Electronic Supplementary Material (ESI) for RSC Advances

Supplementary Information

Development of low-cost activated carbon cathodes for use in air-cathode microbial fuel cells

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Table S1 EIS fitting results using activated carbon cathodes with diffusion layers, compared to Pt/C cathodes, at set potentials of 0.3 V or 0.1 V.

		AC cathodes at different loadings (mg/cm^2)						Pt Cathodes
Parameters	**E_c (V)**	**11**	**14**	**28**	**43**	**100**	**171**	**Pt/C**
$R_s(\Omega)$	0.3	16.96	14.60	14.58	18.26	17.12	15.30	14.76
$Q_1(F\cdot s^{(a-1)})$		1.18×10^{-3}	2.23×10^{-3}	1.32×10^{-3}	2.65×10^{-3}	3.91×10^{-3}	3.07×10^{-3}	
a_1		0.76	0.71	0.82	0.79	0.69	0.65	
$R_c(\Omega)$		6.25	6.15	0.98	0.23	0.86	0.76	
$Q_2(F\cdot s^{(a-1)})$		0.41	0.43	0.68	0.72	0.74	0.86	0.36
a_2		0.65	0.73	0.48	0.67	0.73	0.54	0.72
$R_{ct}(\Omega)$		12.68	14.87	13.12	3.03	2.91	10.52	24.50
$Z_w(\Omega\cdot s^{-1/2})$		2.57	2.20	1.82	0.80	0.44	0.16	1.32
$R_s(\Omega)$	0.1	13.26	14.89	17.42	17.67	18.30	14.14	14.76
$Q_1(F\cdot s^{(a-1)})$		2.24×10^{-3}	3.52×10^{-3}	1.41×10^{-3}	7.41×10^{-3}	1.31×10^{-3}	1.22×10^{-3}	
a_1		0.75	0.69	0.80	0.67	0.80	0.78	
$R_c(\Omega)$		5.61	5.55	1.70	0.30	0.86	0.62	
$Q_2(F\cdot s^{(a-1)})$		0.35	0.56	0.63	0.82	0.81	0.71	0.40
a_2		0.71	0.73	0.45	0.67	0.52	0.53	0.63
$R_{ct}(\Omega)$		16.74	21.76	22.31	4.68	14.02	12.38	13.08
$Z_w(\Omega\cdot s^{-1/2})$		1.30	0.91	0.71	0.46	0.06	0.25	0.75

Table S2 EIS fitting results using activated carbon cathodes with different PTFE contents (10, 15, 20, 25, 30, 35, and 40 wt %, 43 mg/cm^2) at cathode potential of 0.1 V

PTFE content (%)	**10**	**15**	**20**	**25**	**30**	**35**	**40**
$R_s(\Omega)$	15.24	14.38	17.78	15.22	14.24	15.63	15.64
$Q_1(F\cdot s^{(a-1)})$	2.62×10^{-3}	0.94×10^{-3}	1.05×10^{-3}	9.42×10^{-3}	1.12×10^{-3}	1.21×10^{-3}	1.03×10^{-3}
a_1	0.75	0.83	0.82	0.83	0.82	0.84	0.83
$R_c(\Omega)$	0.62	2.11	1.52	2.95	2.21	2.68	3.72
$Q_2(F\cdot s^{(a-1)})$	0.64	0.59	0.74	0.63	0.50	0.36	0.31
a_2	0.71	0.52	0.57	0.46	0.50	0.48	0.48
$R_{ct}(\Omega)$	3.57	7.54	11.58	14.28	15.53	44.30	35.42
$Z_w(\Omega\cdot s^{-1/2})$	0.41	0.53	0.37	0.54	0.29	0.08	0.15

