Integration of Aptamers on Graphene Field Effect Transistors for the Ultra-Sensitive Detection of SARS-CoV-2 Spike Protein

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Abstract
Due to COVID-19 pandemic, novel analytical tools to perform SARS-CoV2 detection in a reliable and fast way are a priority. These devices should work with low sample volume and a non-invasive approach. Biosensors based on graphene field-effect transistors (GFETs) are thus a highly attractive technology. In fact, they allow real-time label-free electrical detection, scalability, relatively inexpensive mass production, miniaturization, and the possibility of on-chip integration of both sensor and measurement systems [1]. Moreover, graphene has unique properties such as high carrier mobilities and electrical conductivity, flexibility, biocompatibility, facile chemical functionalization, and large specific surface area, allowing the immobilization of high density of bioreceptors, leading to increased sensitivity [1]. Therefore, we are addressing the development of GFETs biosensors based on aptamers as bioreceptors for the label-free detection of SARS-CoV-2 Spike protein (Sp). With this aim, we employed GFET devices produced by Graphenea (GFET-S20) [2], a Spanish company. Each microchip contains two arrays of 6 GFETs, connected by a common source and a gold gate electrode integrated in the centre of the microchip. The graphene surface of the GFETs was non-covalently functionalized, allowing the immobilization of the specific aptamers for the SARS-CoV-2, followed by a blocking step. The GFETs were then electrically characterized at each surface modification step. The measurements in solution were performed with an ionic liquid gate configuration. The GFETs aptasensors allowed the detection of down to 1 femtomolar SP in PBS. The GFET aptasensor exhibits a high electrical sensitivity for the SARS-CoV2 spike protein detection due the combined effect of the graphene properties and their functionalization with aptamers. This allows us to explore this technology for the detection of the SARS-CoV-2 whole virus in real samples, such as saliva, potentially without any preliminary treatment.

REFERENCES
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