AN AMPEROMETRIC GLUCOSE SENSOR WITH COMBINED ENZYME LAYERS

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SUMMARY

An amperometric needle-type glucose sensor (1) consisting of a silver tube (cathode) and a platinum wire (anode) was developed. The sensor was provided with two enzyme layers (glucose oxidase (GOD) in cellulose acetate, catalase). The destructive influence of H_2O_2 generated in the GOD layer could be minimized and the oxygen dependence of the analytical signal was improved.

1. INTRODUCTION

Common enzymatic glucose sensors based on GOD do not work for a long time because of enzyme inactivation. The amperometrically detected species H_2O_2 formed within the GOD layer according to equation 1

$$\text{glucose} + H_2O + O_2 \xrightarrow{\text{GOD}} \text{gluconic acid} + H_2O_2 \qquad (1)$$

contributes to the destruction of the enzyme. If the H_2O_2 is removed faster from the GOD layer by an additional catalase layer, the lifetime of the sensor and the oxygen dependence of the sensor output can be improved. Both enzyme layers are coated with a polyurethane membrane.

(1) Shichiri, M.; Kawamori, R.; Goriya, Y.; Yamasaki, Y.; Nomura, M.; Hakui, N.; Abe, H.; Diabetologica 24: 179 - 184 (1983).

2. RESULTS

2.1. CALIBRATION PLOTS

Linear calibration plots for glucose concentrations from 0 - 700 mg/dl are obtained for the catalase supplied sensor (sensor 1) as well as for the reference sensor without catalase (sensor 2) (curves 1 and 2 in Fig. 1).
The calibration plots of sensor 2 lose their linearity in the course of time while the other sensor's calibration plots remain linear (curves 3 and 4 in Fig. 1).

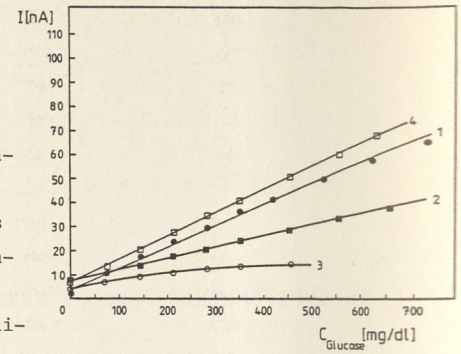

Fig. 1: Calibration plots. Curve 1: Sensor 2 (new). Curve 2: Sensor 1 (new). Curve 3: Sensor 2 (after 24 days). Curve 4: Sensor 1 (after 28 days).

2.2. LIFETIME

The slopes of the calibration plots of both sensors increase during the first days of use (hydrolysis of the polyurethane membrane). The slopes of the calibration plots of sensor 1 stabilize while the slopes of the calibration plots of sensor 2 decrease (enzyme inactivation) (Fig. 2).

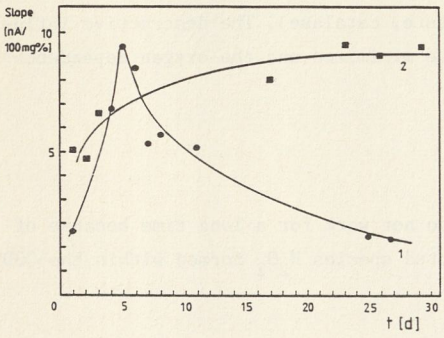

Fig. 2: Slopes of the calibration plots. Curve 1: Sensor 2. Curve 2: Sensor 1.

2.3. OXYGEN DEPENDENCE

The limiting influence of the oxygen concentration in the sample (eq. 1) occurs at smaller O_2 contents when sensor 2 is used (2 mg/l instead of 4 mg/l, Fig. 2). The H_2O_2 diffusing into the catalase layer is transformed into H_2O and O_2. So the O_2 concentration in the vicinity of the GOD layer is enhanced. The signal generating H_2O_2 is used as an additional O_2-reservoir without being totally destroyed, so as if the catalase was coimmobilized directly within the GOD layer.