Bioarchitectures based on organic polymers for energy conversion or electroanalysis

S. Cosnier
University Grenoble Alpes, CNRS, DCM, 38000, Grenoble, France

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. These nano-objects were successfully functionalized by electropolymerization of pyrrolic monomers or pyrene derivatives exhibiting affinity or covalent binding interactions towards biomolecules. Various biomolecule immobilization strategies have been explored involving photografting process, affinity and host-guest interactions. Some new approaches for developing nanostructured biomaterials based on supramolecular assemblies will be illustrated. In particular, an original versatile methodology for molecular grafting on different surfaces via a new photoactivatable diazirine derivative is reported. This pyrene-diazirine, which was electropolymerized onto various electrodes, enabled, under UV irradiation, the photografting of redox mediators and enzymes.[1] Recent examples of electropolymerized films will be presented for the design of labeless immunosensors for dengue or cholera toxin antibody. [2,3]
The need for clean methods of producing electricity has stimulated the emergence of new generation of fuel cells. A subcategory of fuel cells, biofuel cells that convert chemical energy into electrical energy by electro-enzymatic reactions, has attracted considerable attention over the last decade. [4] A vast majority of biofuel cells generates electrical energy from the enzymatic degradation of glucose and oxygen, two substrates present in physiological fluids. Thus, in parallel to the powering of portable electronic devices (mobile phone, digital music player, laptop, GPS, etc), a fascinating application concerns the implantation of biofuel cells in the human body as an autonomous source of theoretically unlimited energy.[5] Recent advances in the design of bioelectrodes based on electrically wired enzymes onto carbon nanotube coatings will be reported. In particular, the the electrosynthesis of a polypyrene-quinone film for the wiring of glucose dehydrogenase will be described. In addition, a new generation of enzyme electrodes based on flexible buckypaper was developed by using linear polynorbornene polymers containing multiple pyrene groups as crosslinker.[6] Furthermore, buckypapers based on bilirubin oxidase and FAD-dependent glucose dehydrogenase, were successfully applied to the elaboration of O_2/glucose biofuel cells providing 24.07 mW cm^{-3}.[7]
Finally, an innovative approach based on the electrical wiring of enzymes in solution by redox glyconanoparticles resulting from the self-assembly of bio-sourced block copolymers will be presented.[8] We demonstrate the self-assembly, characterization and bioelectrocatalysis of redox-active cyclodextrin-coated nanoparticles. These nanoparticles were used as electron shuttles between electrode and bilirubin oxidase providing enhanced current densities for enzymatic O_2 reduction.[9]

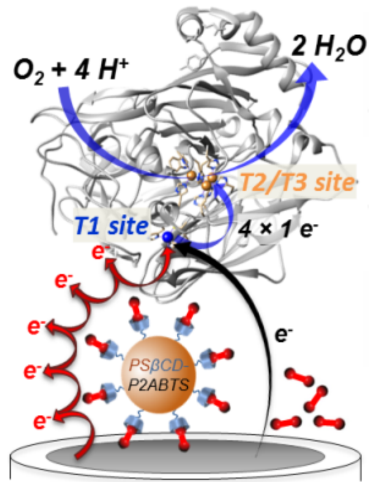

Figure 1. *Schematic representation of the intraelectron transfer chain between redox nanoparticles and bilirubin oxidase.*

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