Paul-Drude-Institut
für Festkörperelektronik

Hybrid two-dimensional materials: fabrication and investigation of heterostructures from ferromagnetic and non-magnetic materials

Background and Project Description: 2D-Materials have gained tremendous attention, at the latest, since the Nobel price was awarded to A. Geim and K. Novoselov in 2010 for the isolation and investigation of single layer graphite, “graphene”, which was theoretically predicted to be thermodynamically instable. Ever since, many other layered structures have been identified and their single-layered crystals isolated and studied. Furthermore, careful but simple mechanical manipulation has been developed, allowing to fabricate multi-layered meta-materials, unknown to nature.

In this project we aim to investigate the heterostructures created from magnetic and non-magnetic layered materials. A prime candidate for the magnetic material is $FeGeTe_{3\text{-}5}$ (FGT), as it is ferromagnetic, even at room temperature, and its magnetization remains out-of-plane without external fields. This material can be grown in-house, yielding the possibility to grow specific material combinations or to provide FGT as a substrate to transfer arbitrary materials, giving a wide choice of parameters to tune the meta-materials properties.

We are currently designing a transfer-station for 2D-materials to be operated in a glovebox, in which the Master’s student can take part in, learning about optics and the alignment of optical systems.

Student’s Role and Responsibilities:

- Fabrication of samples via the all-dry viscoelastic transfer
- Optical investigation via Raman- and photoluminescence spectroscopy

Required Qualifications and Skills:

1. Solid state physics
2. Knowledge about spin dynamics is a plus
3. Patience and dedication

Opportunities and Benefits:

- Collaboration opportunities: The project is part of the DFG priority program 2244: 2D Materials – Physics of van der Waals [hetero]structures.
- Access to state-of-the-art facilities and experts in the respective fields to learn from
- Co-authorship of a scientific publication is highly likely
- Mater’s students will be offered a one-year contract.

Relevant Publications:

- Wang et al., Rev. Mod. Phys. 90, 021001 (2018) Colloquium: Excitons in atomically thin transition metal dichalcogenides
- Shree et al., Nature Reviews Physics 3, 39(2021): Guide to optical spectroscopy of layered semiconductors
- Tornatzky et al., Appl. Phys. Lett. 119, 263103 (2021): Spin dependent charge transfer in MoSe2/hBN/Ni hybrid structures
- Zollner & Fabian, Phys. Rev. Lett. 128, 106401 (2022): Engineering Proximity Exchange by Twisting: Reversal of Ferromagnetic and Emergence of Antiferromagnetic Dirac Bands in Graphene/Cr2Ge2Te6

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For further details or clarification, please feel free to contact us. Lab tours are available for interested applicants.