Master thesis

Group Prof. Morgenstern, II. Institute of Physics B

Surface Potential Mapping of Graphene Devices

Graphene, the first atomically thin two-dimensional material [1], bears many options to be integrated in modern electronic and optoelectronic devices [2]. Realizing this potential is the aim of the graphene flagship, which combines researchers all over Europe includng the RWTH Aachen and AMO GmbH. However, pushing the limits of such devices requires a detailed knowledge on the influence of defects.

In this master thesis, Kelvin Probe Force Microscopy (KPFM) will be used to probe the influence of such defects [3,4] on the electronic transport properties of several types of devices. The devices are prepared using the clean room of the AMO GmbH (Aachen) in cooperation with [Dr. Daniel Neumaier]() (Fig. 1a) [5]. KPFM is performed with a commercial instrument and will map the surface potential of the devices (Fig. 1b) at different gate voltages, while current is flowing. This eventually enables to determine electron mobility or resistivity maps (Fig. 2b) down to the 10 nm scale. The mobility distribution can directly be related to defects or interfaces to contacts, which are maped in the same measurement (Fig. 2a). This is a key feedback for the optimization of device preparation processes.

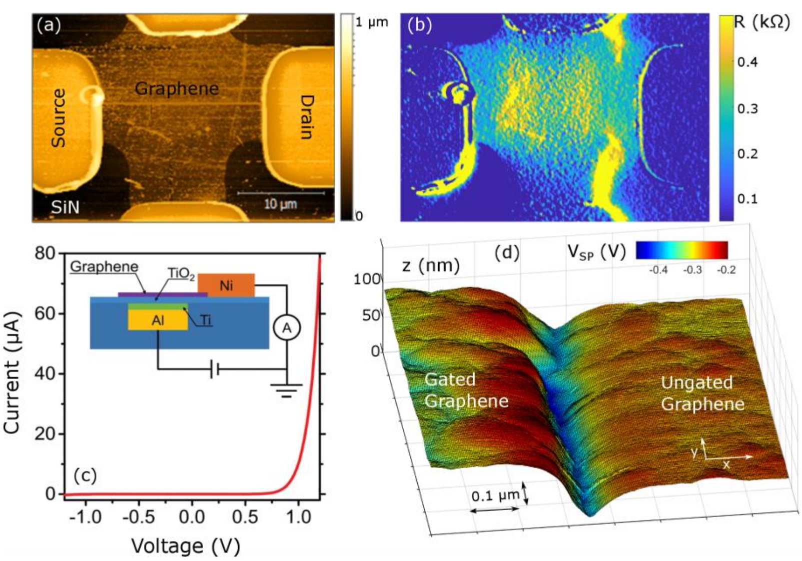

Fig.2 (a) Topography and corresponding **(b)** resistivity map of a graphene field effect transistor at $V_{SD} = 2\,V$. **(c)** Current-voltage curve of a Ti-TiO_2-Graphene diode (shown in the inset) [5] **(d)** V_{SP} fluctuations on the graphene diode at the interface between gated and ungated region.

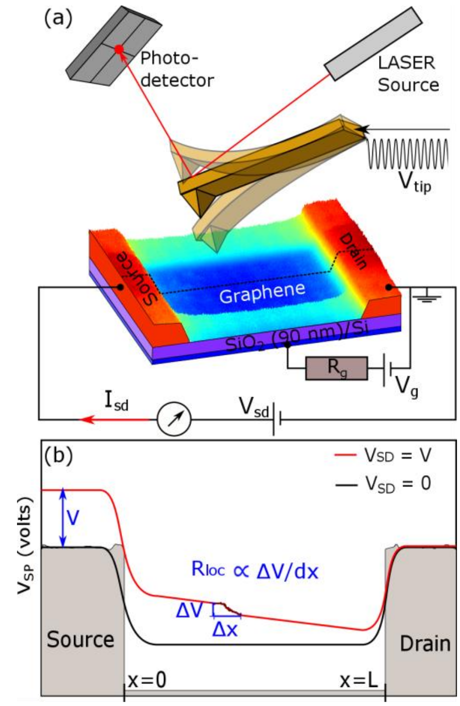

Fig.1 (a) Surface potential (V_{SP}) map of a voltage biased graphene field effect transistor (colored image) with sketched electric circuit below and sketched KPFM tip setup above. **(b)** $V_{SP}(x)$ profiles from source to drain (dashed line in (a)) in the presence (red) and absence (black) of a voltage bias (V_{SD}). Grey shows the topography of the sample. Voltage drop ΔV due to a defect is highlighted

This project aims at a detailed investigation of several graphene based field effect transistors and diodes (Fig. 2 c,d), which are used as THZ detectors [5].

For this project, you should provide a strong interest/background in nano-electronics, experimental skills and enthusiasm to study novel 2D materials.

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