it an ideal candidate for next-generation spintronic devices.

This thesis is embedded in an international collaboration between RWTH Aachen and Tohoku University. You will explore how SnS proximity coupling influences the spin-dependent band structure and magnetic phase stability in BLG using state-of-the-art fabrication and measurement techniques.



a) Crystal structure of bilayer graphene b) A band gap can be opened and tuned when applying an electric displacement field. Magnetic phases (not shown) evolve in the valence band. (c) Optical image of typical bilayer graphene device structure.

Goal of thesis: The goal of this thesis is to fabricate and study high-quality SnS/BLG van der Waals heterostructures to investigate the impact of SOC and ferroelectricity on magnetic phase transitions in bilayer graphene using low-temperature magneto-transport.

You will:

- Fabricate SnS/BLG heterostructures using dry-transfer techniques and exfoliation of 2D crystals.
- Perform structural characterization using optical microscopy, AFM, and Raman spectroscopy.
- Perform transport measurements at cryogenic temperatures (T ~ 100 mK) in high magnetic fields.
- Analyze spin-resolved transport features such as weak localization and hysteretic magnetoresistance.
- Explore the tuning of proximity effects via displacement fields and ferroelectric biasing of SnS.

You will also deepen your understanding in:

- Spin transport, band structure engineering, and ferroelectric proximity effects.
- Cryogenic measurement setups including dilution refrigeration and vector magnets.
- Device processing using e-beam lithography, metal deposition, and 1D contact fabrication.
- Physics of 2D materials, spin-orbit interactions, and correlated phases.

Furthermore, you will participate in group seminars and journal clubs to discuss current developments in this research field.

Contact: For further information and interest in the project, please contact Bernd Beschoten (bernd.beschoten@physik.rwth-aachen.de). More information about our work can also be found at www.stampferlab.org.