

SUPPORTING INFORMATION

Using copper-based biocathodes to improve carbon dioxide conversion efficiency into methane in microbial methanogenesis cells

Gahyun Baek, Le Shi, and Bruce E. Logan*

¹Department of Civil and Environmental Engineering, The Pennsylvania State University,
231Q Sackett Building, University Park, PA 16802, USA

*Corresponding author: e-mail: blogan@psu.edu; phone: +1-814-863-7908; fax: +1-814-863-7304

Table S1. Comparison with previous MMC studies.

Anode material	Cathode material	Cathodic potential (V vs. Ag/AgCl)	Methane production rate (L/L/d)	Cathodic methane recovery (%)	Ref
Ti/ IrO ₂ -Ta ₂ O ₅	GGAC (Ti plate)	-1.05	4.6	27	[1]
Pt/Ti/IrO ₂	GAC	-0.58	4.3	66	[2]
Pt/Ti/IrO ₂	Graphite granules	-1.1	4.1	67	[2]
Ti/IrO ₂	Ti mesh/Pt	-2.5	1.6	65	[3]
Ti/IrO ₂	Ti mesh/Pt	-2.1	1.6	95	[3]
Ti/IrO ₂	Ti mesh/Pt	-1.84	1.6	85	[4]
Ti/IrO ₂	Ti mesh/Pt	-1.6	1.4	62	[3]
Ti/ IrO ₂ -Ta ₂ O ₅	GGAC (Ti plate)	-1	1.0	22	[1]
Pt/Ti	Graphite felt	-0.9	0.5	73	[5]
Pt foil	Graphite felt	-1.3	0.4	69	[6]
Ti/ IrO ₂ -Ta ₂ O ₅	Ni foam	-0.95	0.3	93	[7]
Carbon felt	Carbon felt	-0.75	0.2	89	[8]
Graphite felt	Graphite felt	-0.9	0.1	99	[9]
Graphite felt	Graphite felt	-0.8	0.07	92	[9]
Carbon brush	Carbon cloth	-1	0.03	96	[10]
Carbon fiber brush	Carbon cloth	-1	0.02	36	[11]
Glassy carbon rod	Carbon paper	-0.95	0.007	76	[12]
Carbon brush	Pt/GB	-0.6	0.006	78	[13]
Carbon cloth	Carbon cloth	-0.7	0.005	93	[14]
Pt/Ti	Graphite felt	-0.75	0.005	18	[15]
Carbon brush	Graphite block	-0.9	0	0	This study
Carbon brush	Cu foil	-0.9	0	0	This study
Carbon brush	e-deposition-Cu	-0.9	0.001	28	This study
Carbon brush	Nafion-Cu	-0.9	0.0002	13	This study
Carbon brush	Electroless-Cu	-0.9	0.003	22	This study

