SUPPORTING INFORMATION

Microbial Fuel Cells with Separate Brush-Anode and Integrated-Spacer Dual Cathode Modules

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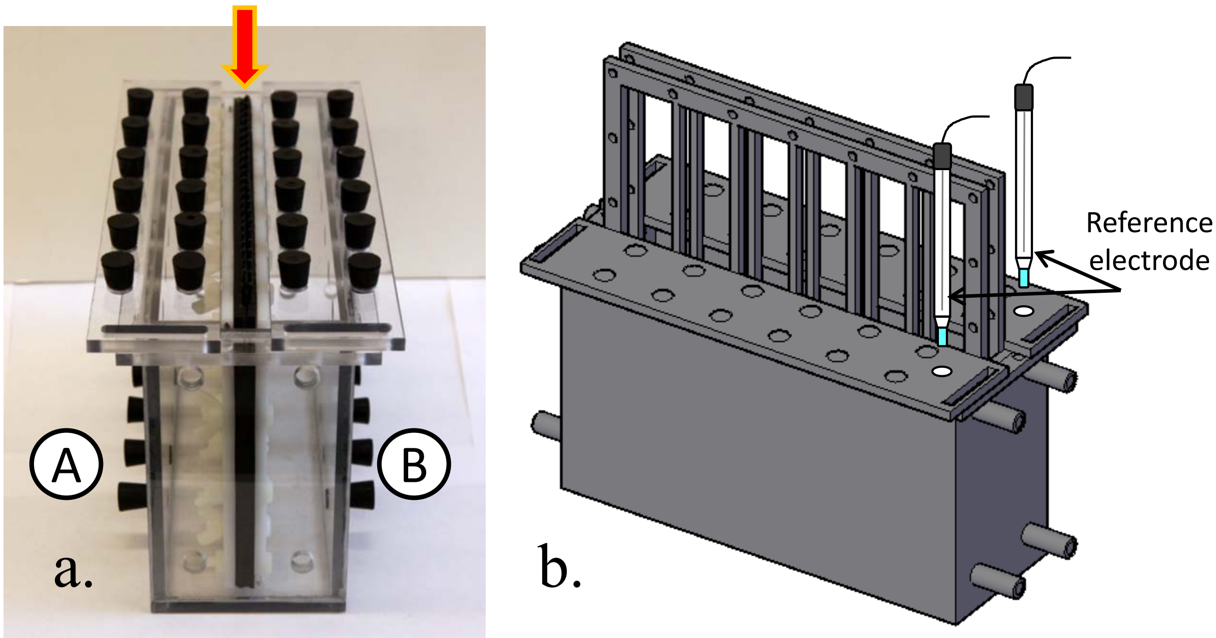
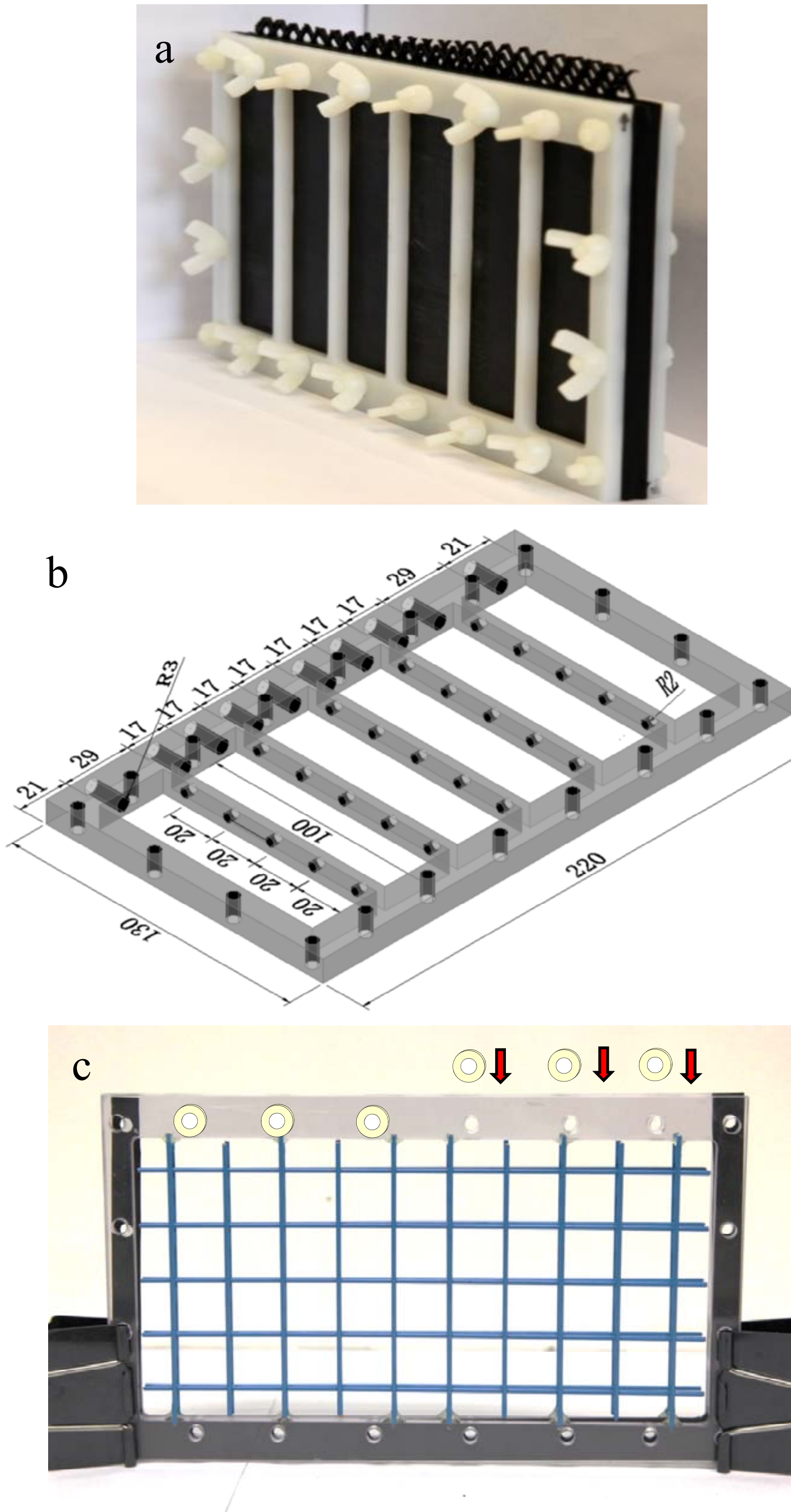


