Journal of Diabetes Science and Technology
Volume 5, Issue 5, September 2011
© Diabetes Technology Society

SYMPOSIUM

BioRadioTransmitter: A Self-Powered Wireless Glucose-Sensing System

Takuya Hanashi, M.S.,[1] Tomohiko Yamazaki, Dr.Eng.,[2] Wakako Tsugawa, Dr.Eng.,[1] Kazunori Ikebukuro, Dr.Eng.,[1] and Koji Sode, Dr.Eng.[1,3]

Abstract

Background:

Although an enzyme fuel cell can be utilized as a glucose sensor, the output power generated is too low to power a device such as a currently available transmitter and operating system, and an external power source is required for operating an enzyme-fuel-cell-based biosensing system. We proposed a novel biosensor that we named BioCapacitor, in which a capacitor serves as a transducer. In this study, we constructed a new BioCapacitor-based system with an added radio-transmitter circuit and a miniaturized enzyme fuel cell.

Methods:

A miniaturized direct-electron-transfer-type compartmentless enzyme fuel cell was constructed with flavin adenine dinucleotide-dependent glucose dehydrogenase complex-based anode and a bilirubin-oxidase-based cathode. For construction of a BioRadioTransmitter wireless sensing system, a capacitor, an ultra-low-voltage charge-pump-integrated circuit, and Hartley oscillator circuit were connected to the miniaturized enzyme fuel cell. A radio-receiver circuit, comprising two field-effect transistors and a coil as an antenna, was used to amplify the signal generated from the biofuel cells.

Results:

Radio wave signals generated by the BioRadioTransmitter were received, amplified, and converted from alternate to direct current by the radio receiver. When the capacitor discharges in the presence of glucose, the BioRadioTransmitter generates a radio wave, which is monitored by a radio receiver connected wirelessly to the sensing device. Magnitude of the radio wave transmission frequency change observed at the radio receiver was correlated to glucose concentration in the fuel cells.

Conclusions:

We constructed a stand-alone, self-powered, wireless glucose-sensing system called a BioRadioTransmitter by using a radio transmitter in which the radio wave transmission frequency changes with the glucose concentration in the fuel cell. The BioRadioTransmitter is a significant advance toward construction of an implantable continuous glucose monitor.

J Diabetes Sci Technol 2011;5(5):1030-1035

Author Affiliations: [1]Department of Biotechnology, Graduate School of Engineering, Tokyo University of Agriculture and Technology, Tokyo, Japan; [2]International Center for Materials Nanoarchitectonics (MANA), National Institute for Materials Science (NIMS), Ibaraki, Japan; and [3]Ultizyme International Ltd., Tokyo, Japan

Abbreviations: (BOD) bilirubin oxidase, (CGM) continuous glucose monitor, (FADGDH) flavin adenine dinucleotide-dependent glucose dehydrogenase, (GDH) glucose dehydrogenase, (IC) integrated circuit, (KB) Ketjenblack, (PPB) potassium phosphate buffer, (Pt/C) platinum-supported carbon

Keywords: BioCapacitor, continuous glucose monitor, flavin adenine dinucleotide-dependent glucose dehydrogenase, glucose dehydrogenase, radio wave transmission, wireless

Corresponding Author: Koji Sode, Dr.Eng., Tokyo University of Agriculture and Technology, 2-24-16 Nakamachi, Koganei, Tokyo 184-8588, Japan; email address sode@cc.tuat.ac.jp