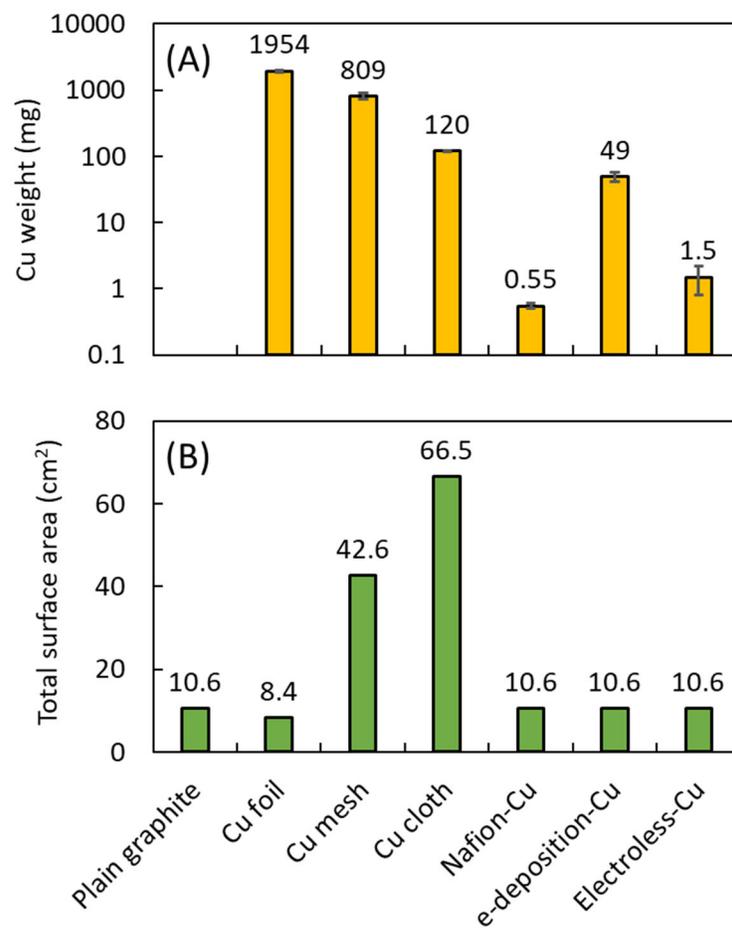


Fig. S1. (A) Total mass of copper and (B) total surface area of each electrode.

