



Bonyoung Koo, Sokhee P. Jung*

Department of Environmental and Energy Engineering, Chonnam National University-Gwangju

TEL : +82-62-530-0853, FAX : +82-62-530-0853

Abstract

Activated carbon (AC) is an inexpensive catalyst for oxygen reduction in an air cathode of microbial fuel cells (MFCs). In the AC-based cathode, carbon black (CB) is used as a conductive supporting material. In this study, it was hypothesized cathodic performance would increase if reduced graphene oxide (rGO) replaces CB in an optimum ratio. rGO replaced CB in the four different weight ratios. Maximum power density was the best in rGO15 (2,642 mW/m²) followed by rGO5 (2,142 mW/m²). In the optimum external resistance operation, rGO5 and rGO showed similar power (~1,060 mW/m²), higher than the others. Linear sweep voltammetry, cyclic voltammetry, and impedance spectroscopy also showed that the optimal rGO additions improved cathodic performance and reduced cathodic internal resistance. Due to the flatter and wider shape of rGO and 5 times higher electrical conductivity than CB, the rGO addition improved the cathodic performance, but the complete replacement of CB with rGO decreased the cathodic performance due to the increased thickness and the morphological crack. The optimum rGO addition is a simple and effective method for improving cathodic performance

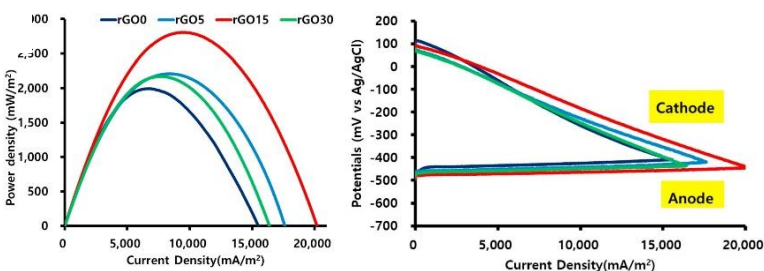
Material and Methods

- Single-chamber MFC, fed batch mode
- Anode: Carbon fiber brush
- Cathode: Different catalyst mixture-coated SSM, projected area of 7cm²

Cathode	Mass (mg)				Ratio (%)			
	AC	CB	rGO	Total	AC	CB	rGO	Total
rGO0	300	30	0	330	90.9	9.1	0	100
rGO5	300	25	5	330	90.9	7.6	1.5	100
rGO15	300	15	15	330	90.9	4.5	4.5	100
rGO30	300	0	30	330	90.9	0	9.1	100

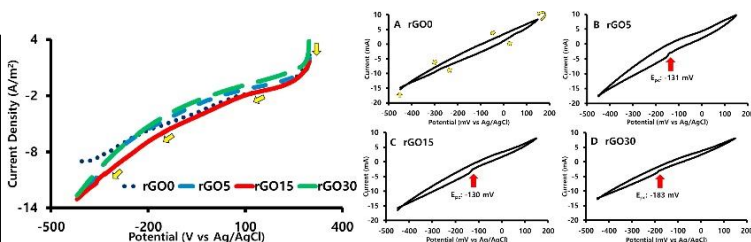
- Medium: 2 g/L of sodium acetate hydrate and a 50-mM phosphate buffer solution (PBS)
- Linear sweep voltammetry Polarization test
- Linear sweep voltammetry
- Cyclic voltammetry
- Electrochemical Impedance Spectroscopy

Results and Discussions

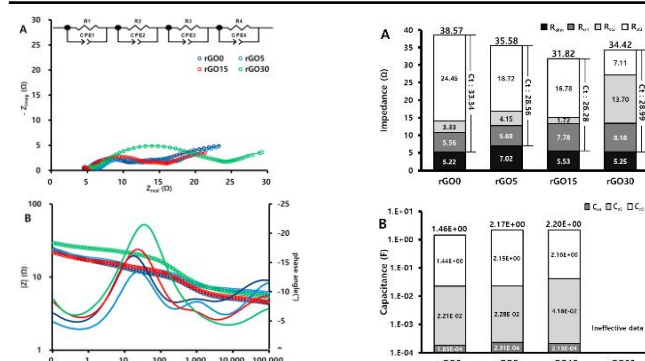


	OCV (mV)	P_{max} (mW/m ²)	i_{max} (mA/m ²)	i_{opt} (mA/m ²)
rGO0	562 ± 15	1955 ± 39	17,565 ± 2034	7532 ± 332
rGO5	560 ± 2	2124 ± 85	15,987 ± 1631	6900 ± 1566
rGO15	569 ± 28	2642 ± 163	19,348 ± 863	9175 ± 213
rGO30	550 ± 8	2120 ± 50	16,158 ± 244	7549 ± 25

	E_{cat}^{opt} (mV)	E_{an}^{opt} (mV)	R_{opt}	R_{int}
rGO0	-187 ± 45	-447 ± 22	49.5 ± 7.7	52.2 ± 12.1
rGO5	-130 ± 78	-452 ± 7	73.0 ± 41.0	66.4 ± 36.5
rGO15	-168 ± 5	-456 ± 10	45.0 ± 1.4	44.8 ± 0.2
rGO30	-169 ± 4	-451 ± 3	53.5 ± 0.7	51.8 ± 1.6



	rGO0	rGO5	rGO15	rGO30
i_{LSV}^{opt} (A/m ²)	9.17	13.01	13.06	12.69
I_{pa} (mA)	8.45	9.71	8.04	8.08
I_{pc} (mA)	-15.44	-16.98	-16.46	-12.79
ΔI_p (mA)	23.89	26.69	24.50	20.87
Reduction peak (mV)	N/D	-131	-130	-183
Reduction current (mA)	N/D	-2.80	-2.80	-3.11



Conclusions

- rGO15 showed the highest LSV polarization maximum power density (2642 mW/m²), the lowest cathodic polarization resistance (42.6 Ω), the lowest total cathodic impedance (31.8 Ω) and the highest LSV current density (13.06 A/m²).
- rGO5 showed the best power (1063 mW/m²) and current (3896 mA/m²) during the optimum resistance operation, the highest CV current production (26.68 mA) and rGO15 showed similar power.
- Due to the flatter and wider shape of rGO comparing and ~200% higher electrical conductivity than CB, the addition of rGO improved cathodic performance, but the complete replacement of CB with rGO decreased the cathodic performance (rGO) due to the increased thickness and the morphological crack.

Acknowledgement

- This research was supported by Basic Science Research Program through the National Research Foundation of Korea (NRF) funded by the Ministry of Education (NRF-2018R1D1A1B07050567), a research grant from Gwangju Green Environment Center in Ministry of Environment (17-04-10-14-12), a research grant from Gwangju Green Environment Center in Ministry of Environment (19-04-70-79-12)