Sol-gel derived V2O5-Pyrrole-GOD nanohybrid for amperometric biosensor applications

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Abstract

Development of a high-performance biosensor for an accurate and simple analysis of glucose concentration has emerged as a hot issue in biosensor field with the increase in the incidence of diabetes. Although polymer-enzyme system has been mostly studied this system shows short-term stability due to swelling of polymer and poor immobilization of enzyme. By introduction of an inorganic component into this system this problem can be resolved and also porosity can be controlled. Sol-gel process is the most attractive way for hybridization of the polymer and inorganic components and it is suitable for biosensor fabrication due to its mild chemistry. In this study glucose oxidase (GOD) was entrapped in V2O5-Pyrrole hybrid as a conducting matrix and electropolymerization was performed to construct enzyme electrodes. The composition of vanadium penoxide, pyrrole, and glucose oxidase in the electrodes was varied to obtain both optimum processing and operating conditions for the biosensor applications. Also, the molecular weight of pyrrole was changed to control the interlamellar distance of V2O5 and thus the overall molecular structure of V2O5-Pyrrole-GOD. Scanning electron microscopy (SEM) images on the biosensors show that glucose oxidase was evenly distributed in the V2O5-Pyrrole matrix. Also, transmission electron microscopy (TEM) revealed the lamellar and intercalated structures of V2O5-Pyrrole systems. The optimum operating conditions for temperature and pH were selected for this system. This biosensor showed much improved long-term stability, sensitivity, and reproducibility compared to polymer-enzyme systems. Another major advantage of using this V2O5-Pyrrole-GOD sensor lies in the possibility of the fabrication of microelectrodes using electropolymerization due to the conductivity of V2O5-Pyrrole matrix.