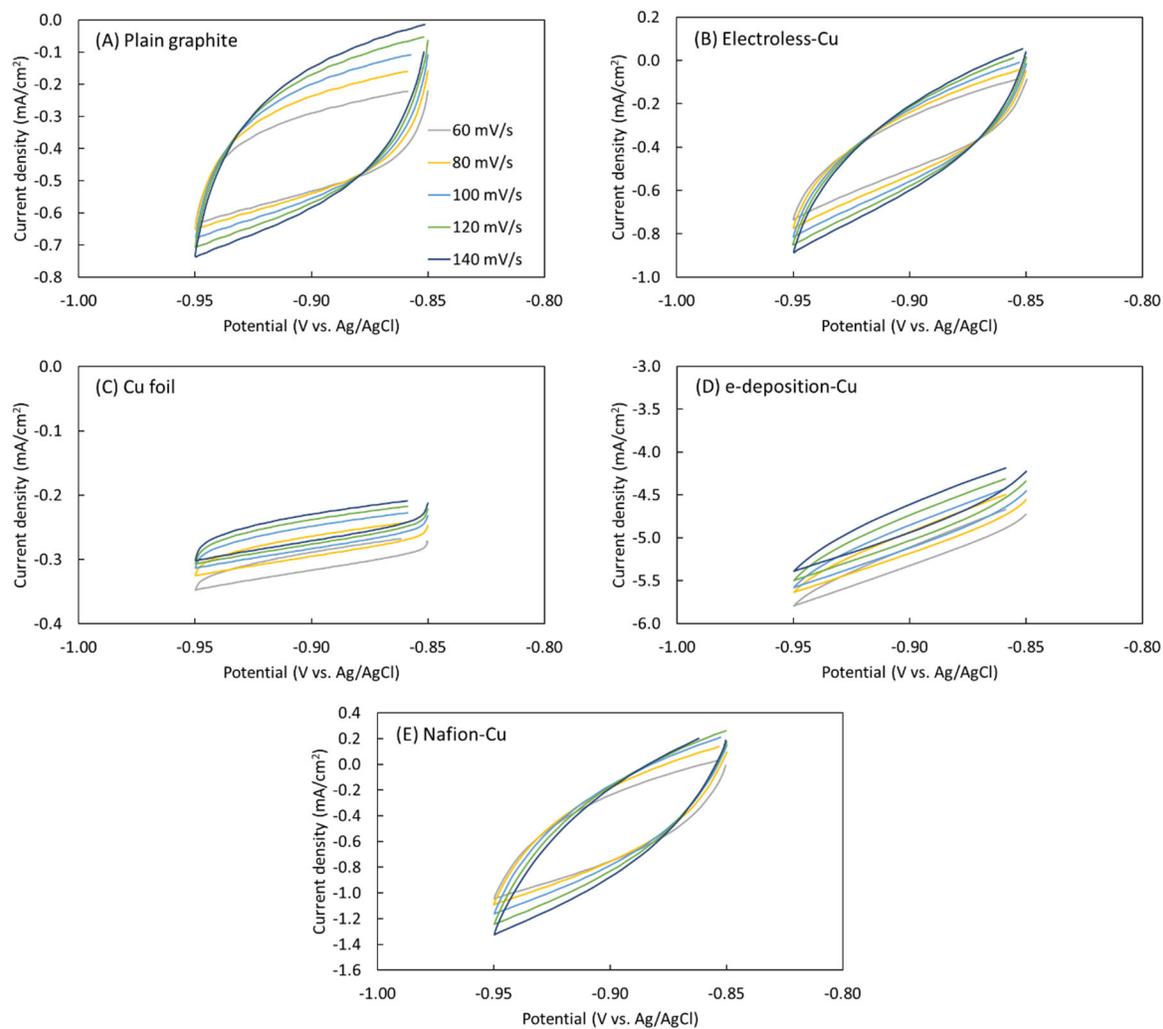


Fig. S2. Cyclic voltammetry (CV) curves using different cathode materials to calculate electrochemical double-layer