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Perspective

Advances in Enzymatic and Non-Enzymatic Electrochemical Glucose Sensing

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DESCRIPTION

Glucose detection is essential not only in the management of diabetes and other medical conditions, but also in a range of organizations such as food and beverage. Glucose sensors were developed in the last century allowing diabetes patients to properly manage their disease and saving lives. Because first-generation glucose sensors have significant sensitivity and selectivity limits more improved techniques for both the medical and industrial sectors have been developed. Because of the wide range of applications a variety of materials and fabrication techniques have been developed to provide innovative glucose sensors with lower cost and ease of use. The development of enzymatic electrochemical sensors which commonly use glucose oxidase has been a key emphasis. Non-enzymatic techniques involving direct electrochemistry of glucose on noble metals, on the other hand, are now a realistic option in the development of glucose biosensors. The processes of electrochemical glucose sensing are discussed with many generations of enzymatic-based sensors, their recent advancements and an outline of the next generation of non-enzymatic sensors. Advances in manufacturing techniques and materials are critical in propelling the field of glucose sensing.

The most relevant group of glucose biosensors is electrochemical sensors, which include both enzymatic and non-enzymatic sensors and are mostly based on amperometric approaches. The direct electrochemical oxidation of glucose is used in non-enzymatic amperometric glucose sensors. In both enzymatic and non-enzymatic glucose biosensors materials such as conductive polymers, enzymes, carbon nanotubes, and Molecularly Imprinted Polymers have been employed (MIPs). MIPs, which are mostly utilized in optical sensing, create polymeric cross linked active sites for specific analyses. They have recently been investigated in electrochemical glucose sensing. Because of their high electro catalytic activity and sensitivity to glucose electro oxidation noble metals and their composites have been employed as electrode materials for non-enzymatic sensors.The absorption of glucose oxidation intermediates (e.g., CO) or solution active species (e.g., Cl) by non-enzymatic glucose sensors is a serious issue that might result in electrode activity being blocked for direct glucose electro-oxidation. Furthermore difficulties of electrocatalytic materials to precisely catalyze glucose oxidation, non-enzymatic amperometric glucose sensors have selectivity than enzymatic amperometric glucose.

Using Os complex as a mediator, non-covalent functionalization of Multiwall Carbon Nanotubes (MWCNTs), GOx and binding proteins, and stabilizing artificial mediators have all been proposed as ways to modify the mediators in electrode-supported enzyme films. After that GOx was entrapped in the matrix generating a polymer or enzyme film that was employed to change the surface of a sub-micrometer scale carbon electrode. By covalently attaching the GOx to the surface of the biosensor and subjecting it to a water-organic combination containing a high amount of organic solvent created a reagent less biosensor with free diffusing mediators. To ensure high electron-exchange efficiency in immobilized mediator-based biosensors, the artificial mediator must be immobilized near both the enzyme's redox centre and the electrode surface. The immobilized mediators have a limited range of motion unlike solution-based mediator biosensors is the fundamental disadvantage of enzymatic biosensors due to enzymes' inherent nature.

Enzymatic-based glucose biosensors appear to be the optimum model for glucose biosensing. However, many challenges limit their effectiveness, such as short operational lifetimes, temperature, and pH range, forcing the employment of more advanced materials and fabrication procedures. Noble and transition metal nanoparticles, carbon nanotubes, graphene, and nanostructured metal oxides are currently the most frequently used materials, and several approaches have been investigated, including the use of semi-permeable coatings, conductive polymers, and metal-based mediators. More research is needed to increase the selectivity and stability of these sensors, as well as novel fabrication processes to enable for miniaturization.

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