Preparation of Enzyme-Immobilized Biosensor by the Combination of Electrodeposition and Electropolymerization

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Management of blood glucose level is of significant importance to prevent serious diabetes complications. Therefore, the recognition of blood glucose level is essential for daily effective treatments and the use of implantable glucose sensor for continuous glucose monitoring (CGM) is getting popular, since it may reduce numbers of stressful self-monitoring of blood glucose (SMBG). However, the size of the sensor chip for CGM in the market is still big and miniaturization of sensors chip is highly demanded, since it lower the physical and mental burden of diabetes patients. Although, several processes are requested for the fabrication of implantable sensor, the immobilization of enzyme play a big role to the quality of the sensor, since enzyme is the center of glucose recognition. Conventional methods of enzyme immobilization are covalent attachment,cross-linking, hydrogel entrapment, electropolymerized polymer entrapment, and the combination of two or more methods. Among the variety of procedure for the immobilization of enzyme, electropolymerized polymer entrapment is interesting, since the enzyme will be immobilized just at the position where the electricity was passed. Similar to this procedure, Matsumoto et al reported that the layer of enzyme can be formed on the electrode by applying a potential of 1.3 V (vs Ag/AgCl) in the enzyme solution containing a nonionic surfactant such as Triton X-100. Since the obtained enzyme layer was not stable, they formed a electropolymerized polyphenol film in order to improve the stability, which also functioned as a permselective film to eliminate the influence of electroactive species excite in the biological fluid such as ascorbic and uric acids.

We consider that this electrodeposition/electropolymerization procedure is significantly interesting and differ with common electropolymerization procedure since the amount of electrochemically produced polymer is low and the thickness of enzyme layer will be significantly thin. This may lead to a sensor with high sensor sensitivity and fast response. In this study, electropolymerizable compounds, such as phenylenediamine, pyrrole and its derivatives, were applied instead of phenol and the enzyme immobilized electrode was prepared. Glucose oxidase was selected as the enzyme and the glucose sensor properties was investigated. As a result, the glucose sensor prepared using phenylenediamine showed good sensitivity with neglectable influence of electroactive ascorbic acid and uric acid. Overall, we consider that the sensor obtained from phenylenediamine is superior than that from phenol.

1. N. Matsumoto, X. Chen and G. S. Wilson, Anal Chem, 74, 368 (2002).