Figure S1. (a) Photograph and (b) schematic diagram of the air cathode modular MFC, showing the relative position of the dual-sided cathode cassette and the reference electrode placement.


a
b
21
29
17
17
17
17
17
17
17
29
21
R3
R2
10
100
20
20
20
20
220
130
c

d

Figure S2. (a) Photograph of cathode cassette with mesh spacers, (b) schematic showing dimensions of the column spacer, (c) the position of washers in the wire spacers, and (d) the dilute hydrochloric acid cleaned cathode module after wastewater operation.

Assembly explanation: In Figure S2c, two nylon washers (McMaster-Carr, standard washer, M5, off-white) with a thickness of 1.0 ± 0.2 mm were added at each screw hole between two rectangle frames on the top edge and passed through by screws. The nylon washers stabilized the structure and left air diffusion slit with a width of 2 mm.

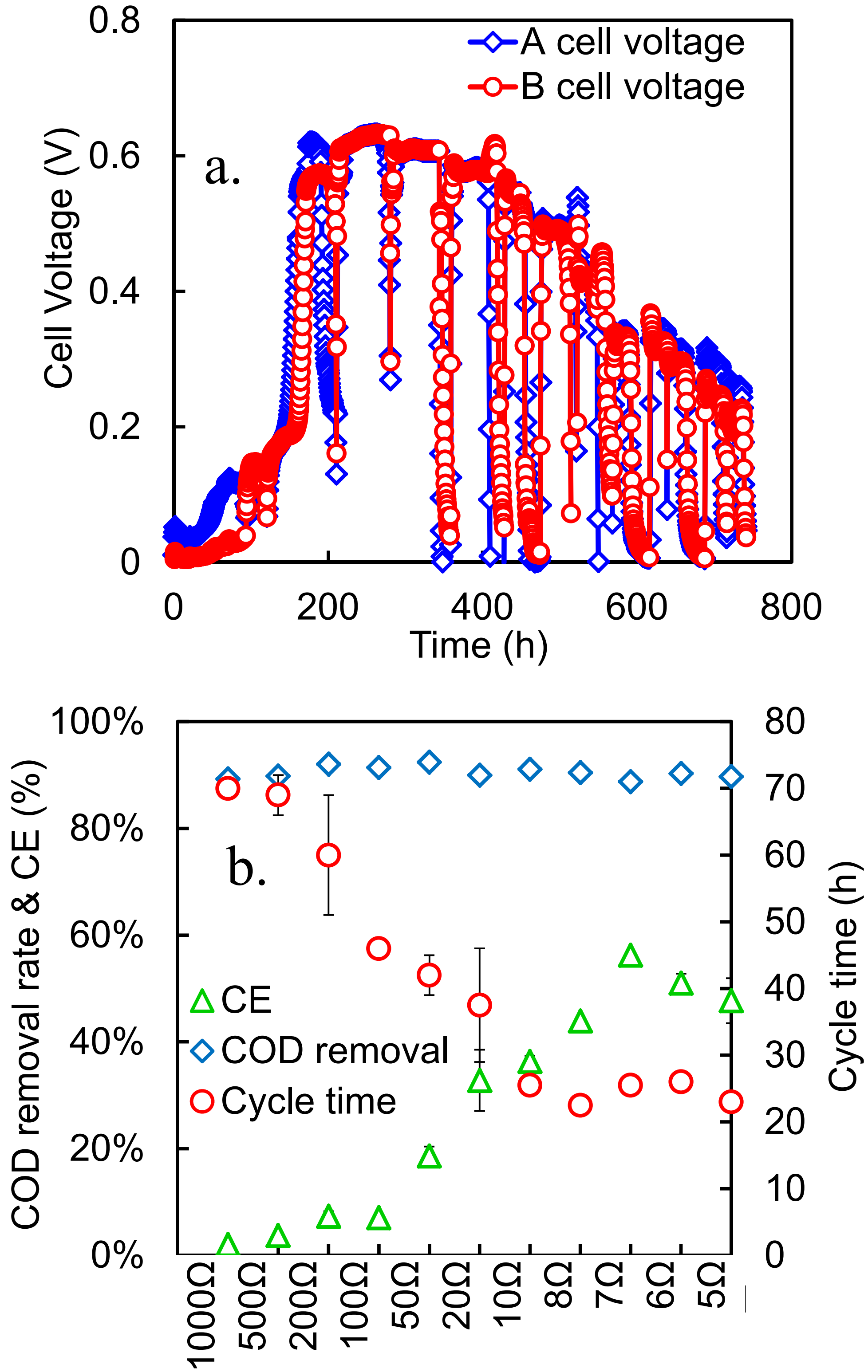
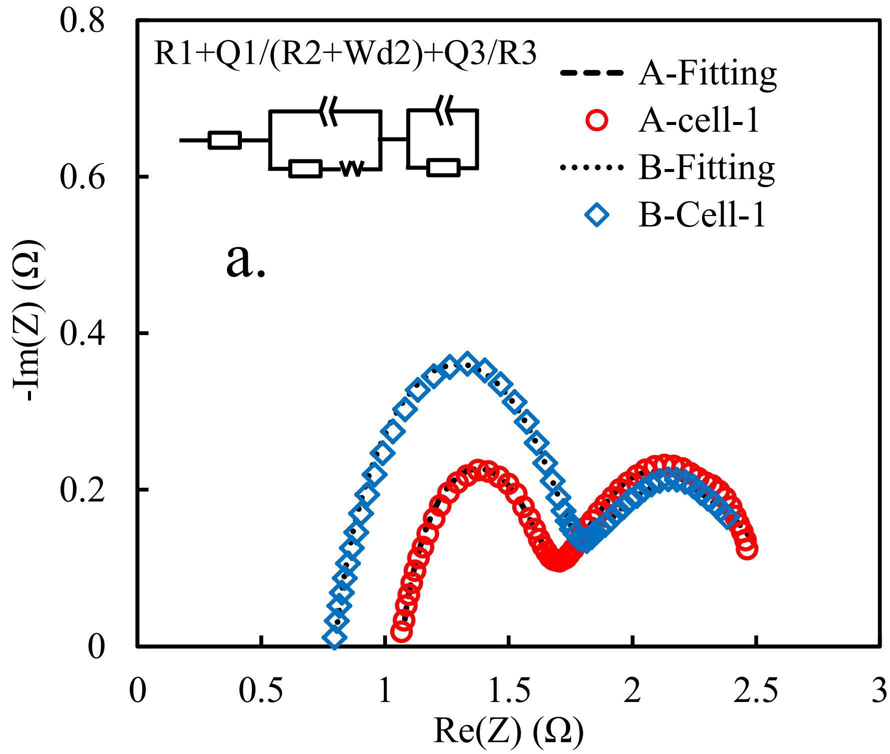
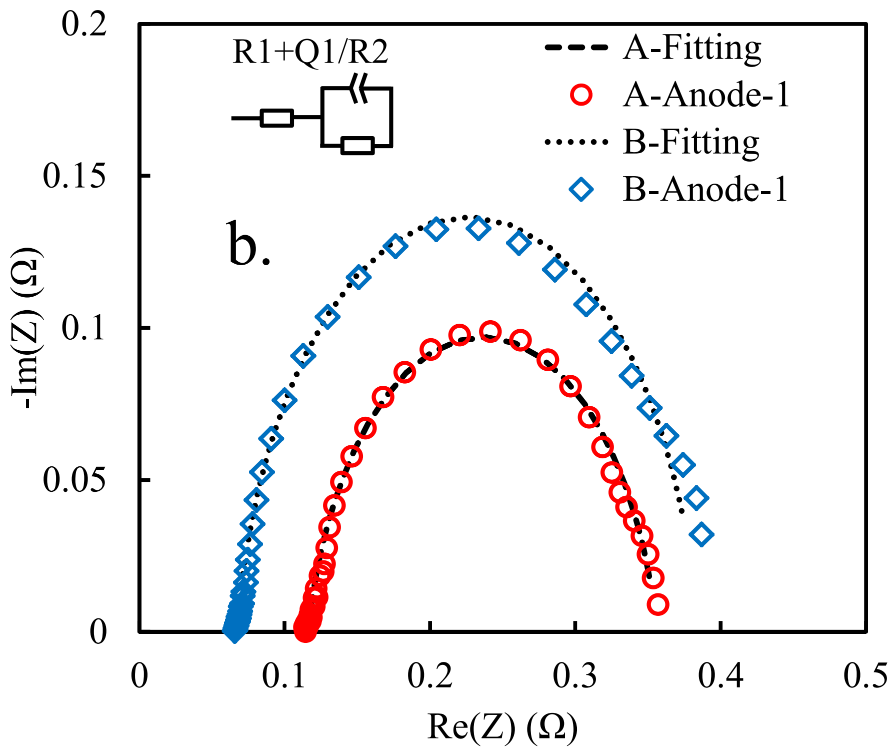


