Graphene Oxide Inkjet-Printed Electronics: Electrochemical Tuning of Charge Transport in Electrolyte-Gated Field-Effect Transistors and Biosensing Applications

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Graphene and its derivatives have been a subject of many studies and found applications in different fields thanks to their extraordinary properties such as excellent conductivity, important electronic sensitivity towards external interactions and high charge mobilities.[1] Employed as an active layer in electrolyte-gated graphene field-effect transistor (EGGFET) configuration, graphene's electrical properties can be modulated by varying the applied gate voltage.[2] For the transistor's active layer deposition, in this work the inkjet printing technique has been employed using our home-made formulation of graphene oxide (GO) ink. An in-situ electrochemical approach has been developed for GO reduction (rGO), allowing us to obtain rGO directly on the transistor's bottom contact structure. [3,4] Electrical characterizations (Figure 1, left) showed that the reduction degree has an important influence on the mobility of charge carriers as well as on the doping levels. Furthermore, this device has been employed for the life-cycle monitoring of photosynthetic organisms (cyanobacteria *Anabaena flos-aquae*). When illuminated, cyanobacteria release oxygen in the solution, which is subsequently reduced at the gate electrode. This phenomenon is detected by an increase in the device output current (Figure 1, right). In the absence of light, the respiration process takes place, resulting in an overall decrease of current. Further results, concerning the effects of water pollutants on the photosynthesis process, will be also presented.

References

[1] B. Zhan et al., Small, 10 (2014) 4042
[2] I. Meric et al., Nature Nanotechnology, 3 (2008) 654
[3] R. Furlan de Oliveira, *Adv. Funct. Mater.*, 29 (2019) 1905375
[4] S. Pei et al., Carbon, 50 (2012) 3210

Figures

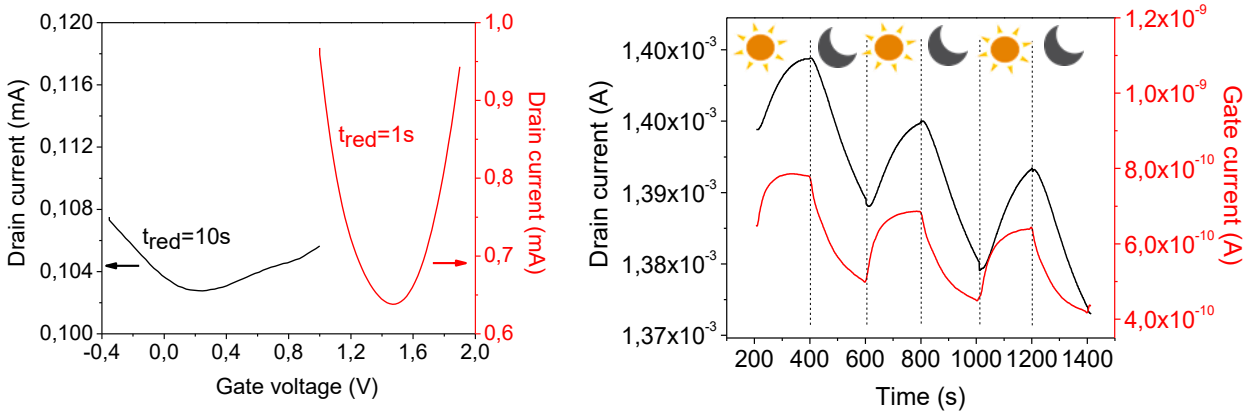

Figure 1: Left) Transfer characteristics of rGO recorded in an EG-GFET configuration upon different reduction times (arrows indicate the corresponding current axe for each transfer curve); Right) Cyanobacteria's life cycle chronoamperometric monitoring in the presence (current increase) and in the absence (current decrease) of light.