Glucose Sensors on Demand

D. Migliorelli, R. Junuzovic, L. Mühlebach, M. Dias Figueiredo Nogueira, S. Generelli

Since several years there is a clear trend towards disposable sensing technology for different applications. Especially in the medical field there is an extraordinary need and demand from the diabetic community, since blood glucose measurement for the management of diabetes comprises approximately 85% of the world market for biosensors. The same trend can be observed in biotech applications: with the increasing adoption of disposable bioreactors the demand for components for on-line control of such disposable bioreactors increased as well.

Despite the many technological advances in biosensor research and development and the introduction of many different products, glucose biosensors still account for approximately 85% of the current world market for biosensors [1]. The reasons why the glucose market was particularly receptive to the introduction of biosensors are numerous, but the single greatest factor was the prevalence of diabetes in developed nations. Electrochemical biosensors (Figure 1), with their ability to give a rapid, accurate answer using a disposable strip, with no possibility of instrument contamination, have dominated the market in the last years.

Figure 1: Glucose sensor strip [1].

The same type of sensors found more recently an application in the field of bioprocess optimization and control. A clear trend towards disposable technology in this field (Figure 2) lead to the increasing demand of on-line measuring devices, for measuring not only pH and dissolved oxygen (DO2) but also glucose, lactate, CO_2 and other parameters. The relative lack of single-use sensors in the market is limiting the adoption of this single-use technologies.

Figure 2: Biosensor integrated in a single use bioreactor [2].

In order to be in line with the very different specifications these applications require, it is necessary to have a technology for the fabrication of glucose sensors with a linear range that can be modulated depending on the target application. Indeed, blood glucose analysis, both point of care and and implanted, need a linear range between 1 mM–30 mM, whereas a much more sensitive range is required for the bioreactor monitoring, which can be between 1 µM–5 mM.

In order to respond to this request, our laboratory developed a method, using the screen printed technology, based on the modification of the polymeric enzymatic membrane, in order to manipulate the linear range of the glucose sensors.

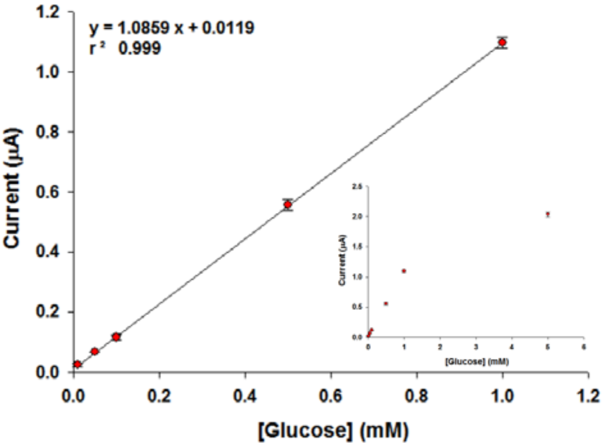

Figure 3: An example of glucose sensor calibration presenting a linear response in the lower concentration range 5 µM–1 mM. Glucose calibration curve in phosphate buffer 0.05 M + KCl 0.1 M pH 7.4.

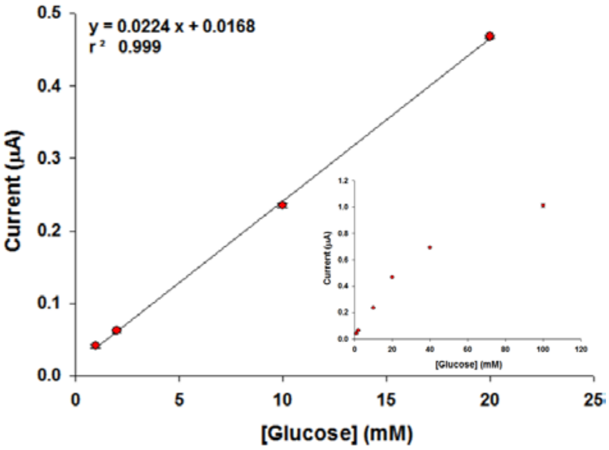

Figure 4: An example of glucose sensor calibration presenting a linear range in the higher concentration range 1 mM–20 mM. Glucose calibration curve in phosphate buffer 0.05 M + KCl 0.1 M pH 7.4

As it is showed in the graphics above (Figures 3 and 4), it is possible to obtain either a high sensitive glucose sensors with a linear range between 5 µM–1 mM (Figure 3), suitable for applications where low detection limit for glucose is required, or less sensitive glucose sensor, but able to recognize glucose concentrations up to 100 mM, with a linear range between 1 mM–20 mM (Figure 4), applicable for blood glucose analysis.

[1] A. P.F. Turner, Chem. Soc. Rev., 2013, 42, 3184.

[2] www.tvc.utah.edu/2015annualreport/applied_biosensors.php