Abstract: Glucose substrates are successfully harnessed to generate electricity in a membraneless biofuel cell with a mesh network of carbon nanotubes pyroquinoline quinone glucose dehydrogenase-modified anode and a laccase-modified cathode. Using glucose as a substrate, this glucose-oxygen biofuel cell is able to produce a steady current density of 337.5 µA/cm² and an open circuit voltage of 524 mV in 360 mg/dL glucose solution. Interestingly, the fuel cell in combination with a capacitor as the transducer element can also be utilized as a glucose monitor while generating electricity simultaneously to power small electronic devices, such as light emitting diode (LED). Moreover, the self-powered glucose monitor exhibited a linear dynamic range of 9 mg/dL to 630 mg/dL glucose. These results and device demonstrations suggest that further research into self-powered glucose monitors can provide major benefit in developing a novel autonomous implantable glucose monitor platform to greatly improve the quality of life for individuals living with diabetes. Copyright © 2016 IFSA Publishing, S. L.

Keywords: Glucose monitor, Diabetes, Biofuel cell, Voltage boosting.

1. Introduction

The current epidemic of diabetes and its potential growth is a public health risk that is unsustainable and must be addressed. According to the Center for disease control (CDC) 2014 report, 29.1 million people in the U.S. suffer from the disease diabetes, which is the seventh leading cause of death. This number is predicted to be doubled or tripled by the year 2050. The cost incurred to keep diabetes under control was 245 billion US dollars [1]. This cost is attributed to the complications that arise due to poor maintenance of blood glucose levels. Some of the complications include retinopathy, neuropathy, gastroparesis, foot complications, ketoacidosis, kidney disease, etc. [2]. Diabetes is a metabolic disorder caused by abnormal blood glucose level and is a result of either insufficient production of hormone insulin by the pancreas or the cells in the body do not respond correctly to the insulin produced thus, defining Type I and Type II diabetes respectively. In addition, gestational diabetes is common in pregnant women during their second trimester. This type of diabetes at times complicates the pregnancy [3]. There is a significant growth in the number of people suffering from Type II diabetes due to the unhealthy lifestyle and stress in their daily life. Normal blood glucose levels for a healthy individual as well as an individual suffering from diabetes is provide in Table 1.