Figure S3. (a) Cell voltage, and (b) COD removal and columbic efficiency of the MFC stack in fed batch mode during startup using acetate amended wastewater



R1+Q1/(R2+Wd2)+Q3/R3
A-Fitting
A-cell-1
B-Fitting
B-Cell-1
a.
-Im(Z) (Ω)
Re(Z) (Ω)
0
0.2
0.4
0.6
0.8
0.5
1
1.5
2
2.5
3



R1+Q1/R2
A-Fitting
A-Anode-1
B-Fitting
B-Anode-1
b.
-Im(Z) (Ω)
Re(Z) (Ω)
0
0.05
0.1
0.15
0.2
0.1
0.2
0.3
0.4
0.5

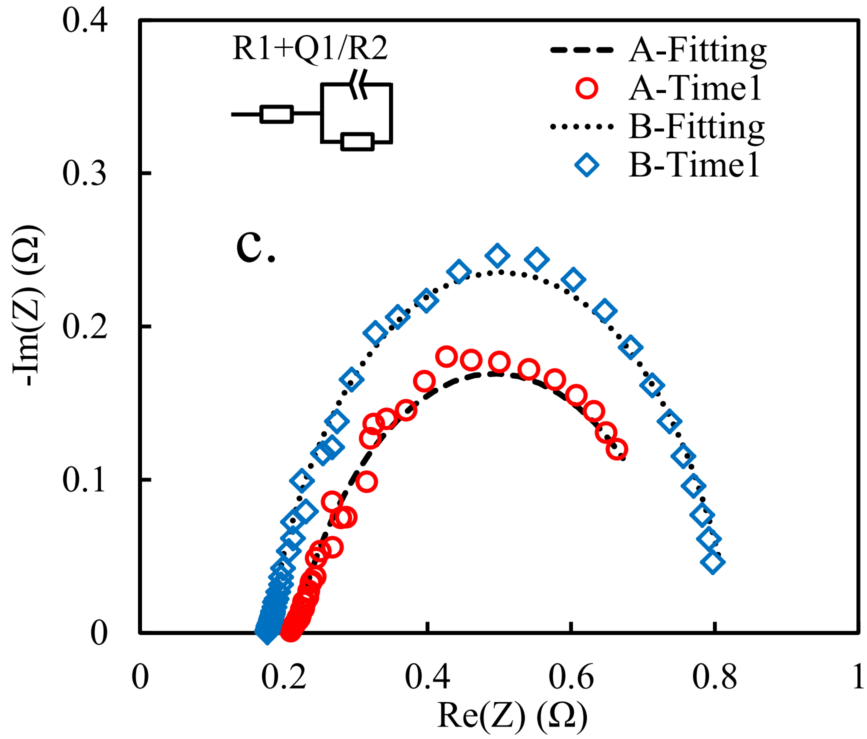


Figure S4. Examples of the Nyquist plats for (a) the whole-cell, and (b) anode impedance of the MFC stack using acetate amended domestic wastewater, and (c) example of anode impedance of the MFC stack in the batch mode using original wastewater.