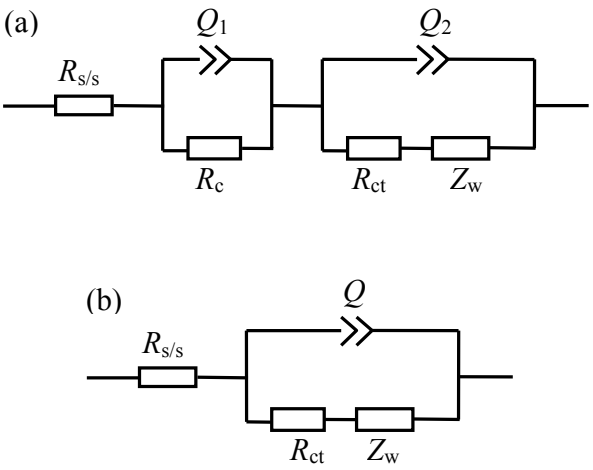

Fig. S1 Equivalent circuits for EIS spectra with (a) AC cathodes and (b) Pt/C cathodes.

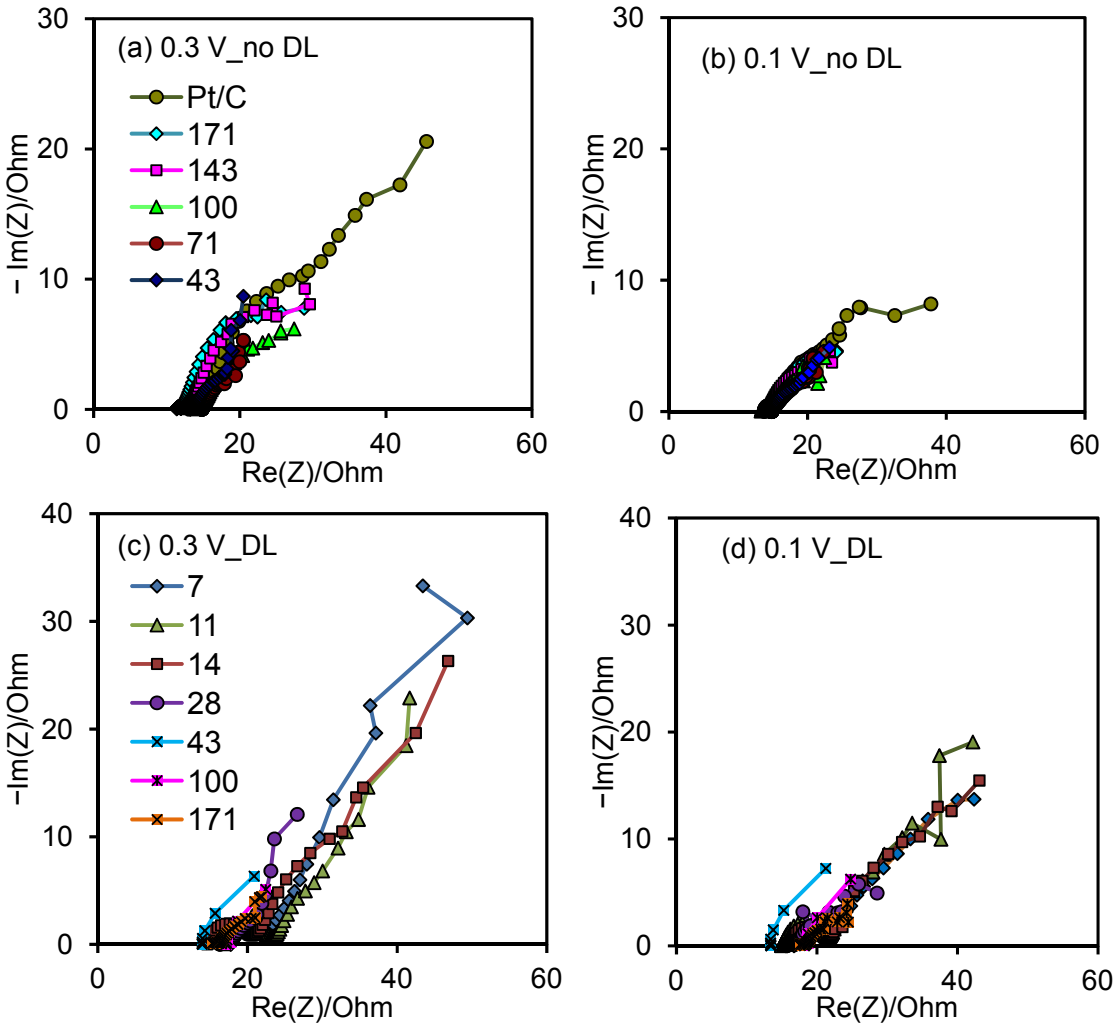

Fig. S2 Nyquist plots of ac air cathodes (a) at 0.3 V, (b) at 0.1 V using 43, 71, 100, 143, 171 mg/cm^2 AC, 10% PTFE without DL; (c) at 0.3 V, (d) at 0.1 V using 7, 11, 14, 28, 43, 100, 171 mg/cm^2 AC, 10% PTFE with DL.

