Bioelectronical devices based on graphene FETs with aptamers for detection of small molecules and peptides

Stefan Jarić[a], Zdenek Sofer[b] Ivan Bobrinetskiy[a]
[a]*Biosense Institute – Research and Development Institute for Information Technologies in Biosystems, Dr Zorana Đinđića 1, 21000 Novi Sad, Serbia*
[b]*Department of Inorganic Chemistry, University of Chemistry and Technology Prague, Technicka 5, 166 28 Prague 6, Czech Republic*
sjaric@biosense.rs

Bio-nano conjugates of graphene field-effect transistors and specific aptamers are discussed here to address the question of sensing mechanism and signal development on two different analyte examples.
First, we used an array of CVD graphene FETs (GFETs) functionalized with aptamer for the selective detection of small molecule Ochratoxin A (OTA), providing fast detection of 10-50 s time response and low detection limit of 1.4 pM [1]. During the assembling, a G-rich aptamer induced a small left shift of the Dirac point, which we hypothesize that aptamers are weakly adsorbed on graphene surface instead of its free-standing form in the absence of OTA (Fig. 1A). Introducing OTA, the right shift is observed due to aptamer 3D reconfiguration and desorption from the graphene suggesting that sensing of small molecules by GFET aptasensor rely on the aptamer direct doping mechanism of the graphene channel.
Second, reduced graphene oxide FETs (rGO-FETs) are employed as an aptasensor for the ultrasensitive detection of peptide NT-proBNP with high dynamic range of 10^0 – 10^4 fg/mL [2]. Aptamer assembly on the rGO surface causes the right shift of the Dirac point due to large net negative charge of phosphate backbone and no adsorption because of rGO structure. The peptide with a size about three times smaller than the aptamer brings positive charge, compensating aptamers negative charge to some extent and causing a negative Dirac point shift only observable in highly diluted buffer solution (0.01X PBS) due to ion screening effect decrement (Fig. 1B). On the contrary, transconductance is a function of both doping and charge scatterer accumulation on rGO surface and such signal is found also in 0.1X PBS.
Finally, in this work we discuss the major role of aptamer conformational changes when detecting the small molecules or peptides with the size comparable or smaller then apatmer.

Acknowledgement: This research is supported by European Commission's Horizon 2020 project ANTARES (SGA-CSA 793570, FPA 664387) and Horizon Europe project Know4Nano (GA 101159710).

References

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Figures

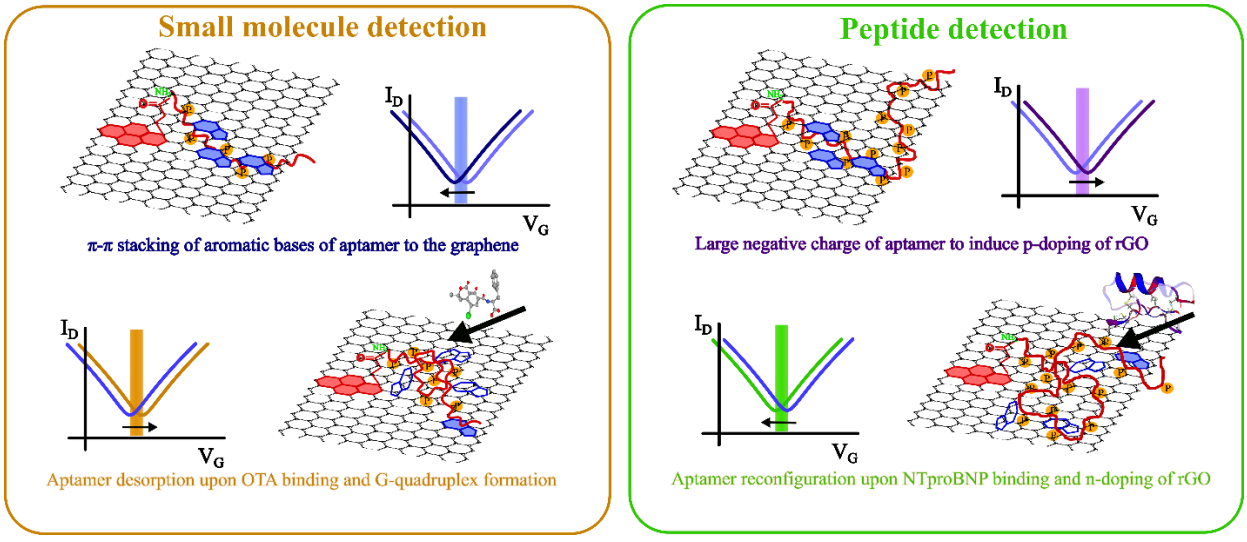

Figure 1: Principles of detection using GFET-aptamer conjugates for the detection of: A) small molecules, B) peptides