POTENTIOMETRIC GLUCOSE SENSOR

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SUMMARY

Potentiometric pH-sensors based on ion selective field effect transistors (ISFETs) were tested for use as glucose sensors with the enzyme glucose oxidase (GOD). The thickness of the membrane covering the sensor did not affect the calibration curve.

1. INTRODUCTION

Sensors which can continuously measure the blood glucose level in patients suffering from diabetes mellitus could become an important part of an artificial pancreas. Present available amperometric sensors can be used only a short period of time because of deposits occurring on the sensor surface. These deposits cause a change of the sensor output (calibration problems!). Potentiometric sensors based on ISFETs offer some advantages.

2. EXPERIMENTAL

The experimental set-up consists of 2 pH-ISFETs (constant charge mode) (Fig. 1). One ISFET is covered with a membrane containing GOD so that the reaction

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

can take place.

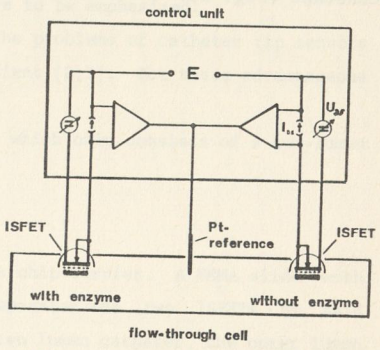

Fig. 1: Measuring cell with pH-ISFETs.

The formation of gluconic acid causes a local change of pH which can be measured with the pH-ISFET. The second ISFET is used as a reference.

3. RESULTS

3.1. CALIBRATION PLOTS

The signal of the sensor varies linearly with the concentration of glucose in the lower concentration range.
The enzyme reaction depends on the oxygen content of the sample (eq. 1). If highly permeable membranes are used the dynamic range of the signal is limited by the oxygen available in the measuring solution. Membranes with low permeability (PVC) can be used for high concentrations of glucose nearly without oxygen influence (Fig. 2).
Coimmobilization of catalase causes a threefold extension of the linear calibration range.

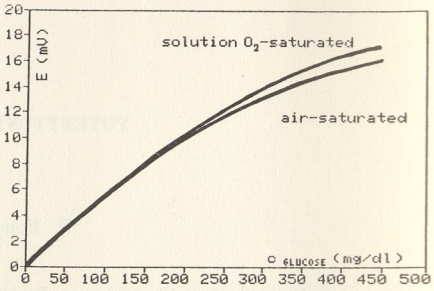

Fig. 2: Calibration plots with PVC-encapsulated GOD at different O_2 concentrations.

3.2. INFLUENCE OF THE MEMBRANE THICKNESS

Amperometric as well as potentiometric sensors were constructed with different membrane thicknesses for comparison.
The slopes of the calibration plots of the amperometric sensor decrease with increasing membrane thickness while the slopes of the potentiometric sensor's calibration plots remain constant (Fig. 3).

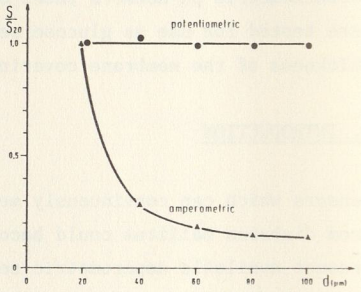

Fig. 3: Signal of the sensor and membrane thickness. The slopes of the calibration plots are standardized on 20 µm membrane thickness.