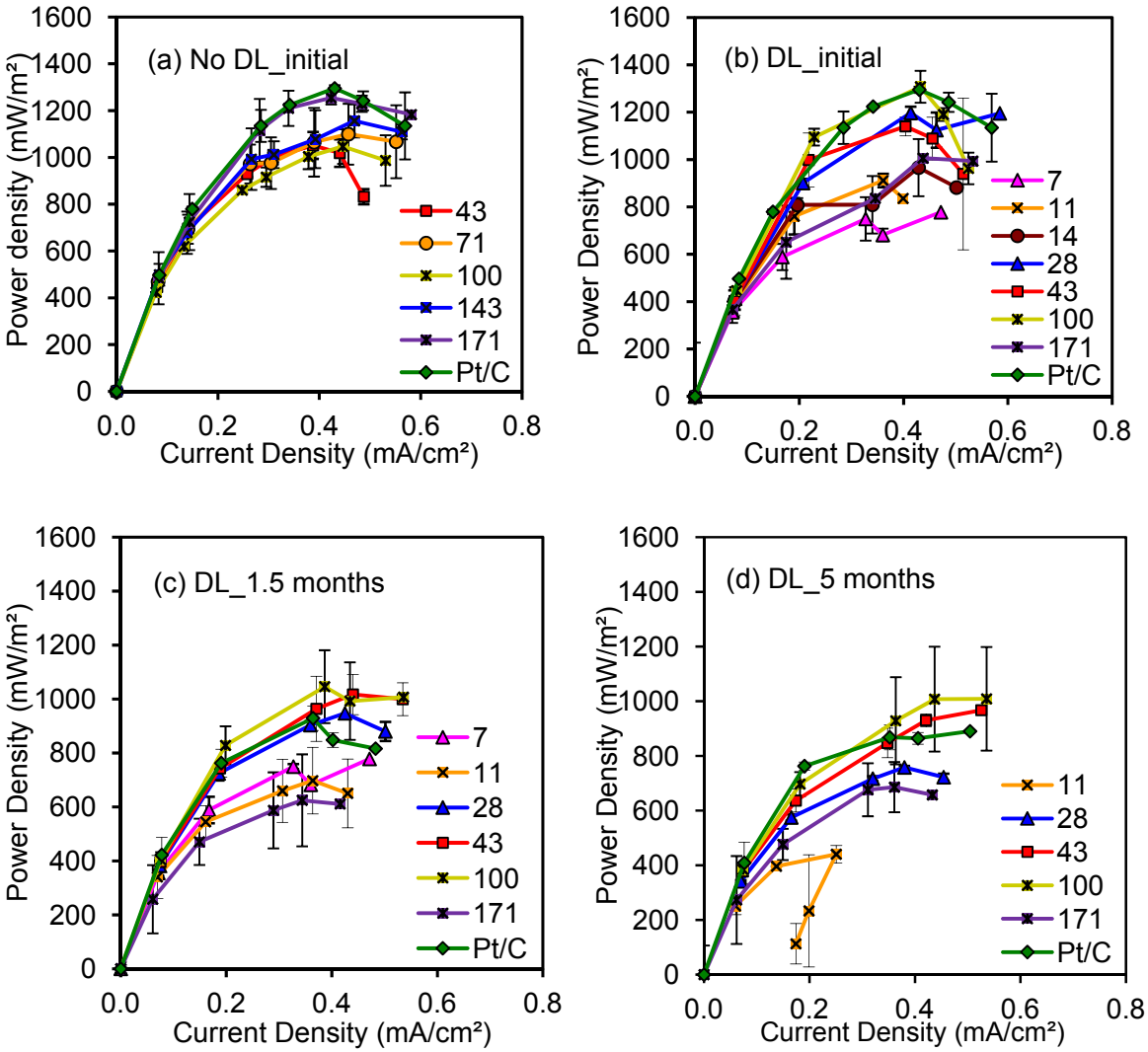

Fig. S3 Power generation obtained using (a) AC cathodes (43, 71, 100, 143, 171 mg/cm^2 AC, 10% PTFE) without DL, Pt/C cathodes in the initial cycles; (b) AC cathodes (7, 11, 14, 28, 43, 100, 171 mg/cm^2 AC, 10% PTFE) with DL, Pt/C cathodes in the initial cycles; (c) AC cathodes (7, 11, 