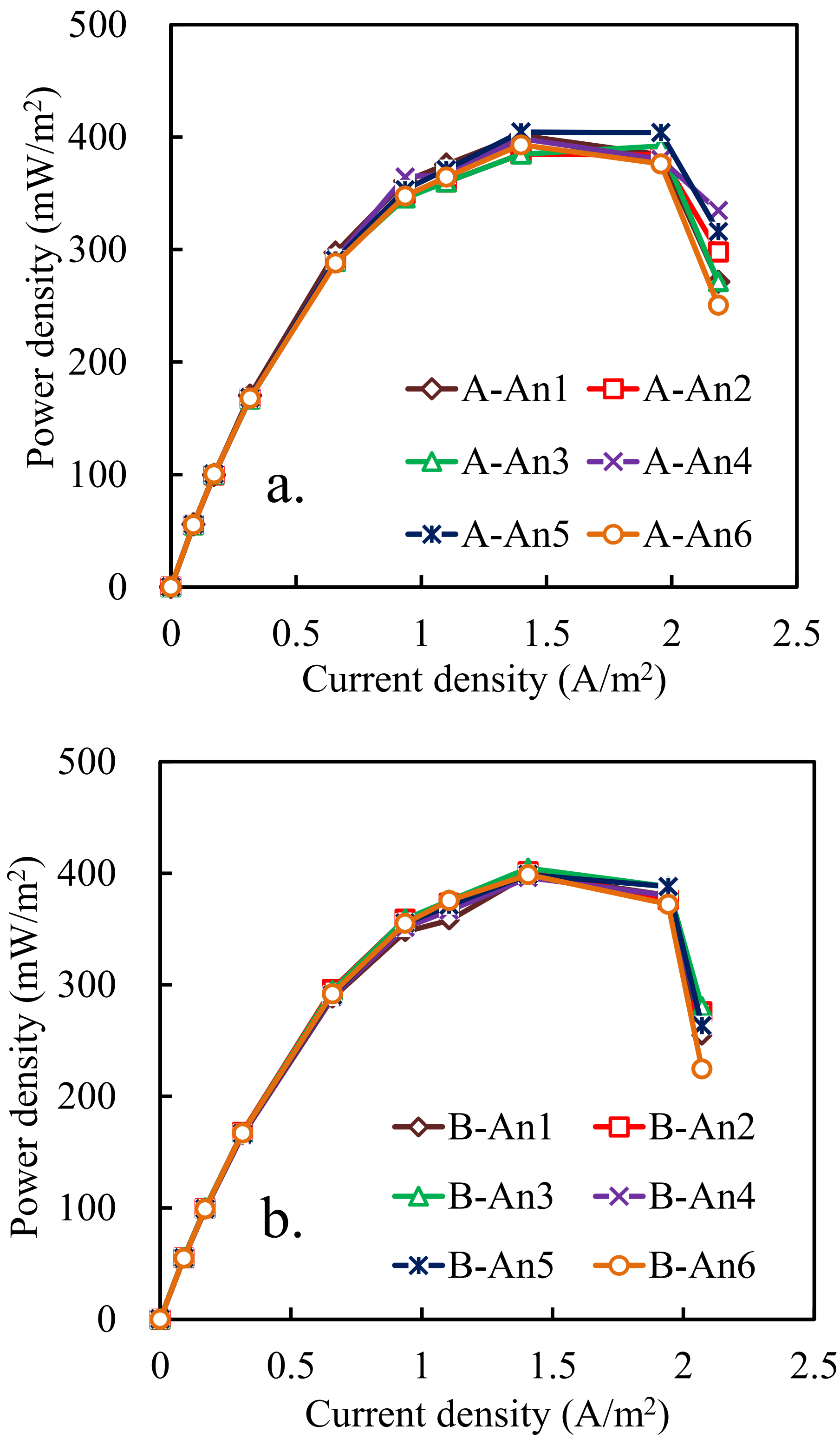


Figure S5. Polarization curve of the anode brushes in the MFC stacks, operated in fed batch mode, using domestic wastewater, for sides A and B.

