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SYMPOSIUM

Flexible Three-Dimensional Electrochemical Glucose Sensor with Improved Sensitivity Realized in Hybrid Polymer Microelectromechanical Systems Technique

Jasbir N. Patel, M.E.Sc.,[1] Bonnie L. Gray, Ph.D.,[1] Bozena Kaminska, Ph.D.,[1] and Byron D. Gates, Ph.D.[2]

Abstract

Background:

Continuous glucose monitoring for patients with diabetes is of paramount importance to avoid severe health conditions resulting from hypoglycemia or hyperglycemia. Most available methods require an invasive setup and a health care professional. Handheld devices available on the market also require finger pricking for every measurement and do not provide continuous monitoring. Hence, continuous glucose monitoring from human tears using a glucose sensor embedded in a contact lens has been considered as a suitable option. However, the glucose concentration in human tears is very low in comparison with the blood glucose level (1/10–1/40 concentration). We propose a sensor that solves the sensitivity problem in a new way, is flexible, and is constructed onto the oxygen permeable contact lens material.

Methods:

To achieve such sensitivity while maintaining a small sensor footprint suitable for placement in a contact lens, we increased the active electrode area by using three-dimensional (3-D) electrode micropatterning. Fully flexible 3-D electrodes were realized utilizing ordered arrays of pillars with different shapes and heights.

Results:

We successfully fabricated square and cylindrical pillars with different height (50, 100, and 200 μm) and uniform metal coverage to realize sensor electrodes. The increased surface area produces high amperometric current that increases sensor sensitivity up to 300% using 200 μm tall square pillars. The sensitivity improvement closely follows the improvement in the surface area of the electrode.

Conclusions:

The proposed flexible glucose sensors with 3-D microstructure electrodes are more sensitive to lower glucose concentrations and generate higher current signal than conventional glucose sensors.

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Author Affiliations: [1]School of Engineering Science, Simon Fraser University, Burnaby, British Columbia, Canada; and [2]Department of Chemistry, Simon Fraser University, Burnaby, British Columbia, Canada

Abbreviations: (Ag/AgCl) silver/silver chloride, (3-D) three-dimensional, (GOx) glucose oxidase, (PDMS) poly dimethylsiloxane

Keywords: 3-dimensional electrodes, flexible electrodes, glucose sensor, pillar electrodes

Corresponding Author: Jasbir N. Patel, School of Engineering Science, Simon Fraser University, 8888 University Dr., Burnaby, BC V5A 1S6, Canada; email address *jpatel@sfu.ca*