Development of glucose biosensor based on ZnO nanoparticles film and glucose oxidase-immobilized eggshell membrane

Abstract

A novel electrochemical glucose biosensor was developed by depositing an ionic liquid (IL) (e.g., 1-ethyl-3-methylimidazolium trifluoromethanesulfonate; [EMIM][Otf]), ZnO nanoparticles (ZnONPs) and eggshell membrane (ESM) on a modified glassy carbon electrode (GCE) for determination of glucose. Glucose oxidase (GOx) was covalently immobilized on eggshell membrane with glutaraldehyde as a cross-linker. Methylene blue was used as a redox indicator to enhance the electron transfer capacity and to ensure stability of both the oxidized and reduced forms in the reaction of enzyme and substrate. The morphological characteristics of microstructures eggshell membranes, chitosan, GOx/ESM, GOx/ZnONPs/IL/ESM and GOx/ZnONPs-IL/CHIT were observed using scanning electron microscopy (SEM). The effects of scan rate, time and pH on the response of glucose biosensors were studied in detail. Under optimal conditions (pH 6.5, 50 s), cyclic voltammetry showed different glucose concentrations on the range of $1 \times 10{-}12$ to 0.6 M, with a detection limit of $1 \times 10{-}13$ M. The GOx/ZnONPs/IL/ESM was found to be more sensitive as compared to GOx/ZnONPs-IL/CHIT. This developed glucose biosensor detection approach has several advantages such as fast, simple and convenient method, sensitivity, low cost, eco-friendly, low concentrations and remarkable catalytic activities of current signals during glucose reaction.