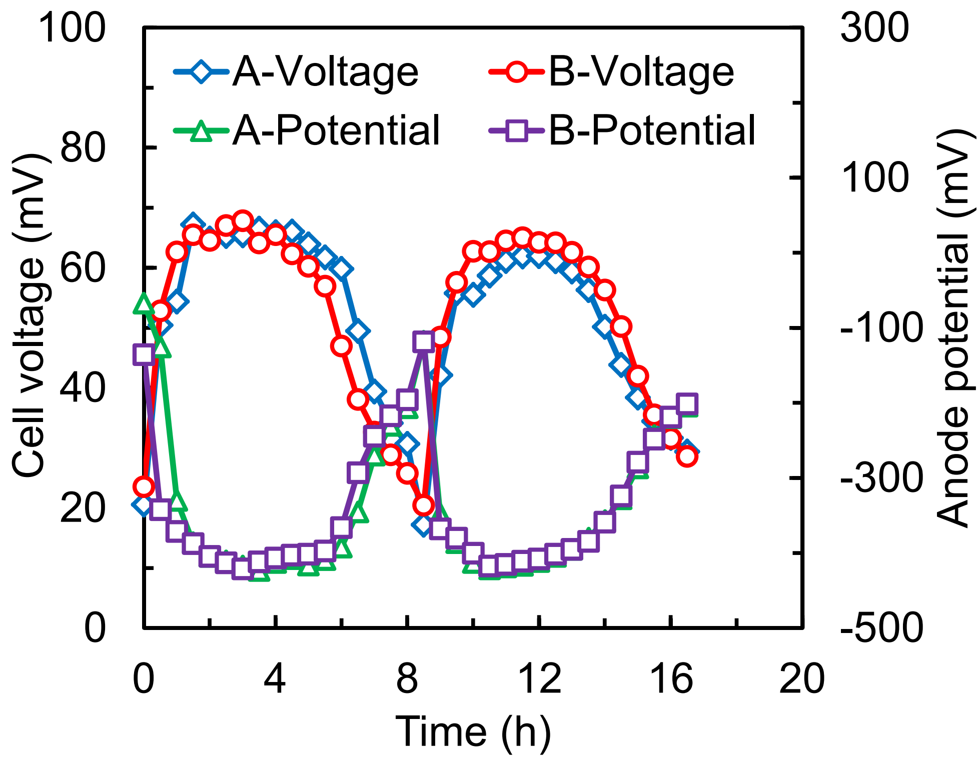
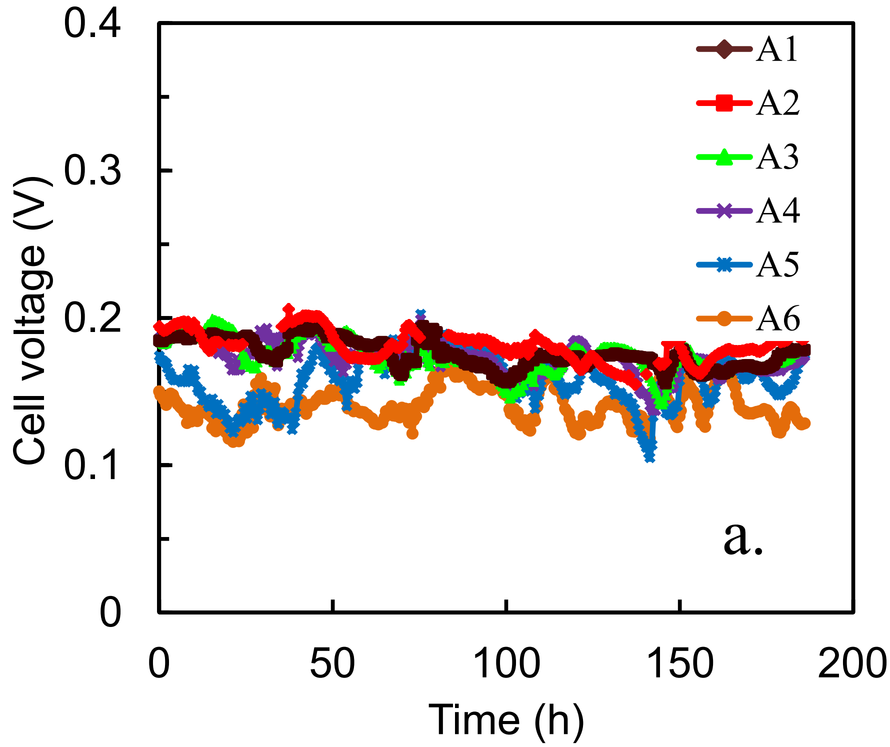
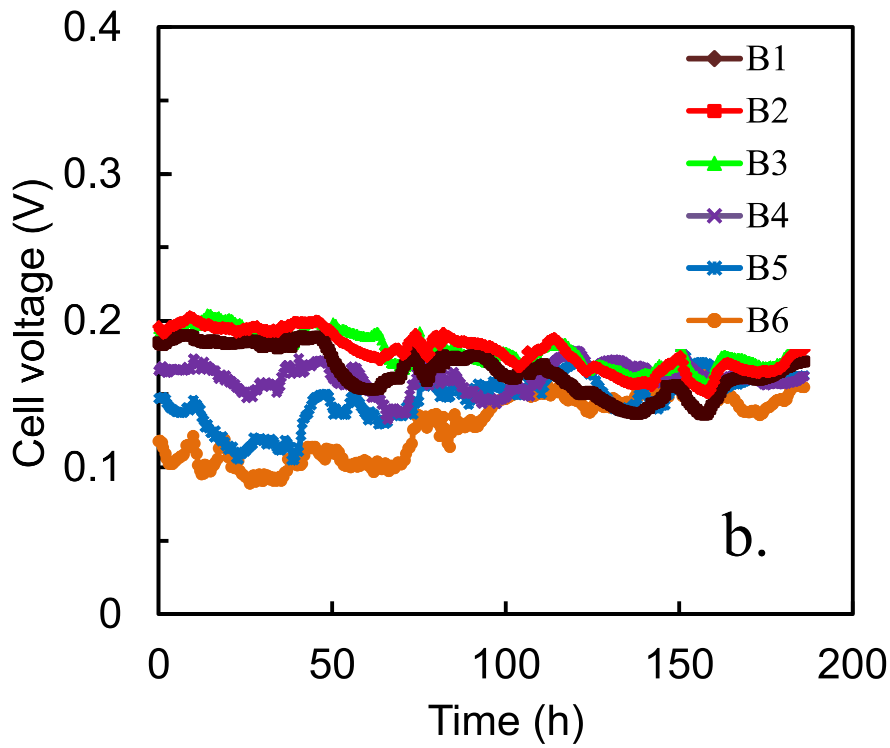


Figure S6. Cell voltage and anode potentials of the MFC module in fed batch mode with an external resistance of 1.5 Ω, using domestic wastewater.



0.4
0.3
0.2
0.1
0
Cell voltage (V)
A1
A2
A3
A4
A5
A6
a.
0
50
100
150
200
Time (h)



0.4
0.3
0.2
0.1
0
Cell voltage (V)
B1
B2
B3
B4
B5
B6
b.
0
50
100
150
200
Time (h)

