Direct Electrical Characterization of Graphene-On-Insulator by Multiple-Point Contact Configuration

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Departamento de Electrónica y Tecnología de Computadores

Luis Segura, Noel Rodriguez, Cristina Fernandez, Akiko Ohata, Carlos Marquez, Francisco Gamiz
Nanoelectronics Research Group, CITIC-University of Granada (Spain)
cfsanchez@ugr.es, noel@ugr.es

The experimental characterization of the physical properties of graphene has been the topic of a large number of studies devoted to research results of this promising material. When the aim was the extraction of electrical parameters, graphene sheets with ad hoc fabricated contacts (electrodes) have been widely used. This task requires complex post-processing of the samples, which takes time and cost. In this work, we propose a new fast characterization technique which combines two- and four-probe measurements enabling a rapid test of large graphene-on-insulator samples.

MEASUREMENTS WITH NEEDLES

SETUP

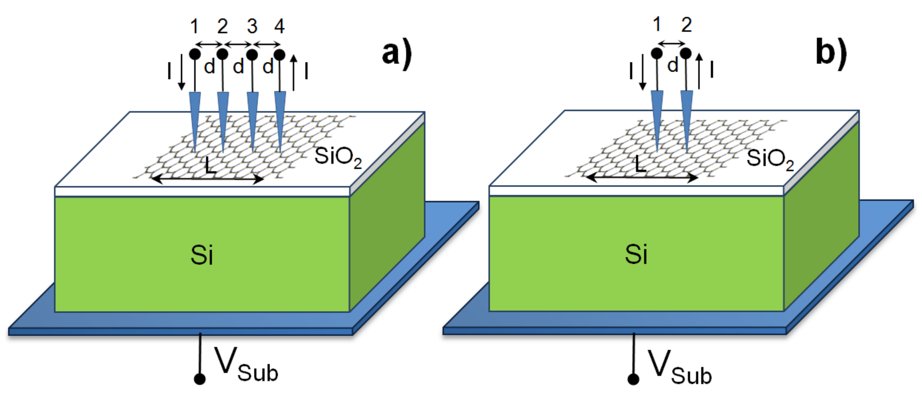
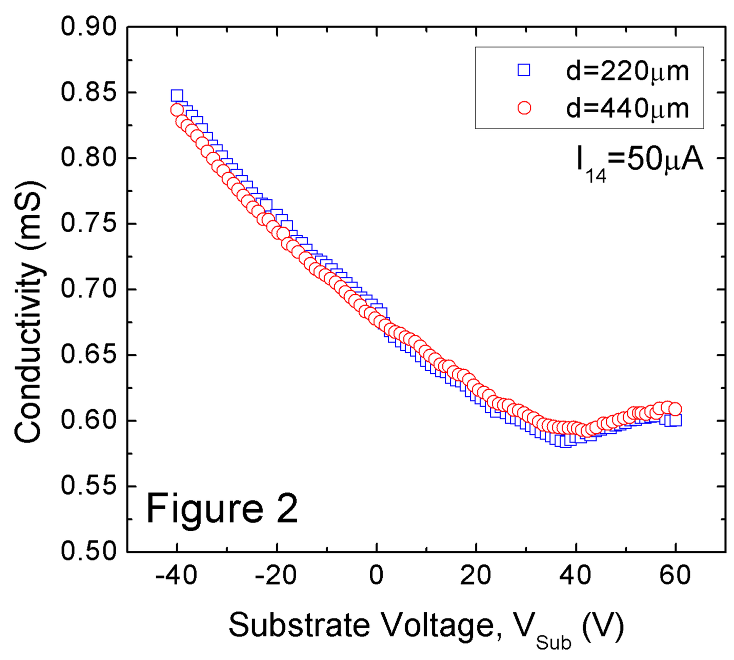


Figure 1. a) Four-probe Kelvin and b) two-needle configurations. In a) probes 1 and 4 force a current flow and probes 2 and 3 measure the voltage drop.

EXPERIMENTAL RESULTS

The **validity** of this contact-based method is sucessfully demonstrated in conductivity curves (Figure 2, four-probe needle configuration).

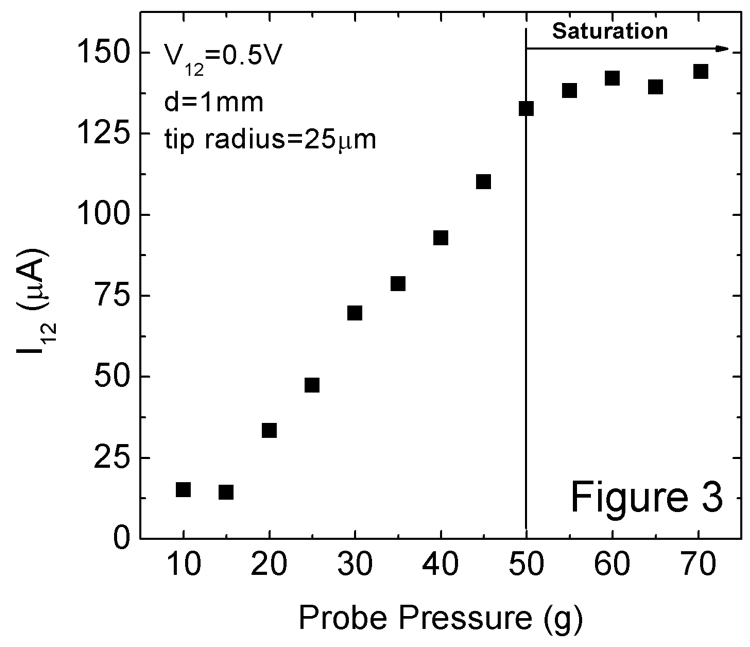
The measurements were **independent** on the **separation between the four neddles**.



