

Electrochemical Characterization of Glucose Oxidase Immobilized in Intrinsically Conducting Polymers: Polyaniline vs. Self-Doped and Substituted Polyaniline

Elektrohemijska karakterizacija glukoza-oksidade imobilisane u elektroprovodnim polimerima poređenje polianilina sa samodopovanim i substituisanim polianilinom

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Abstract

This study investigates the electrochemical behaviour of glucose oxidase (GOx) immobilized in: polyaniline (PANI), self-doped polyaniline (SD-PANI), and poly(o-toluidine) (POT), a substituted aniline derivative. All polymeric materials were synthesized electrochemically via galvanostatic polymerization on graphite electrodes. SD-PANI was obtained by copolymerizing aniline with meta-aminobenzoic acid, introducing internal proton-donating groups to enhance conductivity and enzyme compatibility. The presence of –OH groups increases the hydrophilicity of the polymer, facilitating interactions with aqueous solutions and biological molecules such as enzymes, thereby improving immobilization efficiency. GOx was immobilized by cross-linking via glutaraldehyde. Amperometric measurements in the presence of glucose were used to evaluate the bioelectrocatalytic response. Michaelis-Menten kinetic parameters — the apparent Michaelis constant (K_m) and maximum current response (I_{max}) — were extracted from steady-state current responses using the Lineweaver-Burk method. Although the most favorable kinetic parameters were obtained for PANI, followed by POT and SD-PANI, the highest storage stability of GOx was observed with SD-PANI due to its conductivity in neutral media. These findings highlight the influence of polymer structure and functionalization on enzymatic activity and biosensor efficiency.

Keywords: polyaniline; self-doped polyaniline; poly(o-toluidine); enzyme immobilization; Michaelis-Menten kinetics

Izvod

U ovom radu ispitivano je elektrohemijsko ponašanje glukoza oksidaze (GOx) imobilisane u elektroprovodnim polimerima: polianilinu (PANI), samodopovanim polianilinom (SD-PANI) i poli(o-toluidinu) (POT), koji su dobijeni elektrohemijskom sintezom na grafitnoj elektrodi u galvanostatskim uslovima. Imobilizacija enzima u elektrodnim materijalima izvršena je umrežavanjem glutaraldehidom. SD-PANI je izabran zbog provodljivosti u neutralnoj sredini, dok –OH grupe u POT-u povećavaju hidrofilitnost i olakšavaju interakciju sa enzimima. Amperometrijska merenja u prisustvu glukoze korišćena su za određivanje parametara enzimske kinetike primenom Lineweaver-Burk metode. Najpovoljniji kinetički parametri dobijeni su za PANI, dok je SD-PANI pokazao najveću stabilnost u neutralnoj sredini. Rezultati ukazuju na značaj strukture i funkcionalizacije polimera u efikasnosti elektrohemijskih biosenzora.

Ključne reči: polianilin; samodopovani polianilin; poli(o-toluidin); imobilizacij; Mihaelis-Mentenova kinetika