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Comparative evaluation of microbial fuel cell performance and electrochemistry with different anode configurations, structures and materials

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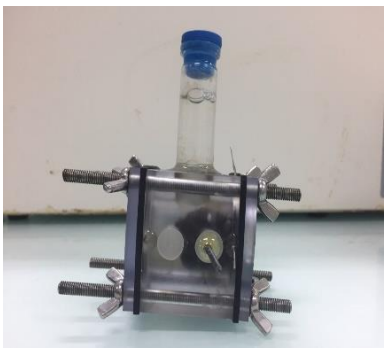
Abstract

Various materials and anode structures have been applied to enhance MFC performance. However, their comparative evaluation of performance and electrochemistry has not yet been investigated in detail under a same condition. In this study, a carbon-cloth anode, an anode-cathode assembly, and a brush anode with two different orientations were tested under a same condition for comparative analyses on their performance and electrochemistry, in order to reveal their unique electrochemical characteristics. The brush anode cells exhibited better performance than the carbon cloth cells. The brush anodes showed 41–72% higher maximum power densities, 18–75% higher maximum current density and 24–32% higher optimum current densities than the carbon cloth anodes. The brush anodes showed 25–43 Ω lower anodic polarization resistance than the carbon cloth anodes. The brush anodes showed 1.6–21.2 Ω lower ohmic impedance, 7.7–10.6 Ω lower charge transfer impedance and 9.3–31.8 Ω lower anodic impedance than the carbon cloth anodes. Anodic ohmic impedance was greatest in the carbon-cloth-anode MFC (21.9 Ω), where loose contact between a carbon cloth and a current collector might cause the high ohmic resistance, and large solution resistance in the cell could diminish anode performance due to slow ion transport. In order to improve MFC performance by modifying anode structures, we suggest the followings: 1) an anode should have large surface area, 2) anodic carbon material and a metal current collector must be tightly connected, 3) locating a brush anode closer to a cathode can be important.

Material & Methods

Cubic shaped reactors contained 28ml volume chamber and an anode



Anode	Shape
Cloth	
Brush	

MFC operation

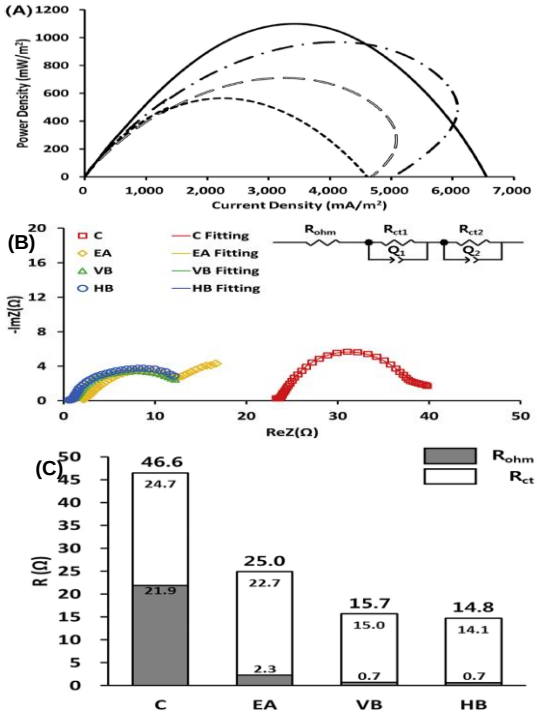
- Single chamber MFC(28 ml)
- Anode : Carbon fiber brush(2.5 × 2.5 cm), Carbon cloth(7 cm^2)
- Cathode : Carbon cloth (7 cm^2)
- Acetate (10 mM) / Medium (PBS, 50 mM)
- External resistance : 100 Ω

Power density curve of shape of Brush and Cloth type

	C	EA	VB	HB
OCV (mV)	739	590	626	595
P_{max} (mW/m^2)	601	706	999	1,034
R_{int} (Ω)	167	135	112	132
R_{an}(Ω)	109	88	97	109
R_{cat} (Ω)	62	47	19	22

Result & Discussion

Power density (A), Nyquist plits and the equivalent circuit fittings of the an odic EIS (B), Impedance distributions revealed by anodic EIS (C)



Conclusions

- The brush anodes showed 41-72% higher maximum power densities, 18-75% higher maximum current density and 24-32% higher optimum current densities than the carbon cloth anodes.
- Anodic polarization resistances on average were 62 Ω for C, 47 Ω for EA, 19 Ω for VB and 22 Ω for HB.
- The brush anodes showed 25-43 Ω lower anode resistance than the carbon cloth anodes.

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