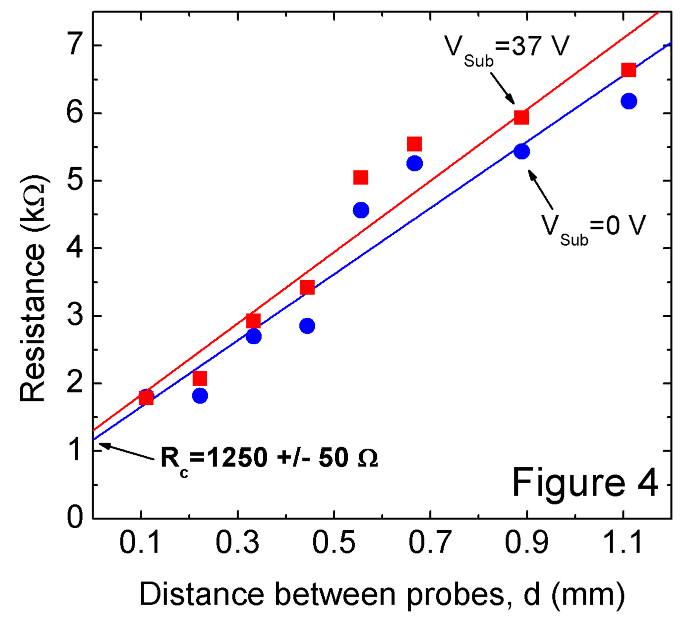
With a two-point contact configuration special caution must be paid to the ***contact resistance, R_c.***

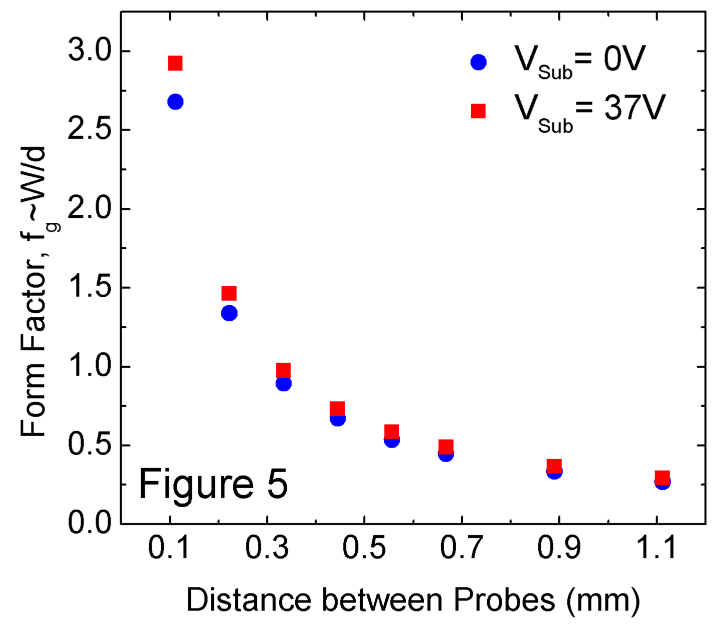
A **linear dependence** is clearly observed with the **probes pressure** (Figure 3).

The **current saturation** is reached **at 50g**. Higher pressure will only contribute to damage the underneath oxide layer (until physical breakdown).



Once the minimum pressure is set, the **total resistance** obtained experimentally ($R_{TOT} = R_{S-Gr} + R_C = \rho_{S-Gr}\, d/W + R_C$) allowed the **extraction of R_C**, where ρ_{S-Gr} is the graphene sheet resistance extracted from previous four-point results.



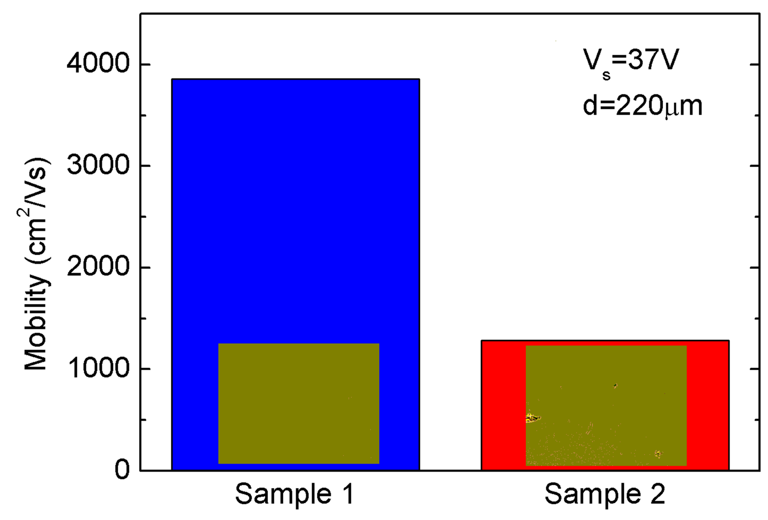


The determination of the **form factor for the current flow (f_g ~ d/W)** is achieved by combining the resistivity obtained from four-point measurements and the two-needle measurements (Figure 5). **For large separations, f_g can be approximated by 0.25.**

APPLICATIONS

This method is extraordinary useful for vendors and research laboratories interested in the fast characterization of graphene samples.

One of the applications of this point-contact technique is the **extraction of decisive electrical parameters** such as the carrier mobility, offering **as-fabricated sample quality characterization.**



CONCLUSIONS

This work presents an electrical characterization method for Graphene-On-Insulator samples based on two- and four-probe point-contact measurements. Due to its simplicity, it can be considered as a productive technique for the fast monitoring of graphene quality.

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