Fabrication of Fully Screen-printed Paper-based Biofuel Cell using Porous Carbon Inks

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There has been considerable recent interest in a paper-based biofuel cell (PBFC), owing to its flexibility and low environmental loading[1)]. Novel flexible configurations (e.g. PBFC) have to be developed to decrease weight and volume of BFCs and to obtain more feasible application in practice[2)]. Moreover, it is need to improve the output power density for practical use. Recently, we developed a screen-printed PBFC, which has a porous structured anode and cathode. The maximum power density of the PBFC was 115 μW cm^{-2} (at 0.39V) [3)].

In the present study, we newly prepared PBFCs using the several porous carbon materials and binders, and its characteristics were investigated by electrochemical impedance spectroscopy.

Figure 1 shows a schematic illustration of the structure of screen-printed paper-based electrode. A commercial carbon ink was printed as lead part on a paper. In the case of anode, for example, Ketjenblack (KB) and styrene-butadiene rubber dissolved in water was used as a porous carbon ink. The porous carbon ink was mixed by ultrasonic dispersing machine, and was printed on the lead part. Then, a glucose oxidase was casted or printed on the porous carbon surface. In the case of cathode, KB and polytetrafluoroethylene, dissolved in isophorone, were used as ink. Bilirubin oxidase was used cathodic biocatalyst. The PBFC was prepared by attaching the anode with the cathode.

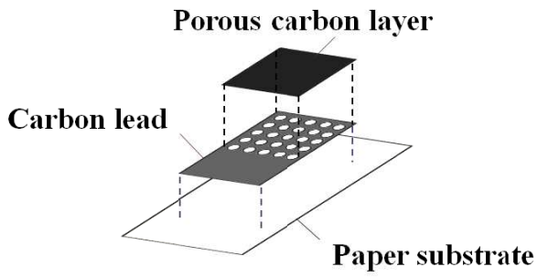

Fig. 1 Schematic illustration of the screen-printed paper-based electrode

Figure 2 shows the schematic illustration of the experimental set-up. When the electrochemical measurements were performed, only the bottom of the papar was immersed in electrolyte solution.

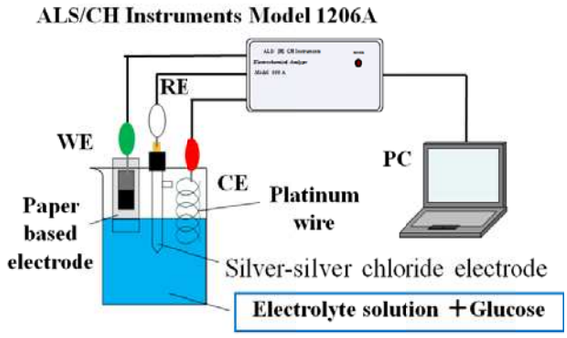

Fig. 2 The schematic illustration of the experimental set-up.

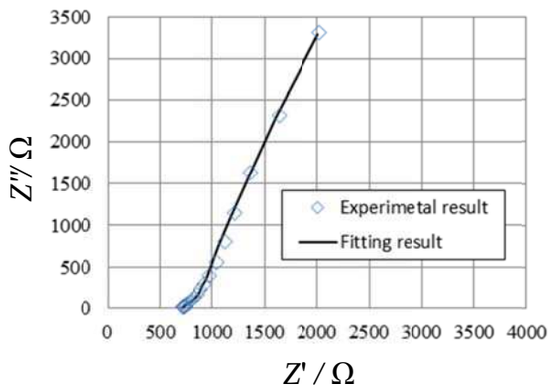

Fig. 3 Nyquist plots of the paper-based cathode at -0.1V

Figure 3 shows the Nyquist plot of the impedance of the cathode. The electric double layer capacitance of the cathode were calculated about 71.7 mF. The effective surface area of the cathode was estimated by using electric double layer capacitance of the activated carbon (10 μF cm^{-2}). The effective surface area was 7171 cm^2. It is found that specific surface area drastically increased by using a porous carbon ink.

Reference

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3) S. Kato, Y. Hoshi, I. Shitanda, M. Itagaki, Proceedings of EIS2013 (2013).