Glucose Oxidase Enzyme Immobilized on a Nanostructured Pencil Graphite Electrode for Biosensor and Biofuel Cell Applications

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The use of ubiquitous and inexpensive materials in electrode construction is an established trend in the modern electrochemistry. For instance, paper-based materials and pencil graphite are examples of electrodes commonly used for sensing applications. Pencil graphite electrodes (PGE) can be a viable alternative to more conventional and expensive electrodes such as platinum and glassy carbon due to their negligible cost, availability, presenting also good electrical conductance properties. These advantages are more evident when disposable applications are equated. Moreover, a wide variety of sizes are commercially available enabling miniaturization of the active site and the whole PGE. Nanostructuration of PGEs can always compensate some lack of performance. Carbon-based nanomaterials not only serve as electron transfer enhancers between the electrode and analyte in solution but also they can serve as bridge or substrate for attachment of biological entities (such as enzymes) to facilitate direct electron transfer (DET). The immobilization of biological entities in these inexpensive electrodes can therefore produce miniaturized, cheap and disposable biosensors or biofuel cells. Particularly, the immobilization of glucose oxidase (GOx) for fabrication of glucose biosensors is important for the clinical field but can also be valuable for monitoring certain contaminants through an inhibitory detection principle [1]. The objective of the present work is the development and characterization of a pencil graphite bioelectrode comprising immobilized glucose oxidase (GOx) capable of achieving DET. The electrical wiring between GOx and the electrode is accomplished by using a tethering agent that binds to the enzyme via covalent amide bonds and adheres to the nanotube walls through irreversible π-π stacking with the aromatic group [2]. First, a 2 mm diameter PGE was mechanically polished, rinsed with water and further modified with single-walled carbon nanotubes (SWCNT) by dropcast and left to dry. Then the modified PGE was immersed for 2 h in a pyrene-based compound and rinsed with water. Finally, PGE was incubated overnight in GOx solution (10 mg mL^{-1}) and rinsed with water before analysis. Redox peaks obtained by cyclic voltammetry with the PGE-SWCNT-GOx biosensor in the absence of glucose proved the DET feature. Detection of glucose was performed by amperometry showing a sensitivity of about 29 µA mM^{-1} cm^{-2} and a limit of detection of 27 µM. The affinity of the bioelectrode towards glucose makes it appropriate to be used as a biosensor or a biofuel cell.

REFERENCES

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