Towards a universal biosensing platform based on graphene/pyrene surfaces for neurotransmitters

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Understanding how the human brain works is key for the development of new therapeutic treatments – such as neural stimulation - and diagnosis of neurological disorders. Implantable neural interfaces allow the recording of electrical signals to better understand the central and peripheral nervous systems[1,2]. Graphene-based field-effect transistors have been recently used as neural sensing devices, taking advantage of graphene's mechanical and electronic properties, and also open the possibility to add chemical recording capabilities, in particular for the detection of neurotransmitters.. Here, we develop a versatile graphene/pyrenebutyric acid (PyBA) platform for the detection of chemical analytes, while keeping the capability of recording electrical neural activity.

To build this platform, we perform physical evaporation of PyBA, a molecule capable to interact with the π system of graphene thanks to its aromatic nature, and to covalently interact, thanks to its carboxylic group, with an aptamer of interest through the formation of a peptidic bond.

In this work, we have optimized the PyBA evaporation conditions, aiming at forming a PyBA monolayer on single layer graphene.

Then, the binding of an aptamer that recognizes a specific analyte – thrombin is used in our particular case - is used to assess the functionality of the biosensing platform. Morphological characterization of the functionalized graphene surfaces is performed by Atomic force microscopy (AFM) and Raman spectroscopy. The presence of thrombin is detected by electrical characterization of the functionalized graphene transistors.

The thrombin biosensing experiments reveal changes in the electrical properties of graphene corresponding to each concentration tested; the obtained detection range is in good agreement with reported approaches based on in-liquid functionalization[3]. Our results demonstrate the ability of the platform to recognize the analyte of interest through binding to its specific aptamer. This graphene/PyBA universal biosensing platform is in the pipeline for the development of a new generation of multifunctional graphene-based neural implants, capable of both electrical neural sensing and neurotransmitter detection.

References

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Figures

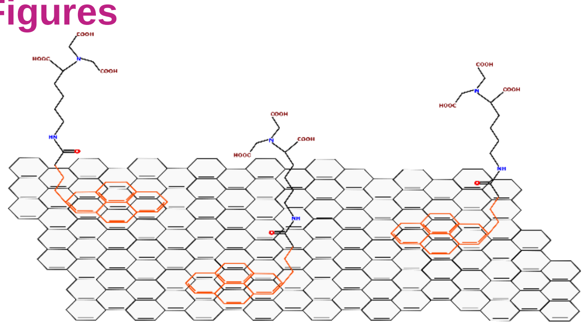

Figure 1 Schematic representation of the PyBA-Aptamer molecules non-covalently stacked to the graphene surface. This is the base of the biosensing platform presented in this work.

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