Israel Arnedo
Albert Redo-Sanchez, David Etayo, Montserrat Fernandez, Elena Taboada, Cristian Martinez, and Alvaro Cordón
das-Nano, Polígono Talluntxe II, Calle M10, Tajonar, Spain 31192

iarnedo@das-nano.com

ONYX: Full-area non-destructive and non-contact equipment for the fast and accurate characterization of mobility, carrier density, and conductivity of graphene by means of terahertz technology

Onyx is a turnkey, non-contact and non-destructive device for the inspection of several properties of graphene and other 2D materials. Onyx generates full-area maps of mobility, carrier density, conductance, resistance, thickness and other parameters from materials such as graphene, TiN, GaN, PEDOT, ITO, NbC, ALD, spin coated photo-resins. The maps provide information about the homogeneity and quality of the deposition process. Similar characterization is currently realized by nano-scale methods, such as confocal Raman spectroscopy, Atomic Force Microscopy, or Transmission Electron Microscopy, and/or macro-scale methods [1], such as van der Pauw or optical microscopy. However, nano-scale methods are slow and cannot characterize large surfaces. Macro-scale methods generate characterization that average the magnitudes and, thus, cannot provide localized information. Onyx provides meso-scale characterization and covers the gap between nano-scale and macro-scale methods. Onyx is a terahertz-based system [2] that works in reflection geometry as opposed to state-of-the-art methods [1-3] and provides mobility, carrier density, and conductance maps in the terahertz range [4].

Figure 1 shows the conductance maps of a sample of CVD monolayer graphene over quartz substrate. Image (a) shows the conductance measured in reflection configuration while image (b) presents the conductance in transmission configuration. As it is shown in (c), the correlation between the two measurements is strong (98%). The results are in excellent correlation with van-der Pauw method. Figure 2 shows (a) the mobility and (b) carrier density maps extracted without any bias according to model described in [5] of another CVD graphene.

Onyx can be integrated with reactors and enable monitoring production in real-time. Therefore, Onyx could support the production of graphene at industrial scale. Onyx can implement characterization standardized protocols for accurate and repeatable measurements.

References

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[3] Frank Ellrich, Michael Theuer, Garik Torosyan, Joachim Jonuscheit, Rene Beigang, IRMMW-THz, (2008).
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[5] Jonas D. Buron, David M. A. Mackenzie, Dirch. H. Petersen, Amaia Pesquera, Alba Centeno, Peter Bøggild, Amaia Zurutuza, and Peter U. Jepsen, Optics Express, 24 (2015) 30721-30729.

Figures

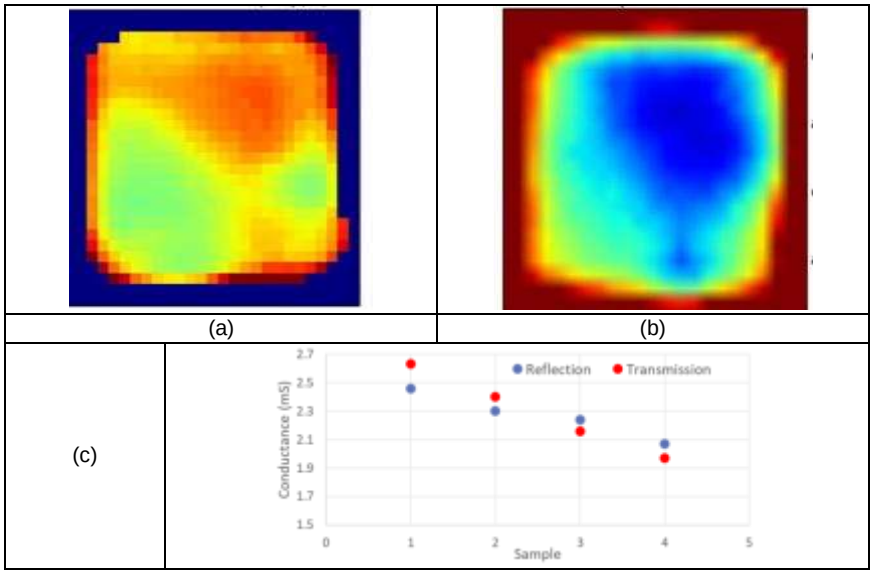

Figure 1: Conductance maps of a CVD monolayer graphene over quartz substrate sample: (a) reflection configuration, (b) transmission configuration, and (c) correlation graph.

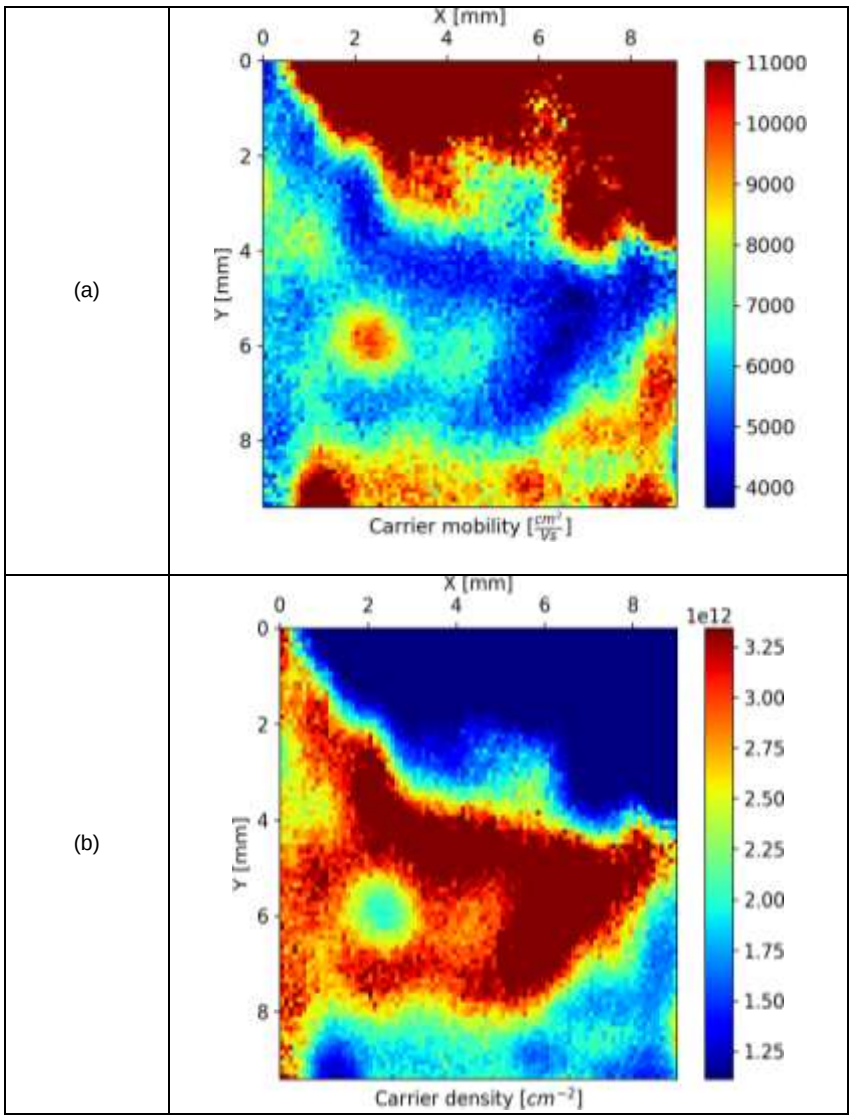

Figure 2: Mobility (a) and carrier density (b) maps of a CVD monolayer graphene over quartz substrate sample.