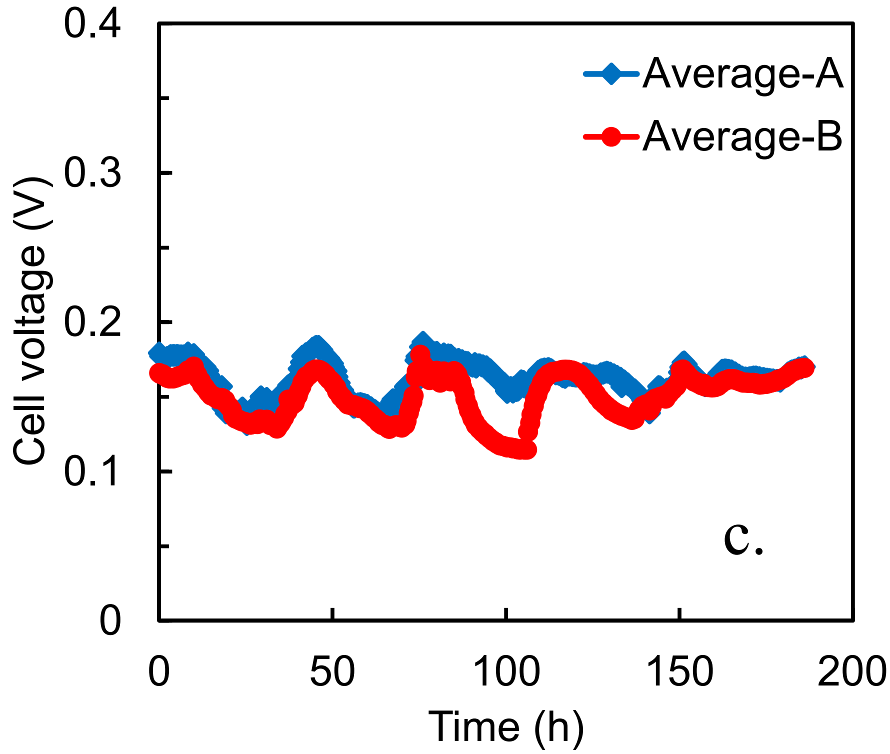


Figure S7. The voltage generated by the anodes of (a) compartment A, and (b) compartment B in the MFCs in fed batch mode, and (c) in continuous mode (HRT = 8 h) using domestic wastewater. The voltage data of the MFC stack were obtained with the anode separately connected with cathode separately with an external resistance of 30 Ω.

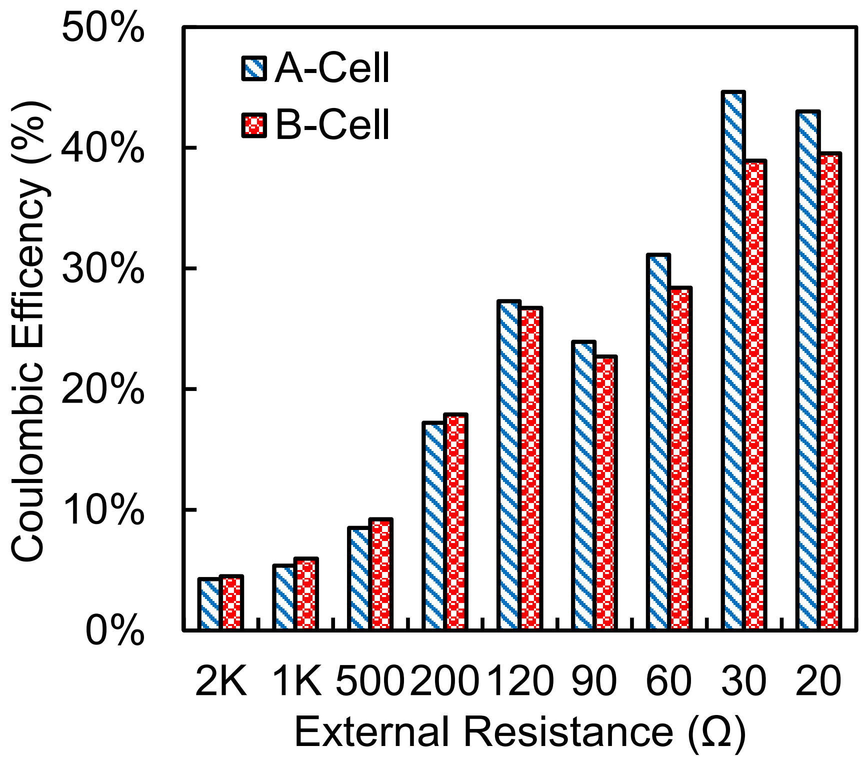


Figure S8. Columbic efficiencies in continuous flow mode measured using different external resistances.

Data explanation: The columbic efficiency (CE) is the ratio of the total coulombs transferred through the external circuit divided by the theoretical amount of coulombs for the measured change in COD. Higher CE indicated a higher percentage of substrate was removed with current generation. The CE of the MFC stack in continuous flow mode was up to 41 ± 2%, which was among the highest CEs recorded in scaled up reactor for domestic wastewater in air–cathode MFCs, consistent with CEs increasing when current and power densities are increased.

