DOI 10.5162/IMCS2018/P1FW.4

# Wearable electronics compatible enzyme-free Cu based biosensor for sensitive glucose detection

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**Abstract:**
Galvanostatic electrodeposition of copper foil was performed in the presence of 2-Acrylamido-2-methylpropanesulfonic acid (AMPS) to obtain an electrochemical sensor for sensitive and selective glucose detection. Electrochemical performances of as-prepared enzyme-free electrodes were evaluated using chronoamperometry, cyclic voltammetry and impedance spectroscopy in 0.1 M NaOH solution. The results revealed that a detection limit of 0.98 µM is obtained along with a linearity of 7–48 µM for glucose sensing. The interference studies show that good selectivity was obtained in the presence of fructose, sucrose, lactic acid, ascorbic acid, urea etc.

**Key words:** Copper foil, AMPS, biosensor, non-enzymatic, glucose, flexible.

## Introduction

Glucose level in the blood of diabetic patients has a vital role and it needs continuous quantitative monitoring to prevent potentially health risks. Many existing glucose biosensors have been designed containing specific enzymes which provide sensitive, selective, and rapid determination of glucose in various body fluids[1]. However, biosensors prepared with enzymes have some disadvantages such as high cost, low thermal - chemical stability, critical operating conditions and complicated production procedures[2]. Thus, it is desirable to use non-enzymatic sensing platforms in order to overcome all these challenges.

The most powerful technique to obtain high performance enzyme-free biosensors is to develop nanostructured materials with the high surface area. This provides a large number of adsorption sites for specific agents compared to biosensor analogs with the planar surface. The use of metal oxides, noble metals and polymers has been attracted growing interest for preparing sensing electrodes [3-5]. It is well known these materials can be used to obtain various morphologies such as nanotubes, nanofibers, nanoplatelets, nanowires etc. by changing their optimum production parameters[6]. Besides, these materials can be easily used in miniaturized devices, lab-on-chip platforms, portable, wearable, attachable and flexible sensor systems[5]. Generally, smart sensor systems contain sensing electrodes, wearable patches, wireless communication parts, actuators, user interface and software.

In this study, we aimed to design cheap and flexible electrochemical sensors for sensitive and selective detection of glucose using metal oxide coated copper based flexible electrodes which are compatible with fully integrated platforms.

## Experimental

The Cu/AMPS electrode was prepared by controlled galvanostatic electrodeposition. In the preparation process, copper electrode was washed with ethanol, acetone, deionized water (DI) using ultrasonic bath for 15 min., respectively, and dried at the room temperature for 24 h. Cu foil (1x6 $cm^2$) was used as a substrate for the electrochemical deposition and another piece of Cu foil used as a counter electrode. Electrolyte solution was prepared with 0.4 M $CuSO_4$ and 1.5 M $H_2SO_4$ and 2-Acrylamido-2-methylpropanesulfonic acid was added to the mixture. 30s deposition time was applied at a constant current density of 0.5 A/cm$^2$ to obtain Cu/AMPS electrode. This electrode was optimized evaluating various concentration of 2-Acrylamido-2-methylpropanesulfonic acid. All experiments were performed at the room temperature (25±2°C). The obtained electrode was used as the sensing material for sensitive glucose detection.

Characterizations of Cu/AMPS electrodes were performed by Diffuse Reflectance Infrared Fourier Transform spectroscopy (DRIFT) and Scanning electron microscopy (SEM) technique. Electrochemical sensing behavior of the electrodes was investigated using different electrochemical techniques such as electrochemical impedance spectroscopy (EIS) chronoamperometry (CA) and cyclic voltammetry (CV). Cu/AMPS electrodes showed a linear amperometric response at an applied potential of 0.5 V towards the detection of glucose from 5 to 50 μM with a detection limit of 0.90 μM and its response time was found to be 2 s. The selectivity of the Cu/AMPS electrode was investigated in the presence of possible interfering agents such as fructose, sucrose, lactic acid, urea, $Ca^{2+}$, $K^+$, $Mg^{2+}$ etc.

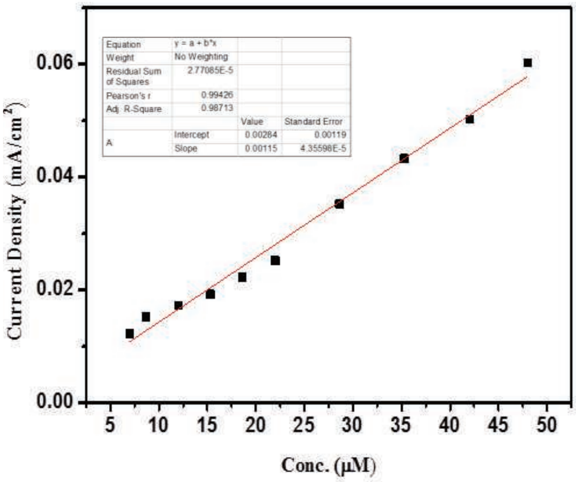


Fig. 1. Calibration curve of glucose which is calculated from chronoamperometric study on Cu/AMPS electrode.

## Acknowledgement

This study is supported by Scientific Research Project Coordination Unit of Istanbul University under the project number of BYP-49483. The authors would like to acknowledge the Elektrosens Health and Counseling Services Inc. for their kind helps.

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