

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

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### 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  $\mu\text{m}$ ) 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  $\mu\text{m}$  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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**Abbreviations:** (Ag/AgCl) silver/silver chloride, (3-D) three-dimensional, (GOx) glucose oxidase, (PDMS) poly dimethylsiloxane

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