capacitance (C_{dl}) and estimate electrochemically active surface area.

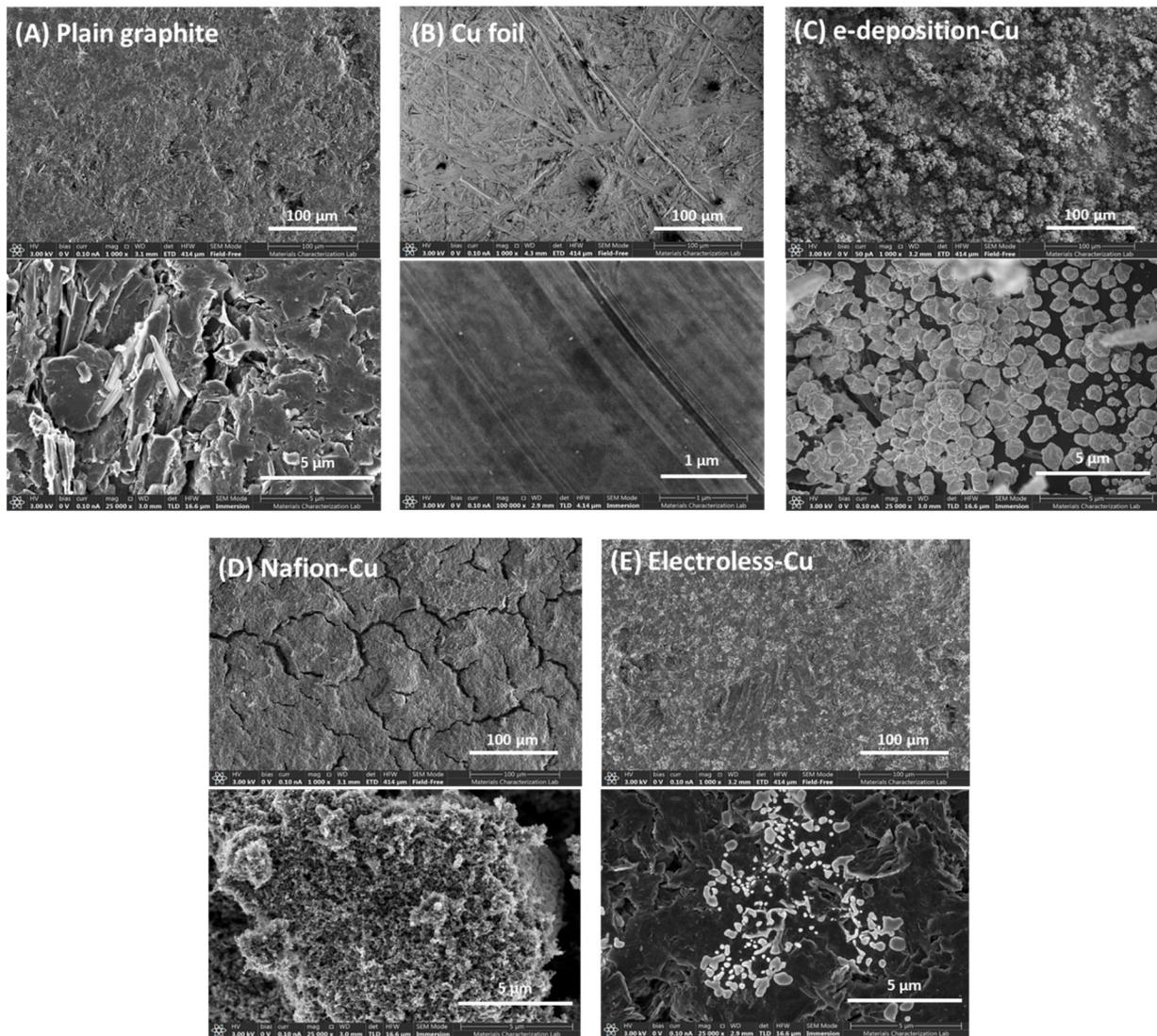
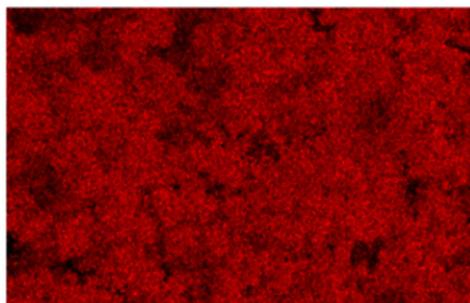


