# Electrical Properties of Laser Reduced Graphene Oxide 

C. Marquez, N. Rodriguez, R.J. Ruiz, F. Gamiz<br>University of Granada, Campus Fuente Nueva SN, Granada, Spain<br>noel@ugr.es


#### Abstract

In spite of being named the poorest flavor of graphene, reduced Graphene Oxide (rGO) is presented as a material with increasing interest in the field of flexible electronics [1]. This work explores the electrical characteristics and perspectives of rGO produced through laser-assisted reduction of GO (Figure 1) [2]. This method has many advantages over its counterparts, i.e. cheap, repeatable, easy to implement in mass production... but its distinctive characteristic is the possibility to produce, without any mask, large high-quality rGO patterns (Figure 2) with micrometer resolution [2]. The precise control of the photothermal power, laser excursion speed, and the initial concentration of the GO dispersion has allowed the decrease of the sheet resistance from the typical $\mathrm{k} \Omega / \mathrm{sq}$ range down to $250 \Omega / \mathrm{sq}$, even breaking the values extracted from large polycrystalline CVD-graphene samples (Figure 3) [3]. A broad set of electrical results based on the standardization of non-destructive point-contact characterization methods for the bare materials will be presented. These results cover the conduction mechanisms and the correlation between electrical noise spectral density and the rGO quality. We will disclose the path for the optimization based on the selection of the critical reduction parameters, focusing the discussion on flexible conductive structures.


## References

[1] M. Rogala, I.Wlasny et al., Gaphene oxide overprints for flexible and transparent electronics, Applied Physics Letters 106 (2015), 041901/1-4
[2] N. Rodriguez, C. Marquez, et al., Scribing Graphene Circuits. Proceedings Future Trends in Microelectronics, 2015, 54.
[3] A. Reina, X. Jia, et al., Large Area, Few-Layer Graphene Films on Arbitrary Substrates by Chemical Vapor Deposition, Nano Lett. 9 (2009), 30-35.

Figures


Figure 1. Sample with nine $1 \mathrm{~cm} \times 1 \mathrm{~cm} \mathrm{rGO}$ squares reduced at increasing laser intensity from 50 mW up to 140 mW . Laser speed $1 \mathrm{~mm} / \mathrm{s}$.


Figure 3. Sheet resistance of rGO on PET substrate extracted from four-point contact measurements as a function of the initial dispersion concentration for two laser reduction intensities.

