Development of a graphene aptasensor for the attomolar detection of HCV

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Biosensors based on graphene field-effect transistors have become a promising tool for detecting a broad range of analytes. However, they lack the stability and reproducibility required to step into biotechnological and biomedical applications. In this work, we use a promising physical protocol for the covalent functionalization of graphene, based on controlled ion-sputtering in vacuum [1], to construct a graphene solution gated field-effect transistor (g-SGFET) aptasensor able to detect the hepatitis C virus (HCV) core protein. These devices are highly specific and robust, achieving attomolar detection of the viral protein target in buffer and in human blood plasma. Their improved sensitivity is rationalized by ab-initio calculations that show a negligible charge injection to the graphene, while the induced polarization at the graphene interface is significantly enhanced by an antenna effect induced by the covalently bound molecule leading to a net movement of the Dirac cone at short distances. Such an unexpected effect together with the versatility of the functionalization protocol, paves the way for using this kind of graphene-based platforms for real-time diagnostics of different diseases [2].

References

[1] R. A. Bueno et al. Nat. Comm. 8, (2017) 15306.
[2] I. Palacio et al. Biosensors and Bioelectronics 222, (2023) 115006.

Figures

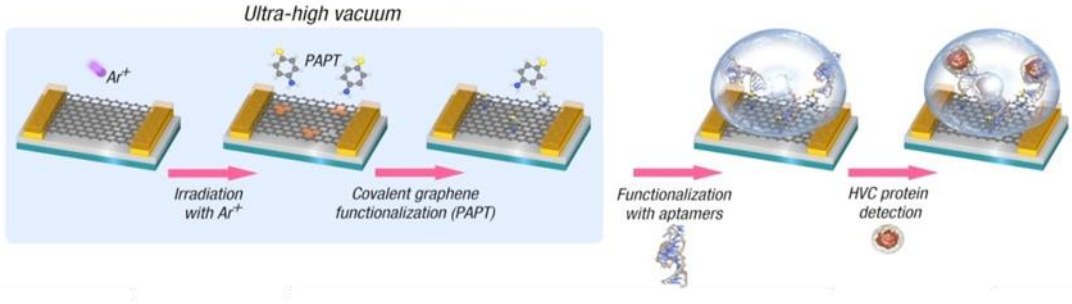

Figure 1: Protocol to develop a covalent g-SGFET aptasensor. The first steps, carried in ultra-high vacuum (UHV), consist of the covalent functionalization of the g-SGFET through a highly controlled methodology after which a functional platform is obtained. This robust platform is functionalized with our synthesized aptamer of high specificity and affinity towards recognizing the HCV core protein. These two final steps are carried in air.