The use of polypyrrole as a platform for different mediators in glucose/O_2 biofuel cell

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Economic and environmental factors along with the human behavior of consumption, which is still very dependent on the use of non-renewable fuels sources, increasingly force the demand for "clean" and efficient energy production processes. In this scenario, the biofuel cells are an interesting possibility to be used as battery for small portable electronics devices and biosensors, such as in vivo application as micro-pumps and pacemakers[1,2]. Despite the many improvements achieved in the past years, there still are many challenges to be faced, such as increasing the stability of biomolecules used as catalysts, and improvements in electronic transfer and consequently the output power densities[3]. Glucose/O_2 biofuel cell has been studied using glucose oxidase (GOx) as biocatalyst in the anode side. This enzyme has been widely used in electrochemistry due to its biochemical stability and electrocatalytic activity[4]. Pyrrole has good electrical conductivity, polycationic nature, and water solubility. As matrix for enzyme immobilizations, usually is used in its polymeric form. An interesting possibility employing polypyrrole in bioelectrodes preparation is to trap mediator species into the polymer net[5].

In this work, we investigate the performance of bioelectrodes for Glucose/O_2 biofuel cell using different mediators entrapped in a polypyrrole matrix, aiming to improve the electron transfer processes through the electrode surface.

GOx was anchored onto a 1 cm^2 carbon cloth, and prior to enzyme immobilization, a polypyrrole film was electropolymerized at the carbon support by applying 0.7 V vs SCE for 10 minutes, in a solution containing pyrrole and mediator (ferrocenium hexafluorophosphate (Fc), 8-hydroxyquinoline-5-sulfonic acid hydrate (HQS) or $[Os(bpy)_2PVP_{10}Cl]Cl$) in 0.1 $molL^{-1}$ sodium nitrate. After that, 50 µL of a buffer solution pH 5.0 containing GOx (275 U/ml) and PAMAM dendrimer was dropped directly onto the electropolymerized carbon cloth. The redox polymer used in this study was prepared as described earlier[6].

Fig. 1 display the representative SEM image of the carbon cloth platform containing the polypyrrole film, in which we can observe the formation of a very uniform and homogeneous film through the carbon fibers (Fig. 1).

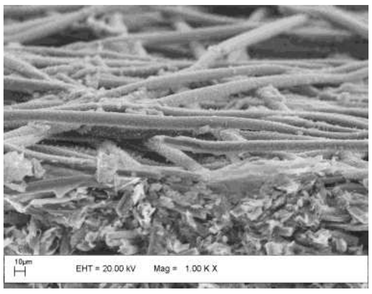

Fig 1. SEM images of polypyrrole film.

Power density measurements were accomplished in a cell consisting of two compartments. A gas diffusion membrane (ELAT) composed by platinum 20% in C (E-TEK) hot pressed in a Nafion® membrane was employed as the cathodic material. The cathodic side was kept in direct contact with air. The cell compartment (10 mL) was filled with buffer solution and 0.1 $molL^{-1}$ glucose.

Power density tests were performed with the different mediator's molecules in order to evaluated different mediators: Fc, HQS and $[Os(bpy)_2PVP_{10}Cl]Cl$ (Fig. 2).

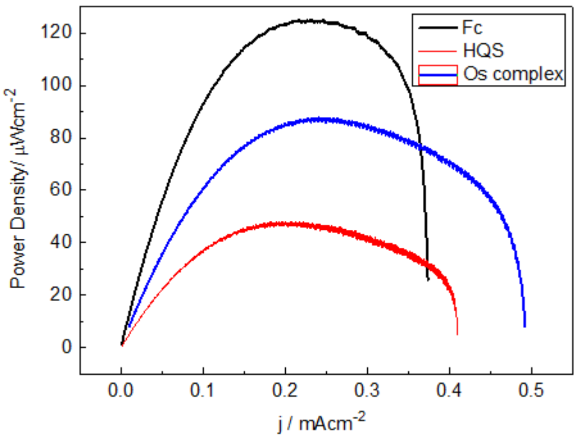

Fig. 2. Power density curves obtained with the different mediators tested.

The maximum power density obtained for Fc, HQS and $[Os(bpy)_2PVP_{10}Cl]Cl$ were about 124, 87, 47 µW respectively. The results have shown that the bioelectrode containing entrapped mediators in polypyrrole and employing PAMAM dendrimers seems to be a friendly environment for GOx immobilization; besides, the prepared bioelectrodes were able to generate power values comparable to recent literature[7,8].

Acknowledgements

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