Graphenea

Measurement Protocols and Handling Instructions

Graphene Oxide Field-Effect Transistor Chip: GOFET

Typical Measurement Configurations

The following explains the electrical measurements that can be performed on the different devices in GOFET.

2-probe devices

These devices allow field-effect measurements by simultaneously applying two voltages:

- Source-drain voltage (V_{SD}): applied between the two probes (source and drain), while one of them is grounded (see Figure 1a). V_{SD} enables the transport of charge carriers through the graphene oxide channel, with an associated source-drain current (I_{SD}). V_{SD} can be varied in order to get the desired I_{SD} outcome (see Figure 1b).
- Gate voltage (V_G): applied to the Si on the substrate. V_G creates an electric field on the graphene oxide channel, modulating the conductivity of graphene oxide (see Figure 1c). However, this modulation can be negligible or simply not present in graphene oxide.

The Si can be contacted either from the top surface by scratching the 90 nm-thick SiO_2 with a diamond pen in one of the chip corners; or alternatively from the underside of the chip, for instance using a probe station chuck.

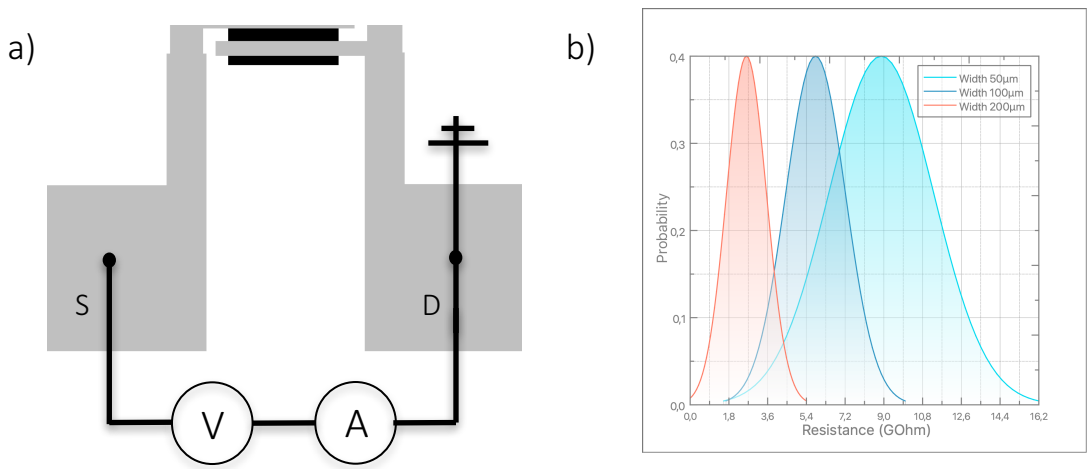

Figure 1. a) Scheme of the 2-probe device, with the corresponding electrical measurement configuration. b) Typical resistances in the devices with different widths.

Interdigitated electrodes

These devices have an interdigitated electrodes. These contacts are ideal for active layers which thickness presents certain variations across their dimensions, as the geometry intrinsically averages the response across the whole device.
This contact scheme also provides larger current densities for the same amount of voltage, compared with a traditional 2-probe geometry, without affecting much the active area and actual device footprint.

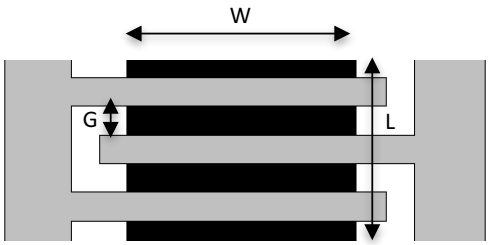

Figure 2. Scheme of the interdigitated electrode geometry.

The resistivity of graphene oxide is usually expressed per thickness unit, i.e. the so-called sheet resistance R_s:

$$R = R_S \frac{L}{W},$$

being R the resistance of graphene oxide and W and L the width and inner length of the graphene channel, respectively. In an interdigitated electrode configuration with n pairs of fingers, its resistance R_n changes to

$$R_n = R_S \frac{G}{nW},$$

being G the gap between electrodes. Thus, the relation ship between R_n and R is

$$R_n = R \frac{G}{nL},$$

In the geometries presented here a factor of 5 orders of magnitude in current densities should be achieved compared with a 2-probe geometry.

Cleaning & storage

Graphene oxide is highly reactive due to the different functional groups present at its surface. We recommend to wash the GOFETs in DI water for 4h and dry with an Ar or N_2 gun to remove ambiental contaminants prior to its use.

In order to preserve the effectivity of this treatment, storage of the chips in a low humidity environment (N_2 cabinet, desiccator, or vacuum) is highly recommended. Graphene oxide is extremely sensitivy to humidity so electrical characterization should be carried out in inert atmosphere or vacuum, ideally immediately after carrying out the cleaning procedure.

Basic handling instructions

The graphene oxide used in our GOFETs is high-quality monolayer CVD graphene and highly prone to damage by external factors. To maintain the quality of your devices, we recommend taking the following precautions:

- Be careful when handling the GOFET chip that tweezers do not make contact with the device area. Metallic tweezers should be avoided, as they can damage/scratch the chip edges/surface
- Treat the devices as sensitive electronic devices and take precautions against electrostatic discharge
- Ideally store in inert atmosphere or under vacuum in order to minimize adsorption of unknown species from the ambient air
- Do not ultrasonicate the GOFET dies
- Do not apply any plasma treatment to the GOFET dies
- Do not subject the GOFET dies to strongly oxidizing reagents

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