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Nanostructured Carbon Materials for Bioelectrochemical Applications

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Abstract:

The outstanding properties of nanostructured carbon such as carbon nanotubes or graphene made them a widely used material as electronic or electrochemical transducer in biosensor devices. Carbon nanotubes (CNTs) possess the outstanding combination of nanowire morphology, biocompatibility and electronic properties. Furthermore, their ease and well-documented organic functionalization brings new properties to nanostructured electrodes such as specific docking sites for biomolecules. Moreover, CNT films exhibit a high electroactive surface area due to the natural formation of highly porous three-dimensional networks, suitable for the anchoring of a high amount of bioreceptor units, leading consequently to improved sensitivities. Furthermore, the controlled formation of porous structures with reproducible identic morphology led to reliable high performing label free impedimetric immunosensors [1]

Since several years, monolayer graphene and related 2D carbon materials are shown as promising alternative to CNTs. However, graphene should be seen as complementary material to CNTs like the plasmonic coupling with gold surfaces in SPR biosensors [2].

Nanostructured carbon also became essential electrode materials for energy storage or harvesting. In particular, enzymatic glucose biofuel cells have gained wide attention due to the possibility to harvest energy from complex media like body fluids. Further advantages are that the biological energy production can take place at neutral pH and at room temperature by converting a wide range of sustainable (bio)-fuels. However, the main drawback for enzymatic biofuel cells are their limited power output and operational life time. One of our proposed design of bioelectrodes for enzymatic biofuel cells is based on free standing carbon nanotube pellets that allows high enzyme loading in a protective environment with satisfying stabilities [3]. Other carbon nanotube shapes like buckypapers were functionalized and tested for the energy conversion of glucose [4]. Some alternative approaches to optimize the electron transfer [5] is presented .

References:

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