Developing future technical standards for the metrology of electrical properties of graphene

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At the present time, the main barrier limiting the adoption of graphene as an industrial product for electronics is the difficulty manufacturing large areas with uniform and reproducible electric properties. The project GRACE - *Developing electrical characterisation methods for future graphene electronics,* is a Normative (code 16NRM01) Joint Research Project (JRP) of the European Metrology Programme for Innovation and Research (EMPIR). The project outcome will contribute to the development of technical standards within the IEC Technical Committee 113 "Nanotechnology for electrotechnical products and systems" (IEC/TC 113). This includes providing input to standardization projects currently under development but also initiating new measurement standards based on the projects results. Especially the round robin tests, with participation of the national metrology institutes involved in this project, will help to validate the measurement methods. This will increase the quality of the documentary standards developed by IEC/TC 113 and support their uptake in the graphene community. Within the project, started in 2017, graphene samples on quartz substrates, having 1 cm^2 area, were produced via chemical vapour deposition (CVD) and made available to the partners in order to experiment with different electromagnetic measurement techniques. Among those, contact-based methods (van der Pauw, electrical resistance tomography [1], coplanar waveguide) and non-contact ones (different types of scanning probe microscopy, THz wave spectroscopy, losses in microwave resonator) are included. Preliminary results show good consistency between a subset of these techniques, in particular for what concerns quantitative assessment of samples homogeneity, about which we will report at the Conference.

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References

[1] A. Cultrera, L. Callegaro, *IEEE Trans. Instrum. Meas.*, 9, (2016), 2101.

Figures

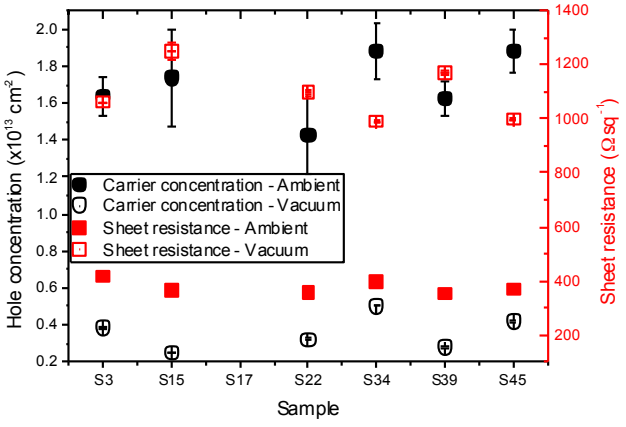

Figure 1: van der Pauw characterization of individual CVD graphene samples cut from a single quartz wafer in different ambient conditions.