28, 43, 100, 171 mg/cm^2 AC, 10% PTFE) with DL, Pt/C cathodes after 1.5 months; (d) AC cathodes (11, 28, 43, 100, 171 mg/cm^2 AC, 10% PTFE) after 5 months

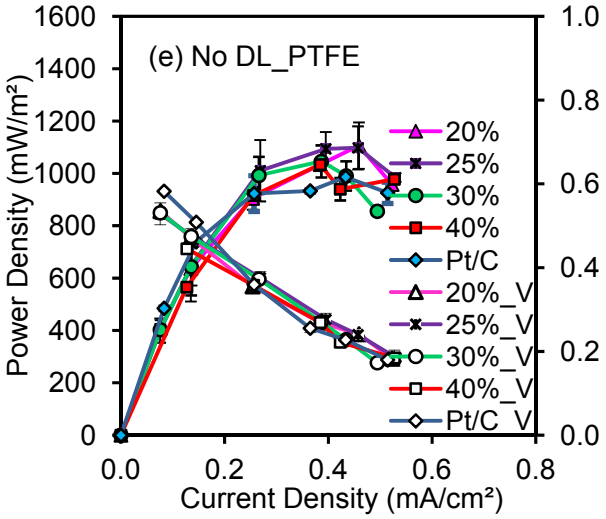

Fig. S4 Power generation obtained using AC cathodes (20, 25, 30, 35, 40% PTFE, 43 mg/cm^2 AC) without DL, Pt/C cathodes after 1 month

