# MINIATURIZED GLUCOSE BIOSENSOR BASED ON LOCALIZED ELECTROCHEMICAL IMPEDANCE SPECTROSCOPY

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Electrochemical impedance spectroscopy is successfully applied in biosensors, where the recognition element (enzymes or cells) is immobilized directly on the electrode [1]. The reaction products diffuse into the solution and have to be registered by the electrode, but it is blocked by the recognition element itself. Using localized impedance spectroscopy, the recognition element and the recording electrode are at a certain distance from each other, which allows the reaction products to be recorded. Localized impedance spectroscopy is performed in tandem with scanning electrochemical microscopy (SECM), using ultramicroelectrode.

To evaluate immobilization efficiency and activity of glucose oxidase, SECM and localized impedance were employed. This method was chosen as non-destructive, an operator can choose the precise location and measurements can be performed in the optimal medium [2]. Also, changes in electrochemical activity can be recorded in real time. SECM can be combined with electrochemical impedance spectroscopy (SEIM), which showed great results for the characterization of a glucose oxidase based detection of glucose [3]. SEIM can be used to obtain more advanced mapping of the electrochemical system and the results can be visualized by plotting one of the calculated parameters, e.g. charge transfer resistance or double-layer capacitance as a function of 3D coordinates [4].

During research different glucose oxidase surface concentration were immobilized on the dielectric surface. Using SEIM method the lowest detectable amount of enzyme was found. Obtained results show suitability of localized electrochemical impedance spectroscopy for the development of miniaturized glucose biosensor.

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[1] N. Bhalla, P. Jolly, N. Formisano, and P. Estrela, "Introduction to biosensors," *Essays Biochem.*, vol. 60, no. 1, pp. 1–8, 2016.

[2] M. M. N. Zhang, Y. T. Long, and Z. Ding, "Filming a live cell by scanning electrochemical microscopy: Label-free imaging of the dynamic morphology in real time," *Chem. Cent. J.*, vol. 6, no. 1, pp. 1–6, 2012.

[3] I. Morkvenaite-Vilkonciene, P. Genys, A. Ramanaviciene, and A. Ramanavicius, "Scanning electrochemical impedance microscopy for investigation of glucose oxidase catalyzed reaction," *Colloids Surfaces B Biointerfaces*, vol. 126, pp. 598–602, 2015.

[4] I. Morkvenaite-Vilkonciene, A. Valiūnienė, J. Petroniene, and A. Ramanavicius, "Hybrid system based on fast Fourier transform electrochemical impedance spectroscopy combined with scanning electrochemical microscopy," *Electrochem. commun.*, vol. 83, pp. 110–112, 2017.