Liquid-gated transistors based on reduced graphene oxide for sensing and biosensing

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Liquid-gated transistors (LGTs) have been recognized as powerful electrical transducers of physical, chemical and biochemical events due to their unique characteristics, such as high sensitivity, signal amplification ability, multi-parametricity, inherent operation in water, and low working voltages [1]. Traditionally, organic semiconductors and conducting polymers have been employed as the active thin-film materials in LGTs. The use of reduced graphene oxide (rGO), however, offers several additional characteristics to LGT sensors and biosensors, namely ultrathin thickness, flexibility, elevated conductivity, low-cost and green (water-based) processing. The main advantage of rGO though lies on its rich chemical functionality endowed by oxygen groups (-OH, -COOH, -COC-) that allows one to tether (bio)molecules on the device while preserving the rGO elevated conductivity [2]. Thus, LGT sensors and biosensors based on functionalized rGO films can be developed for one or more targeted analytes. Here we present a robust, all-green, and industrial scalable fabrication of rGO LGTs for sensing and biosensing. Rigid and flexible rGO devices have been fabricated and functionalized with chemical and biochemical species. The first route exploits the direct covalent binding of amino-terminated crown-ether molecules on the GO basal plane through the ring opening reaction of its epoxide groups. The functionalized GO is therefore electrochemically reduced to produce functional rGO LGTs for the detection of metal cations in solution. For this purpose, two derived strategies have been studied, the in-situ GO functionalization (in solution) and the ex-situ one (as a film). The second application relies on the biochemical functionalization of rGO LGTs also by epoxide ring opening reactions to attach Lupuzor™ – a biological drug for the treatment of systemic Lupus [3]. For both chemical and biochemical functionalization strategies, the GO and rGO structural, morphological and electrical properties in LGT configuration have been detailed investigated. This work aims to gain deeper insights on realistic development of commercial sensors and biosensors based on functionalized 2D materials.

References

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Figures

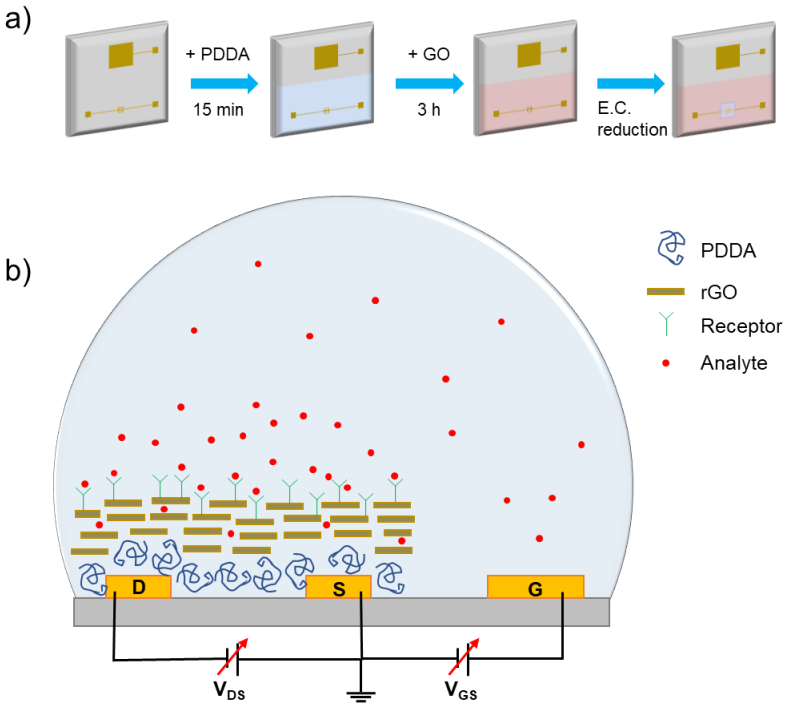

Figure 1: Schematics of the preparation of the test pattern (a), DC operation of the rGO-LGT (b).