A Needle-type Bio-Layer Interference Sensor for Continuous Glucose Monitoring in Human Serum

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***Abstract*— By 2030, diabetic patients are anticipated to occupy about 69 percent in underdeveloped countries and 20 percent in developed countries. Therefore, it is expected that glucose sensors may be still a market leader in medical device markets. In this paper, we demonstrate a needle-type bio-layer interference (BLI) sensor, which can monitor the glucose level continuously. By employing dialysis procedures we developed, this sensor could measure the glucose level change of human serum. Combined with system technology, this sensor holds great promise in a wearable online continuous glucose monitoring system for patients in emergency room or casual ward.**

I. Introduction

Diabetes mellitus is a metabolism disease which makes it difficul to maintain the glucose level in the body [1]. In monitoring of the glucose level, currently, various types of glucose sensors, from homecare strip sensor to continuous glucose monitoring (CGM) sensor, are available in markets. Most of these commercial sensors are enzyme based electrochemical devices. Although they have many advantages, e.g., high accuracy and handiness, in glucose monitoring, patients still need to undergo painful specimen collection procedures, i.e., repeated stabing, and the cost of the inspection is proportional to the enzyme consumption [2]. Also, since those are the electrochemical sensors, their performance can be influenced by the existance of the electromagnetic fields [3]. Recently, we develop a needle-type BLI biosensor for continuous glucose monitoring based on competitive binding [4]. In this study, we firstly demonstrate that this needle-type BLI sensor can detect the glucose level continuously in human serum.

II. Materials and Methods

The needle-type BLI sensor consists of a streptavidin coated optical fiber conjugated with a semi-permeable polycarbonate membrane (pore size: 50, 100, or 200 nm), which is enclosed in a syringe needle (gauge #19). And the fiber was connected to a BLI sensor system (Octet RED, Forte-Bio). This system measures the concentration of the glucose level by the competitive assay using concanavalin A (Con A) (Fig 1(a)). The signals were quantified by measuring wavelength shift triggered from binding of biological material, i.e., glucose, with Con A. Since the bindings of smaller molecules, e.g., glucose molecules, limit the signal-to-noise ratio, we replaced the glucose molecules with glycoproteins which are heavier signal generators. To evaluate the performance of this platform in human serum, we utilized the glycoproteins as signal generators and compared the results with those of defined artificial conjugate, i.e., bovine serum albumin (BSA) mannose conjugates.

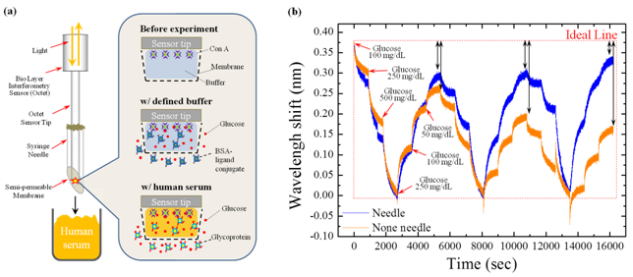

Fig. 1. (a) Working principle, (b) Continuous glucose detection results of the needle-type BLI sensor.

III. Results and Conclusion

As shown in Fig. 1(b), the signal drift, which is a critical issue in continuous molecule sensing, decreased from 45% in the conventional BLI system to 15% in the proposed needle-type system. Also, the noise peaks usually observed at the time of sample change were significantly attenuated, providing more stable glucose measurements.

In this study, we firstly demonstrate that the proposed needle-type BLI sensor can continuously detect the glucose level in human serum more stable with minimal signal drift.

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