Magneto-Transport Investigation of PASG-grown Graphene/van der Waals Heterostructures

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Graphene is the most promising candidate for the next generation of DC electrical resistance standards based on the quantum Hall effect (QHE). To date, only epitaxial graphene (EG) grown on SiC by Si sublimation meets the necessary metrological requirements. In particular, the use of the polymer-assisted sublimation growth (PASG) technique enables large-scale, highly reproducible, and homogeneous graphene growth [1]. For metrological standards, both high measurement precision and relaxed operating conditions, such as reduced magnetic fields and higher temperatures, are important criteria. These characteristics can be further improved through targeted optimization of EG properties.

A key requirement for implementing PASG-grown EG as a QHE resistance standard is precise control of the charge carrier density, which can be achieved by doping the EG. So far this has been investigated with molecular dopants such as F4-TCNQ [2] or via proximity induced doping effects through metal intercalation [3]. In this work we explore an alternative strategy for tailoring EG properties by stacking a variety of layered two-dimensional materials on top of the EG, including hBN and transition-metal dichalcogenides such as MoS_2, WSe_2 and $NbSe_2$. To characterize the resulting van der Waals heterostructures, Hall bar devices are fabricated from PASG-grown graphene using electron beam lithography. Subsequently, the 2D materials are exfoliated from bulk crystals and suitably large and homogeneous flakes are transferred onto the completed Hall bars using a polymer-based stamp technique [4] (see Fig. 1). By establishing a direct interfacial contact between the exfoliated flakes and the EG, we aim to induce proximity effects that modify the electronic properties of the EG, including carrier mobility enhancement, doping contributions and spin-orbit coupling [5-7]. These effects are investigated using low-temperature magneto-transport measurements and Raman spectroscopy.

References:
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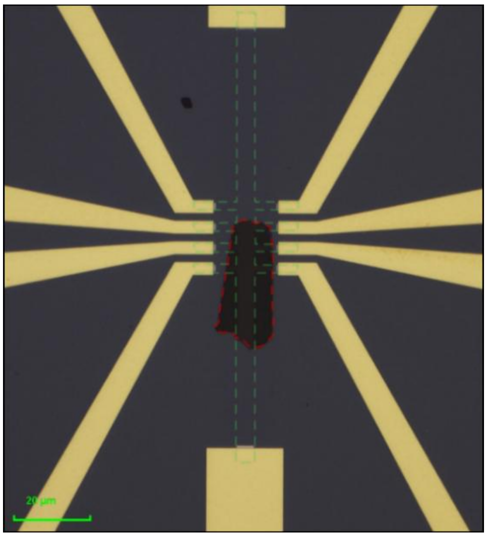

Fig. 1: Optical microscope image of a lithographically structured graphene Hall bar fabricated with gold contacts and with an hBN flake stacked on top. The graphene area is highlighted by a green dashed outline and the flake area by a red dashed outline. The Hall bar dimensions are 5 µm × 100 µm.