# Development and Characterization of CNT/Biopolymer Electrodes for Bio-fuel Cell

M. Todo[1], K. Yamauchi[2] and T. Arahira[3]

[1] Research Institute for Applied Mechanics, Kyushu University, Kasuga, Japan
[2] Interdisciplinary Graduate School of Engineering Sciences, Kyushu University, Kasuga, Japan
[3] Fukuoka Dental College, Fukuoka, Japan

*Abstract*— **CNT/biopolymer composite materials having continuous porous structure were developed as the electrode materials for bio-fuel cell. Biodegradable polymer, PLLA, and natural biopolymer, collagen, were utilized as the polymer matrix of the composite materials. Enzymes were also distributed in the composites. Microstructures of the composites were observed using a field-emission scanning electron microscope. A simple experimental set-ups of bio-fuel cell were also constructed using the composite materials as the electrodes. Fundamental electric property such as electrification was then examined using the systems.**

*Keywords*— **Bio-fuel cell, nanocomposite materials.**

## I. Introduction

Recent years, much attention has been paid to bio-fuel cells in which electrons released from decomposed glucose molecules are utilized, and a variety of researches have been conducted [1-4]. They are known to be very safe electric generators for human beings and environments because the fuel is saccharide and the catalysts are biological materials. Furthermore, the devices can be miniaturized because the structure is very simple without separator dividing anode and cathode. The bio-fuel cell has been considered as an implantable power source for medical devices such as pacemaker and artificial heart. However, the bio-fuel cells currently developed do not have enough power to support those medical devices and very limited durability. Therefore, new electrode materials that can improve electric productivity and durability are needed to be developed.

A basic model of typical bio-fuel cell is illustrated in Fig.1. Both the electrodes consist of electroconductive material, mediator and enzyme, and the enzyme in anode is usually different from that in cathode to yield redox reaction in the system. It has been found that carbon nanotube (CNT) can be used in electrode instead of using mediator [2]. CNT is known to have excellent electroconductivity and specific surface area.

In the present study, CNT was applied to develop a new electrode material. CNT filled poly(L-lactide) (PLLA) and CNT filled collagen porous composite materials were developed as electrode materials for bio-fuel cells. The microstructures of the composite materials were observed using a field-emission scanning electron microscope to characterize the distribution condition of CNT and the porous structures. A fundamental experimental set-up of bio-fuel cell was also constructed to examine the basic property of the composite materials as the electrode.

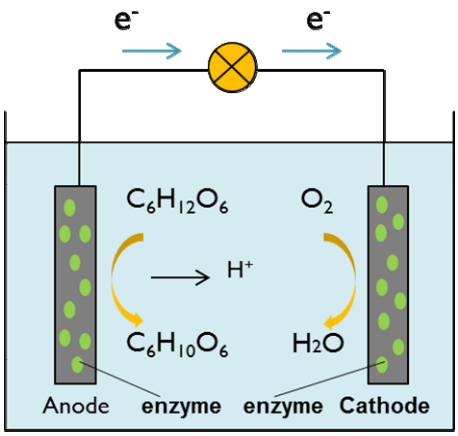


Fig.1 A basic bio-fuel cell model.

## II. Experimental

CNT filled PLLA porous composite material was fabricated by the freeze-drying method. PLLA pellets were dissolved into 1,4-dioxiane so that the PLLA concentration became 3wt%. CNTs were then mixed with the PLLA solution so that the CNT concentration became 3wt%. Glucose oxidase and catalase were added to the CNT/PLLA solution for the anode and laccase was added to the solution for the cathode. The amount of each enzyme was 20 mg. Those solutions were filled into molds and then freeze-dried at -50ºC to fabricate porous structures.

CNT/collagen porous composites were also fabricated by the freeze-drying method. CNTs were mixed with a type I collagen solution of 1 wt%. Then, the solution filled in molds were freeze-dried at -50 ºC. CNT/collagen porous

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