Long term stability of GOD sensor

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INTRODUCTION

Glucose sensors are delivered, in standard conditions, in dry state. It enables their storability up to several years. The stability of enzyme in wet conditions is significantly lower. On the other hand the buffer or dialysate prefilled calibrated sensor is immediately prepared for use. The dry glucose sensor needs to stabilize its response
1 – 5 hours in normal conditions. The prefilled and calibrated glucose sensor brings significant advantage - immediate use - which is only limited by its lifetime. The verification of the function and stability of prefilled glucose sensor "in vitro" is described in this poster.

EXPERIMENT AND METHOD

The glucose sensor performance was studied in FIA (Flow Injection Analysis) arrangement at flow rate 10 µL/min. Basic solution was phosphate buffer pH 7. Eight sensors AC1-GOD in FC2-TL (thin layer hydrodynamics arrangement) were measured. Glucose sensors were also tested for long term stability under continuous glucose load. Each sensor was calibrated (1 measurement) then it was used 72 hours in a clinical study on patients and then it was measured until exhausting of enzymatic activity each week. The sensors were stored in refrigerator
at 8°C.
The calibration curve was approximated by power function $y = a*x^b$ (fig.1). The magnitude of response and area under response curve were analyzed. Both values were corrected for background current.
Long term stability of parameters a, b was measured from 1/2014 till 5/2014.
The sensor stability was also tested under continuous and intermittent (2 hours load, 2 hours buffer) glucose load (3mM). Continuous glucose load (5mM) was used to evaluate the time which is needed for signal change of 2 %. It enables the estimation calibrations frequency for signal stability 2 %. Stability at other calibration frequencies was obtained by linear extrapolation.

RESULTS AND DISCUSSION

The typical glucose sensor calibration curve (dependence of current on concentrations) is in fig.1.
Dependence of parameter a of calibration curve on time is in fig.2. The parameters decrease is faster at cells No. 17, 19. As it was identified significant difference between response "in vitro" and "in vivo" the sensors 19 and 23 were used 2 times "in vivo" (144 hours at catheter output). No significant change of sensor "in vitro" characteristics was observed. However the sensor readings are approx 10 times lower 1 hour after end of "in vivo" study. Then their characteristics are still slightly improving with time. (See fig. 3 - the red lines highlight the time, when the sensor was used on patient (7.3. - 10.3.2014, 21.3. - 24.3.2014).)
Fig. 4 shows 24 hour sensor current profile at intermittent glucose load (3mM). The sensor was used for 14 days in this regime. Signal stability at glucose load (3mM) is analyzed in Fig.5. The stability
is expressed as time of 2 % signal change. The fluctuations were caused by air bubbles which destabilized the signal.

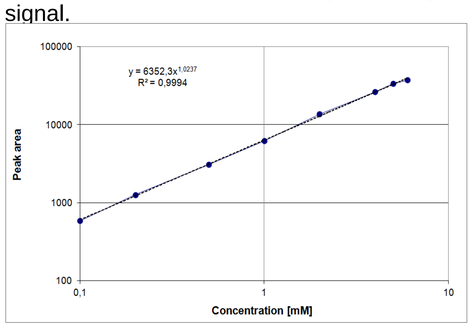

Fig. 1. Typical glucose calibration curve (dependence of current on concentrations).

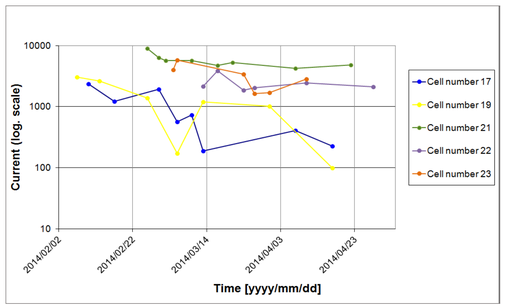

Fig. 2. Dependence of parameter a of calibration curve on time.

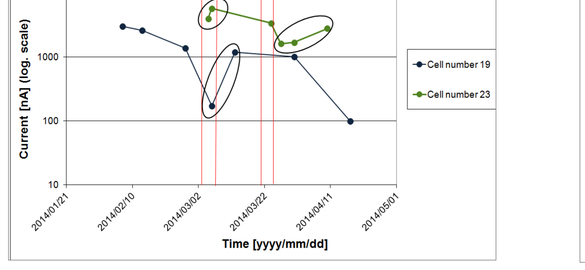

Fig. 3 . Dependence of parameter a of calibration curve on time, cell n.19, 23.

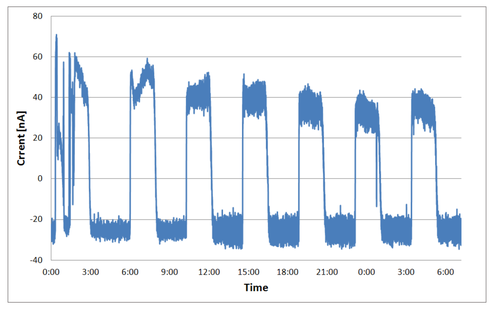

Fig. 4 . The measurement of long-term stability GOD sensor with 3mM glucose solution.

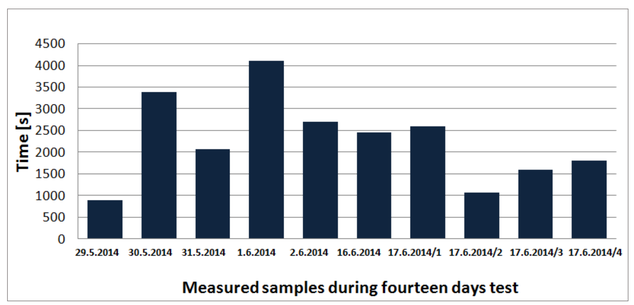

Fig. 5 . Graph of time required for a signal change of 2 %.

CONCLUSIONS

1. Dialysate solution prefilled and calibrated glucose sensors can be used and stored at least 3 months. (expiration > 3 months)
2. Sensors exhibit sufficient stability during 14 days (216 hours of continuous use in glucose solution 5mM)
3. Mean signal decrease is 2 %/hour. Under 5 mM of continuous glucose load.
4. The glucose measurement with precision 1% needs the calibration each hour at least. The glucose measurement with precision 10% needs the calibration at least each 10 hours.
5. The sensor signal decreases approximately 10 times after 4 months of measurement. The signal is however still sufficient to use the sensor after its calibration.
6. The prefilled and precalibrated sensors can be immediately used. They give the acceptable results in 10 minutes after introduction of the microdialysis catheter in the vein.

ACKNOWLEDGEMENT

This work was supported by Probe Scientific Ltd.

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