Design of biofuel cells and biosensors:recent advances in electrode biomaterials

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Abstract: For four decades, the development of biointerfaces has been the subject of increasing research efforts in the field of biosensors and energy conversion. In particular, the functionalization of electrodes by biomaterials based on electrogenerated polymers and/or carbon nanotubes or graphene is widely used for the design of biosensors and biofuel cells. Recent examples of electrochemically polymerized films exhibiting affinity or covalent binding interactions towards biomolecules, will be presented for the design of enzyme electrode, labeless immunosensors, aptasensors and DNA sensor for metabolites like glucose, thrombin, bisphenol A, cocaine, or cholera toxin antibody [1,2]. Concerning carbon nanotube coatings, the latter were successfully functionalized by electropolymerization of pyrrolic monomers or via π−π stacking interactions with pyre-ne derivatives exhibiting both affinity or covalent binding interactions towards biomolecules. Various biomolecule immobilization strategies have been explored involving photografting, insertion, intercalation, π stacking or supramolecular coordination complex phenomena.
The ever-increasing depletion of fossil fuels and the need for clean methods of producing electricity have stimulated the emergence of biofuel cells that convert enzymatically chemical energy into electrical energy. Considerable attention has recently been paid to the implantation of biofuel cells in the human body with the aim to power implanted medical devices. The possibility to develop biofuel cells via the functionalization of CNT will be described and some examples of implanted biofuel cells in living animals will be briefly presented [3,4]. Recent advances in the design of bioelectrodes based on electrically wired enzymes will be reported. In particular, different strategies for achieving a controlled orientation of laccase or bilirubin oxidase on carbon nanotube-based electrodes for the direct dioxygen reduction will be presented [5]. A new generation of flexible buckypaper electrodes was produced by using copolymers containing pyrene. High performance biocathodes for direct oxygen reduction were thus constructed by immobilization of laccase on anthraquinone-modified buckypapers [6]. Hybrid biofuel cells involving O_2/H_2 or O_2/glucose system will be also described.

References:

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