Improvement of CVD-graphene interaction with supported lipid bilayer for the application in novel electrochemical biosensors

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In our work we investigate the development of a novel electrochemical biosensor using graphene as transducer and electroactive membrane proteins as biological recognition elements. Graphene is used as transducer because of its unique properties. namely high surface area, electrical conductivity, ultra-high electron mobility, wide electrochemical potential window, low charge-transfer resistance and reduction of overvoltage. All these properties allow the enhancement of the direct electron transfer between graphene and the membrane proteins. [1,2] Membrane proteins are selected as biosensing element since they are the key factors in cell metabolism, e.g. in cell-cell interactions, signal transduction and transport of ions and nutrients. Thanks to this important function, membrane proteins are a preferred target for pharmaceuticals, with about 60% of consumed drugs addressing them. For applications in electrochemical biosensors, the main problem is related to the denaturation of membrane proteins when they get in contact with electrode surface, so they need to be embedded in a system mimicking their native environment, as the supported lipid bilayers (SLBs).

The graphene is synthesized by chemical vapour deposition (CVD) and completely characterized by scanning electron microscopy (SEM) imaging, Raman spectroscopy, X-ray photoelectron spectroscopy (XPS) and water contact angles (WCAs) measurements, both before and after peculiar graphene treatments, performed in order to improve its biocompatibility and enhance its interaction with SLBs. The graphene-SLBs interaction is investigated via electrochemical impedance spectroscopy (EIS), using an equivalent circuit for the interpretation of EIS data: its parameters are determined from the best fitting of theoretically calculated impedance plots to experimental ones.

References

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[2]   Bing, J., Biosensors and Bioelectronics, 55 (2014) 464-469
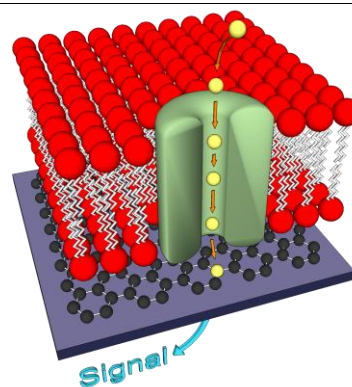
Figures

Figure 1: Scheme of the biosensor, with graphene as transducer and a membrane protein embedded in the SLB.