Optical Sensors for Biotechnology and Food Industry

Maixnerová, Lucie
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Student: Mgr. Lucie Maixnerová
Supervisor: Ing. Gabriela Kuncová, CSc.

A surveillance of quality and freshness of food as well as regulation of biotechnological process require cheap and fast, online monitoring techniques for a determination of biologically active substances such as biogenic amines, glucose, cholesterol, alcohols, etc.

A biosensor is an analytical device, used for the detection of an analyte that combines a biological component with a physicochemical detector [1].

In my work I focus on optimization of preparation, mathematical description and determination of long-term stability of a sensitive layer (SL) of the enzymatic sensor with optical oxygen transducer for a determination of biogenic amines and glucose.

The biological part of the SL was the immobilized diamine oxidase. This enzyme catalyzes oxidative deamination of biogenic amines, resp. glucose oxidase, which catalyzes the oxidation of glucose. The optical transducer was a ruthenium complex. Fluorescence of this complex is quenched proportionally with oxygen concentration. Sacharose was added as a porogen all components were encapsulated in a UV-curable inorganic-organic polymer Ormocer®. Various SLs were prepared differing in composition and UV-curing time.

The analytical characteristics of SL for the detection of biogenic amine, putrescine, were dependent on oxygen concentration. Sensitivity (S) varied from 0.70 to 6.87 μs.l.mmol^{-1}, the limit of detection (LD) varied from 0.01 to 0.43 mmol.l^{-1}, the limit of quantification (LQ) varied from 0.04 to 1.43 mmol.l^{-1} and linear dynamic range (LDR) varied from 0–0.10 to 0–1.75 mmol^{-1}.

Glucose SL performed S varied from 0.19 to 0.41 μs.l.mmol^{-1}, LD varied from 0.15 to 0.30 mmol.l^{-1}, LQ varied from 0.50 to 1.00 mmol.l^{-1} and LDR varied from 0–1.50 to 0–3.50 mmol.l^{-1}. The analytical characteristics were dependent on SL thickness and UV-curing.

A mathematical model of reaction-transport processes inside the SL was proposed, which revealed qualitative dependencies of the biosensor behavior (S, LD, LQ, LDR and response time) on the thickness of

the SL, concentrations of substrates in the solution, enzyme activity and SL permeability.

Analytical characteristics of SL, both glucose and putrescine, were repeatedly checked during two years (putrescine) and three month (glucose). Within this periods S, LD, LQ, and LDR fluctuated with a relative standard deviation in the range from 5% to 9%.

References

1. Turner, Anthony; Wilson, George and Kaube, Isao (1987). *Biosensors: Fundamentals and Applications*. Oxford, UK: Oxford University Press. p. 770. ISBN 0198547242.