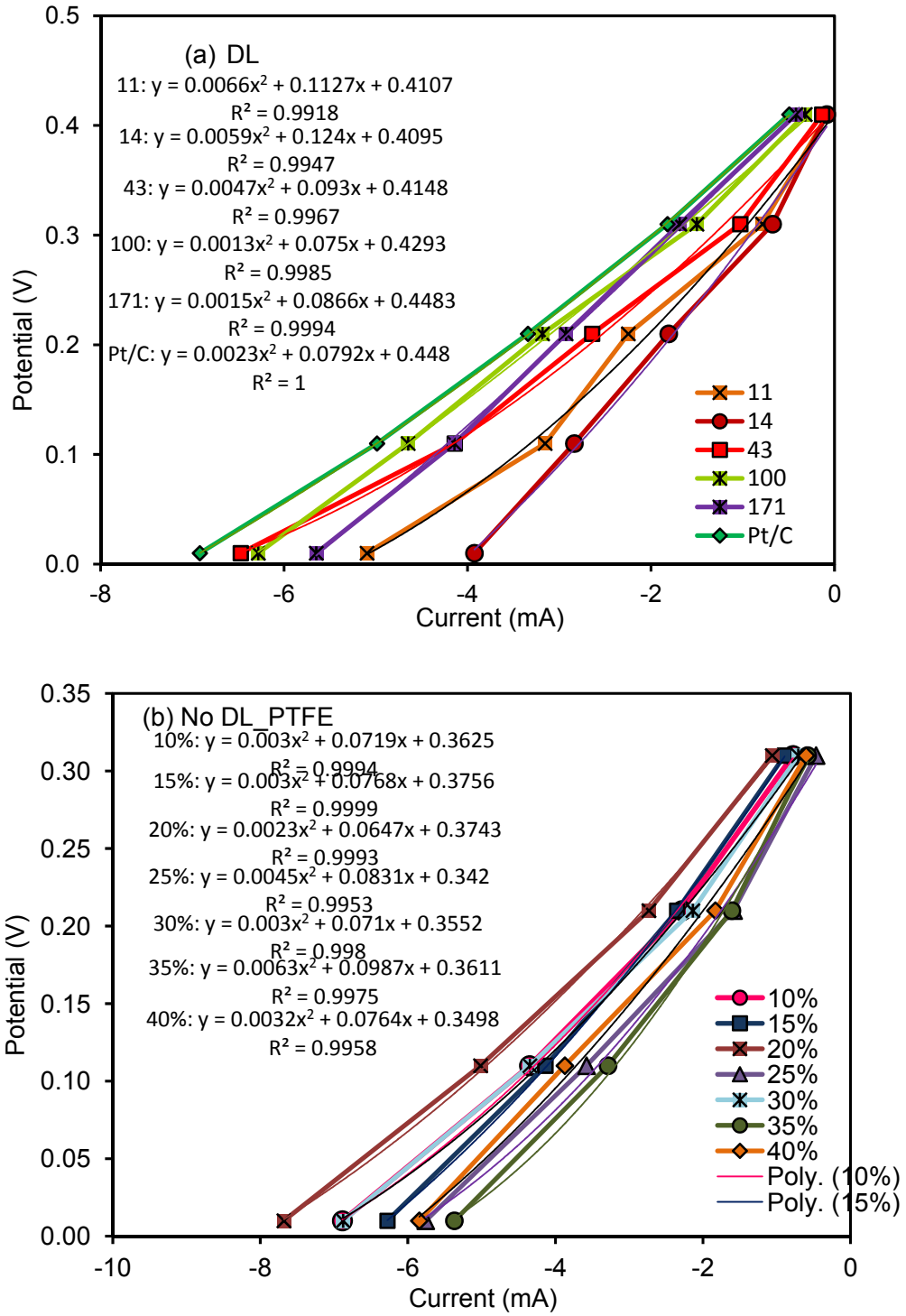

Fig. S5 Regressions for cathode current-voltage curves using (a) AC cathodes (11, 14, 43, 100, 171 mg/cm^2 AC, 10% PTFE) with DL and Pt/C cathodes; (b) AC cathodes (10, 15, 20, 25, 30, 35, 40%, 43 mg/cm^2 AC) without DL

