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Enhanced Area of Current Collector Increase Power Generation of Microbial Fuel Cell

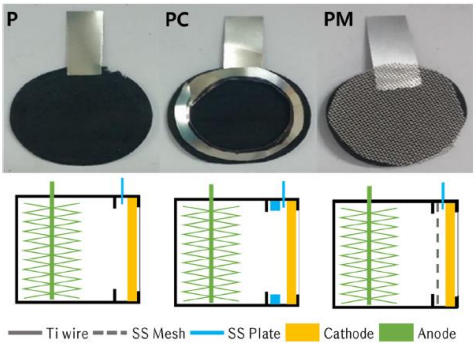
Hyungwon Chai, Sokhee P. Jung*

Department of Environment and Energy Engineering, Chonnam National University, Gwangju 61186, Republic of Korea
E-mail: sokheejung@chonnam.ac.kr

Abstract

Microbial fuel cell (MFC) is an innovative environmental and energy system that converts organic wastewater into electrical energy. For the practical implementation of MFC as a wastewater treatment process, a number of limitations need to be overcome. Improving cathodic performance is one of the major challenges, and introduction of a current collector can be an easy and practical solution. In this study, three types of current collectors made of stainless steel (SS) were tested in a single-chamber cubic MFC. The three current collectors had different contact areas to the cathode (P 1.0 cm^2, PC 4.3 cm^2, PM 6.5 cm^2) and increasing the contacting area enhanced the power and current generations and coulombic and energy recoveries by mainly decreasing cathodic charge transfer impedance. Application of the SS mesh to the cathode (PM) improved maximum power density, optimum current density, and maximum current density by 8.8%, 3.6%, and 6.7%, respectively, compared with P of no SS mesh. The SS mesh decreased cathodic polarization resistance by up to 16%, and cathodic charge transfer impedance by up to 39%, possibly because the SS mesh enhanced electron transport and oxygen reduction reaction.

Material & Methods



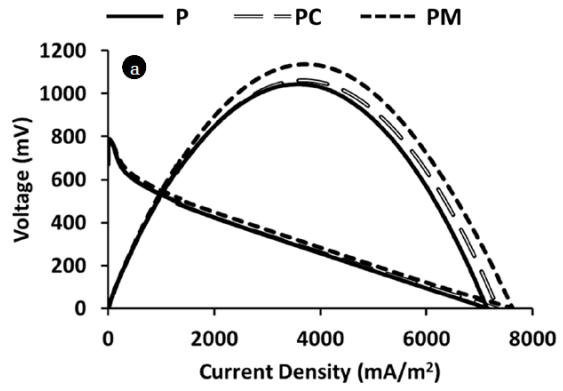
1. Anode & Cathode
   A brush electrode was made with a carbon fiber brush (25-mm dia meter and 50-mm length) as anode. Platinum-coated carbon-cloth cathode was made of carbon cloth, with a PTFE diffusion layer on t he air facing side and Pt catalyst layer on the solution side.
2. Current collector
   Three different current collectors were made of non-corrosive stainl ess steel plate (SUS 304) and stainless steel mesh (# 30, type SU S 304). A broad stainless steel plate (1 cm^2 of contact area) (P), ro unded rim (4.3 cm^2 of contact area) (PC), a broad stainless steel m esh (6.5 cm2 of contact area) (PM) were applied to a cathode.

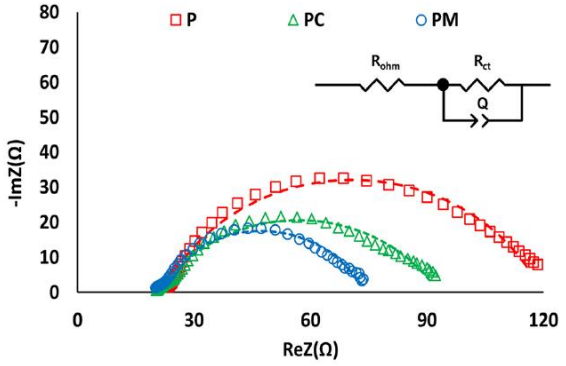
Conclusions

- Increasing contacting area of a carbon cloth cathode to a metal current collector increased the power, current densities, and coulombic and energy recovery of the MFC by decreasing cathodic resistance.
- Application of a SS mesh to the cathode (PM) improved maximum power density, optimum current density and maximum current density of the MFC by 8.8%, 3.6% and 6.7%, respectively, comparing with P having no SS mesh.
- In overall, by applying a SSM, cathodic polarization resistance decreased by up to 16%, and cathodic charge transfer impedance decreased by up to 39%.

Result & Discussion

Power Density of each reactors and EIS test





- Maximum power density = 1,136 mW/m^2
- Optimum current density = 3,752 mA/m^2
- Maximum current density = 7,610 mA/m^2
- Cathodic ohmic impedances were slightly different in the three forms: 20 Ω for PM, 21 Ω for PC and 22 Ω for P.
- However, there was bigger difference in cathodic charge transfer impedance: 53 Ω for PM, 72 Ω for PC and 97 Ω for P.

Acknowledgements

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