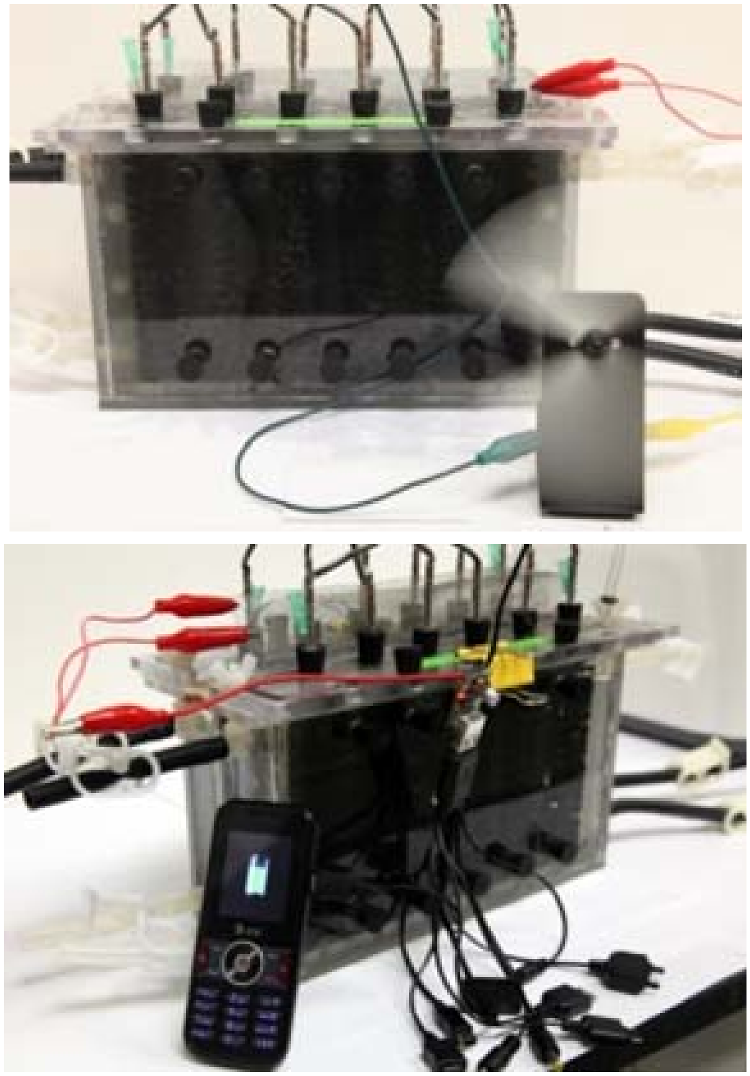


Figure S9. Photographs of the MFC module fed domestic wastewater that was used to power a fan or charge an AT&T cellphone.

Table S1: Simulation of whole-cell impedance changes of the MFC stack by using three kinds of spacers with acetate amended wastewater.

Whole-Cell resistance	Mesh Spacer			
R1 (Ω)	1.065	1.032	0.7965	0.7776
R2 (Ω)	0.555	0.5821	0.9412	0.7067
Rd2 (Ω)	0.1118	0.07295	0.06579	0.07489
R3 (Ω)	0.9654	1.046	0.8644	0.88
TR (Ω)	2.6972	2.73305	2.66789	2.43919

Whole-Cell resistance	Column Spacer			
R1 (Ω)	1.061	1.02	1.091	1.049
R2 (Ω)	0.7926	0.1736	0.626	0.5882
Rd2 (Ω)	0.01986	0.09781	0.2784	0.302
R3 (Ω)	0.1781	0.7734	0.0741	0.06277
TR (Ω)	2.05156	2.06481	2.0695	2.00197

Whole-Cell resistance	Wire Spacer			
R1 (Ω)	1.018	0.9892	1.118	1.097
R2 (Ω)	0.5152	0.532	0.0415	0.0577
Rd2 (Ω)	0.222	0.2249	0.08482	0.07123
R3 (Ω)	0.1091	0.05583	0.9034	0.7717
TR (Ω)	1.8643	1.80193	2.14772	1.99763

Table S2: Simulation of anode impedance changes of the MFC stack by using three kinds of spacers with acetate amended wastewater.

Anode Resistance	Mesh Spacer			
R1 (Ω)	0.1161	0.1159	0.06752	0.0672
R2 (Ω)	0.241	0.2643	0.3171	0.3328
TR (Ω)	0.3571	0.3802	0.38462	0.4

Anode Resistance	Column Spacer			
R1 (Ω)	0.1526	0.1695	0.2288	0.2196
R2 (Ω)	0.3311	0.3212	0.4117	0.3725
TR (Ω)	0.4837	0.4907	0.6405	0.5921

Anode Resistance	Wire Spacer			
R1	0.1928	0.195	0.09618	0.09558
R2	0.1872	0.191	0.2278	0.2124
TR	0.38	0.386	0.32398	0.30798

Table S3: Simulation of anode impedance of the MFC stack in the batch mode using original domestic wastewater.

Anode Resistance	T1		T2		T3	
R1 (Ω)	0.2136	0.1789	0.2358	0.1673	0.222	0.1647
R2 (Ω)	0.56	0.647	0.4264	0.595	0.4788	0.5482
TR (Ω)	0.7736	0.8259	0.6622	0.7623	0.7008	0.7129

Anode Resistance	T4		T5		T6	
R1 (Ω)	0.2137	0.1627	0.2378	0.1626	0.2276	0.1619
R2 (Ω)	0.5194	0.7217	0.6495	0.93	1.383	1.85
TR (Ω)	0.7331	0.8844	0.8873	1.0926	1.6106	2.0119