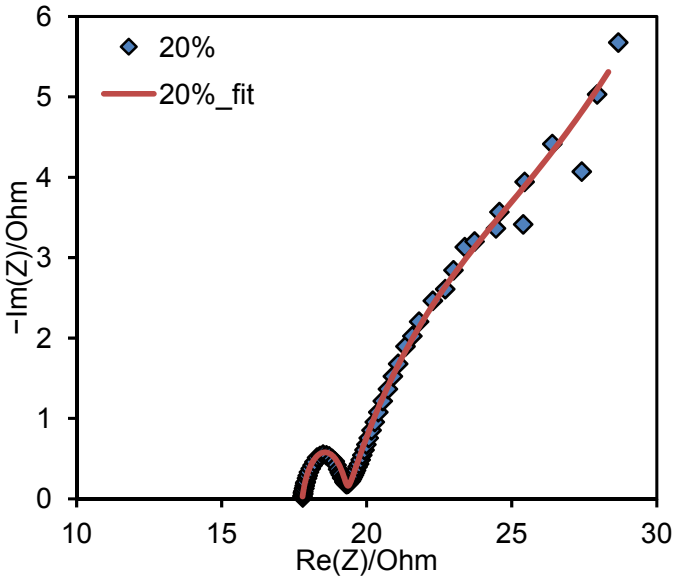

Fig. S6 An example of Nyquist plots for AC cathode (with 20% PTFE content) and the fitting curve with equivalent circuit

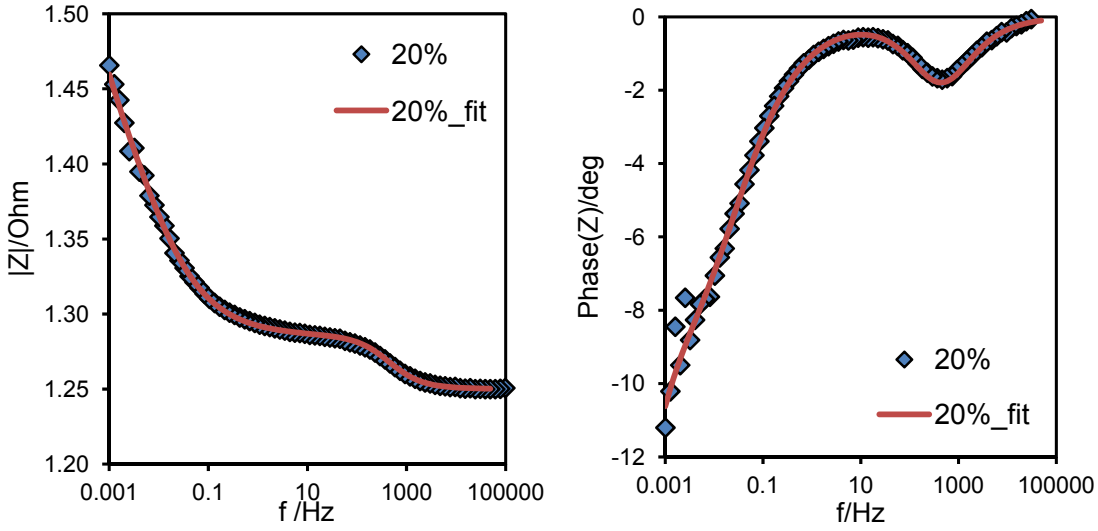

Fig. S7 Bode plots for AC cathode with 20% PTFE and the fitting curves with the equivalent circuit

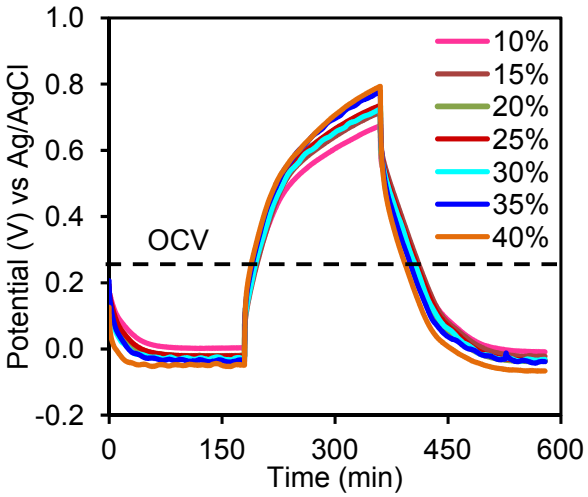

Fig. S8 Charge-discharge diagram for AC cathodes with different PTFE binder contents (10, 15, 20, 25, 30, 35, 40%, No DL, 43 mg/cm^2 AC)