

Electrochemical Sensor Array for Glucose Monitoring Fabricated by Rapid Immobilization of Active Glucose Oxidase within Photochemically Polymerized Hydrogels

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Abstract

Background:

Currently, monitoring blood glucose levels for diabetic patients is invasive and painful, involving pricking the finger to obtain a blood sample three to four times daily. The need for frequent tests and pain involved with testing leads to poor compliance. In order to raise compliance, we propose to create an implantable electrochemical sensor array that would monitor glucose levels continuously.

Methods:

Glucose sensor arrays were fabricated on gold electrodes on flexible polyimide sheets by photopolymerization of the biocompatible polymer poly(ethylene glycol) diacrylate (PEG-DA) to develop hydrogels and encapsulate the sensing elements. Using conventional silicon fabrication methods, arrays of five gold microdisk electrodes were fabricated using lift-off photolithography and sputtering techniques. A redox polymer was then attached electrostatically to the electrode, and glucose oxidase was entrapped inside the hydrogel on the array of electrodes by ultraviolet-initiated photopolymerization of PEG-DA.

Results:

When the array of fabricated sensors was sampled together the elements behaved like one large electrode with peak current equivalent to the sum of individual array elements. The enzyme, glucose oxidase, catalyzed the oxidation of glucose and then exchanged electrons with the redox polymer in the hydrogel. The entrapped glucose oxidase was found to respond linearly to increasing glucose concentrations (0–360 mg/dl), as determined using cyclic voltammetry.

Conclusion:

The fabricated microarray sensors were individually addressable and showed no cross talk between adjacent array elements as assessed using cyclic voltammetry. We have fabricated an array of glucose sensors on flexible polyimide sheets that exhibits the desired linear response in the biological range.

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Abbreviations: (bpy) 2,2'-dipyridyl, (DMF) *N,N*-dimethylformamide, (FAD) flavin adenine dinucleotide, (GOX) glucose oxidase, (HCl) hydrochloric acid, (MUA) 11-mercaptopundecanoic acid, (Os(bpy)₂Cl₂) osmium(bipyridine)₂ dichloride, (PEG-DA) poly(ethylene glycol) diacrylate, (PF₆⁻) hexafluorophosphate, (POs-EA) poly[vinyl pyridine osmium (bipyridine)₂chloride]-coethylamine, (UV) ultraviolet

Keywords: biocompatible, cyclic voltammetry, glucose sensor, microarray

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