Graphene devices for biosensing applications

Pedro Alpuim[1,2]
[1]*International Iberian Nanotechnology Laboratory – INL, 4715-330, Braga, Portugal*
[2]*Department of Physics, University of Minho, 4710-057, Braga, Portugal*

pedro.alpuim.us@inl.int

Abstract

The importance of biosensors in biomedical research keeps increasing at a fast pace, as they are routinely used in a wider range of applications. Graphene low-dimensionality, as well as its high carrier mobility and chemical stability, allows to fabricate relatively simple, label free, highly sensitive biosensors, based on different types of devices [1]. Here, we propose the development of a miniaturized biosensing platform based on liquid-gate graphene field-effect transistors (GFETs) achieving detection of DNA hybridization down to attomolar concentration, while being able to discriminate a single nucleotide polymorphism (SNP) [2].
In another approach, we use the z^{-4} nanoscale distance-dependence of the fluorescence lifetime for fluorophores located in the vicinity of graphene to track the hybridization of fluorescently labelled DNA beacons attached to CVD grown graphene with complementary (target) DNA added in solution. We follow the conformational changes of the beacons by determining the fluorescence lifetimes of the labelling dye and converting them into nanoscale distances from the graphene. In this way, we are able to monitor the vertical displacement of the label during DNA-beacon hybridization with an axial resolution reaching down to 1 nm [3].

References

[1] K.S. Novoselov, V.I. Fal'Ko, L. Colombo, P.R. Gellert, M.G. Schwab, K. Kim, A, Nature 490 (2012) 192-200.
[2] R. Campos, J. Borme, J.R. Guerreiro, G.L. Machado Jr, M.F. Cerqueira, D.Y. Petrovykh, P. Alpuim, ACS Sensors 4 (2019) 286-293.
[3] R.M.R. Adão, R. Campos, E. Figueiras, P. Alpuim, J.B. Nieder, 2D Materials 6 (2019) 045056.

Figures

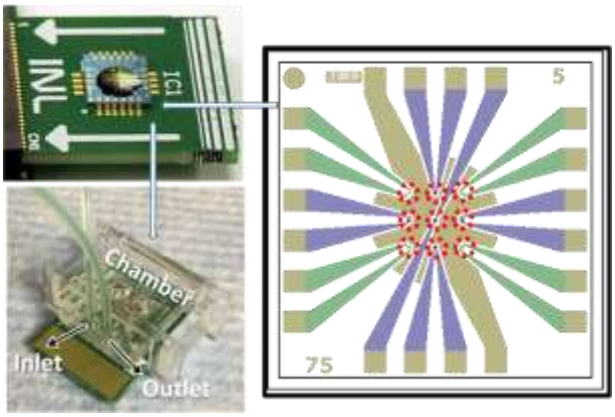

Figure 1: (counterclockwise from right to left) The sensor chip containing 9 GFETs (highlighted in red) is wire-bonded to a PCB to be inserted in the control board. A PDMS flow cell, fitting the sensor layout, can be assembled to the chip prior to insertion in the board.

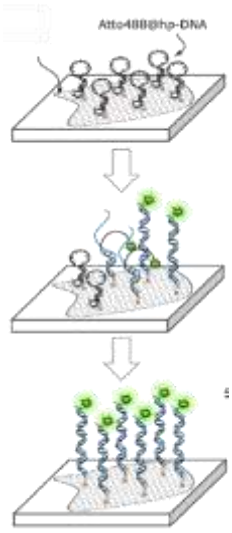

Figure 2: Initially, before the hybridization with target DNA the beacons are in the folded configuration. Upon DNA hybridization, the labeling dye is displaced away from the graphene, and its fluorescence is restored in dependence of the nanoscale distance to graphene.