

# A Textile Electrochemical Sensor based on Ag Coated Fibers

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## Summary:

A textile electrochemical sensor based on Ag coated embroidered fibers is presented to determine glucose concentration. The sensor design consists of 3-electrodes with different shapes and length. This design permits to perform a cyclic voltametric test with the sensor to observe the electrical properties changes produced by dropping of different glucose solutions. The increase of the current measured between the sensor electrodes provides enough information to identify the increase of the glucose concentration along the solutions.

**Keywords:** embroidered, textile, chemical, sensor, flexible

## Background, Motivation an Objective

Electrochemical sensors have been one of the main challenges for the researchers who work integrating sensors over flexible substrates [1], [2], [3]. The electrochemical sensors integrated over substrates as textiles or clothes could provide the users a wide possibility of health care control applications.

Glucose is one of the main health parameters where the interest has been focused over the last years. The importance to control the concentration of glucose in blood/sweat is high to prevent hypoglycemia or hyperglycemia from diabetic people. Textile technologies have proved the possibility to integrate or built electrochemical sensor to measure the glucose concentration [4], [5]. To do it, some chemical treatments over the yarns need to be done to obtain the appropriate sensitivity. Chemical coatings or enzymatic treatments are performed over conventional yarns to obtain sensitive sensors to glucose or other chemical substances.

In this work, a textile embroidered electrochemical sensor has been designed to detect different concentrations of chemical substances. The sensor has been built using commercially available silver (Ag) conductive yarns without additional chemical or enzymatic treatments.

## Description of the New Sensor and Experimental

The embroidered electrochemical sensor has been built following a 3-electrode sensor design

where the longest electrode is the counter electrode (CE) the center electrode is the working electrode (WE) and the right electrode is the reference electrode (RE). Figure 1 shows the embroidered electrochemical sensor.



*Fig 1. Embroidered electrochemical sensor with 3 electrodes. From Left to Right: CE, WE and RE electrodes.*

To embroider the sensor a commercially silver conductive yarn, produced by Shieldex company[6], is used. The yarn has been made by coating with pure silver a polyamide multifilament yarn. Neither chemical treatment nor enzymatic treatment are applied to any of the electrodes to provide sensitivity to any chemical substance. The embroidered sensor is characterized with a Keithley Source Measurement unit SMU2636B (SMU). The process conducted to perform a cyclic voltammetry follows by: First the CE and WE electrodes are connected to the feed channel of the SMU and WE and RE to the measurement channel. Secondly, the cyclic voltammetry values are defined as the feed tension between -200 to 200 mV and scan rate 50mV/s.

To conclude a drop of the glucose solution sample is poured on the sensor and the test is conducted. The SMU obtain the current of both channels and the voltage generated on measurement channel.

To test the response of the sensor, four glucose solutions are prepared. The glucose concentrations present in the solutions are 90, 180, 1800 and 3600mg/dL, respectively.

## Results

Sensor values are obtained performing a cyclic voltammetry with different glucose concentrations. To be more accurate with the results, four different embroidered sensors are prepared. Figure 2 shows the cyclic voltammetry graph of the sensors for each glucose concentration solution.

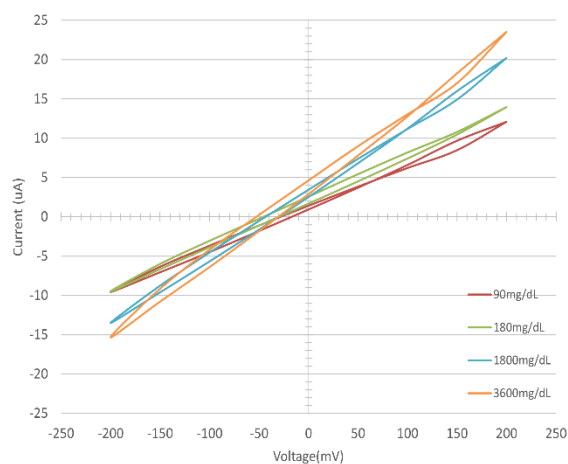


Fig 2. Cyclic voltammetry for the different glucose solutions.

It is observed how the increment in positive side voltage of the cyclic voltammetry values follows the increase of the glucose concentration over the solutions. The tendency observed demonstrates how the current values increases for the concentration increase on the sample solutions. The cyclic voltammetry shows a thin shape along the voltage swept due to the absence of chemical and enzymatic treatments to increase the sensitivity. Meaning that oxidation and reduction values during the cycle are very similar. Figure 3 shows one of the tension feeds points where the glucose effect on the sensor can be observed.

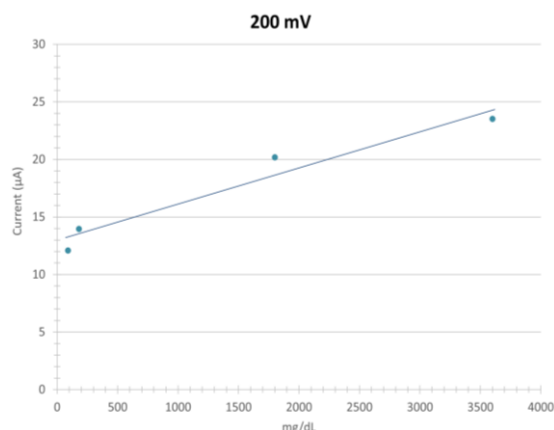


Fig 3. Linear regression for 200mV tension feed.

As it is shown in the graph, the tendency observed in 200mV of tension feed point shows a linear regression value of  $y(\mu A) = 0.0031x(\text{mg/dL}) + 13$  with a  $R^2 = 0.946$ .

The embroidered sensor presented not only shows its ability to detect chemical substance concentration in solutions but also to be a good base to prepare selective sensor on wearable application by providing a stable sensor produced by Ag fibers.

## References

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