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Fabrication of Glucose/O_2 Microfluidic Biofuel Cell with Double Layer of Electrodes

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Abstract : Enzymatic biofuel cells (EBFCs) have drawn the attention of researchers due to its demanding application in medical implants. In EBFCs, electricity is produced with the help of redox enzymes. In this study, we report the fabrication of membraneless EBFC with new design of electrodes to overcome microchannel related limitations. The device consists of double layer of electrodes on both sides of Y-shaped microchannel to reduce the effect of oxygen depletion layer and diffusion of fuel and oxidant at the end of microchannel. Moreover, the length of microchannel was reduced by half keeping the same area of multiwalled carbon nanotubes (MWCNT) electrodes. Polydimethylsiloxane (PDMS) stencils were used to pattern MWCNT electrodes on etched Indium Tin Oxide (ITO) glass. PDMS casting was used to fabricate microchannel of the device. Both anode and cathode were modified with glucose oxidase and laccase. Furthermore, these enzymes were covalently bound to carboxyl MWCNTs with the help of EDC/NHS. Glucose used as fuel was oxidized by glucose oxidase at anode while oxygen was reduced to water at the cathode side. The resulted devices were investigated with the help of polarization curves obtained from Chronopotentiometry technique by using potentiostat. From results, we conclude that the performance of double layer EBFC is improved 15 % as compared to single layer EBFC delivering maximum power density of 71.25 µW cm-2 at a cell potential of 0.3 V and current density of 250 µA cm-2 at micro channel height of 450-µm and flow rate of 25 ml hr-1. However, the new device was stable only for three days after which its power output was rapidly dropped by 75 %. This work demonstrates that the power output of membraneless EBFC is improved comparatively, but still efforts will be needed to make the device stable over long period of time.

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