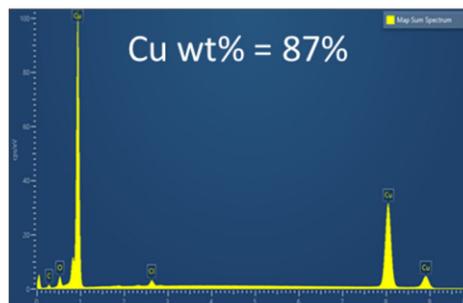
Fig. S3. Scanning electron microscopic (SEM) images of the surface of each cathode materials.

(A) e-deposition-Cu

Cu K α 1

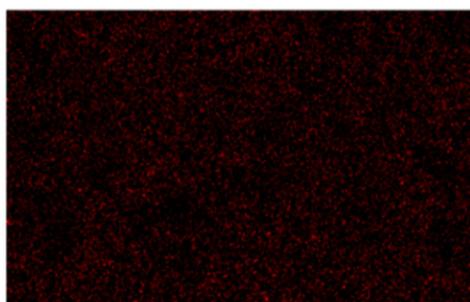


100 μ m

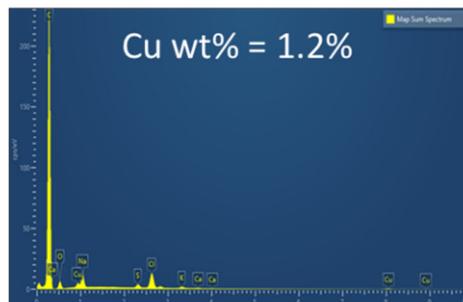


(B) Electroless-Cu

Cu K α 1

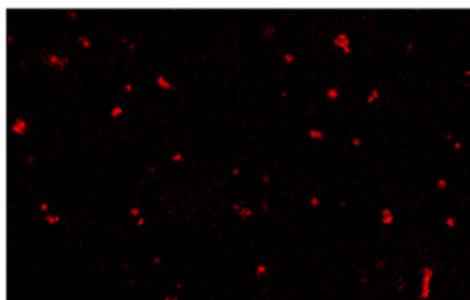


100 μ m



(C) Nafion-Cu

Cu K α 1



100 μ m

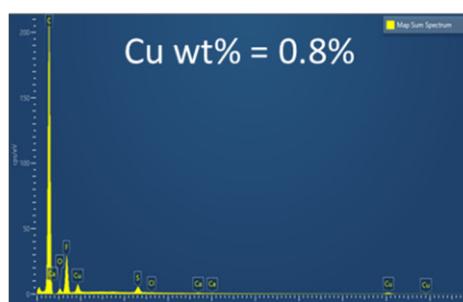


Fig. S4. Energy-dispersive X-ray spectroscopy (EDS) mapping results for the copper-based cathode materials prepared by different coating methods. Atomic percentage of copper was calculated based on the EDS spectrum.

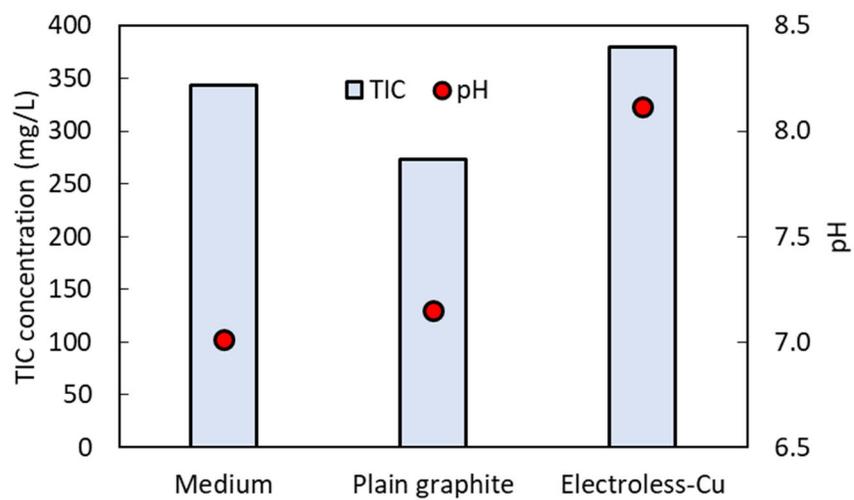


Fig. S5. Changes in pH and TIC concentration after 24 hours of abiotic reaction.

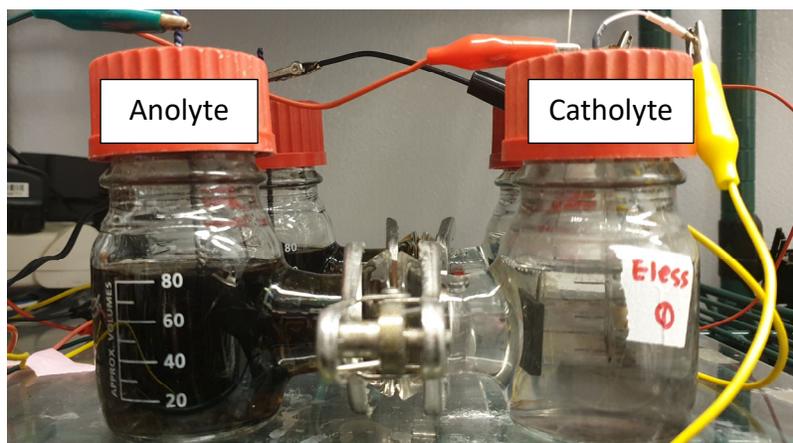


Fig. S6. Change in the anolyte color of electroless-Cu reactors after the fifth cycle.

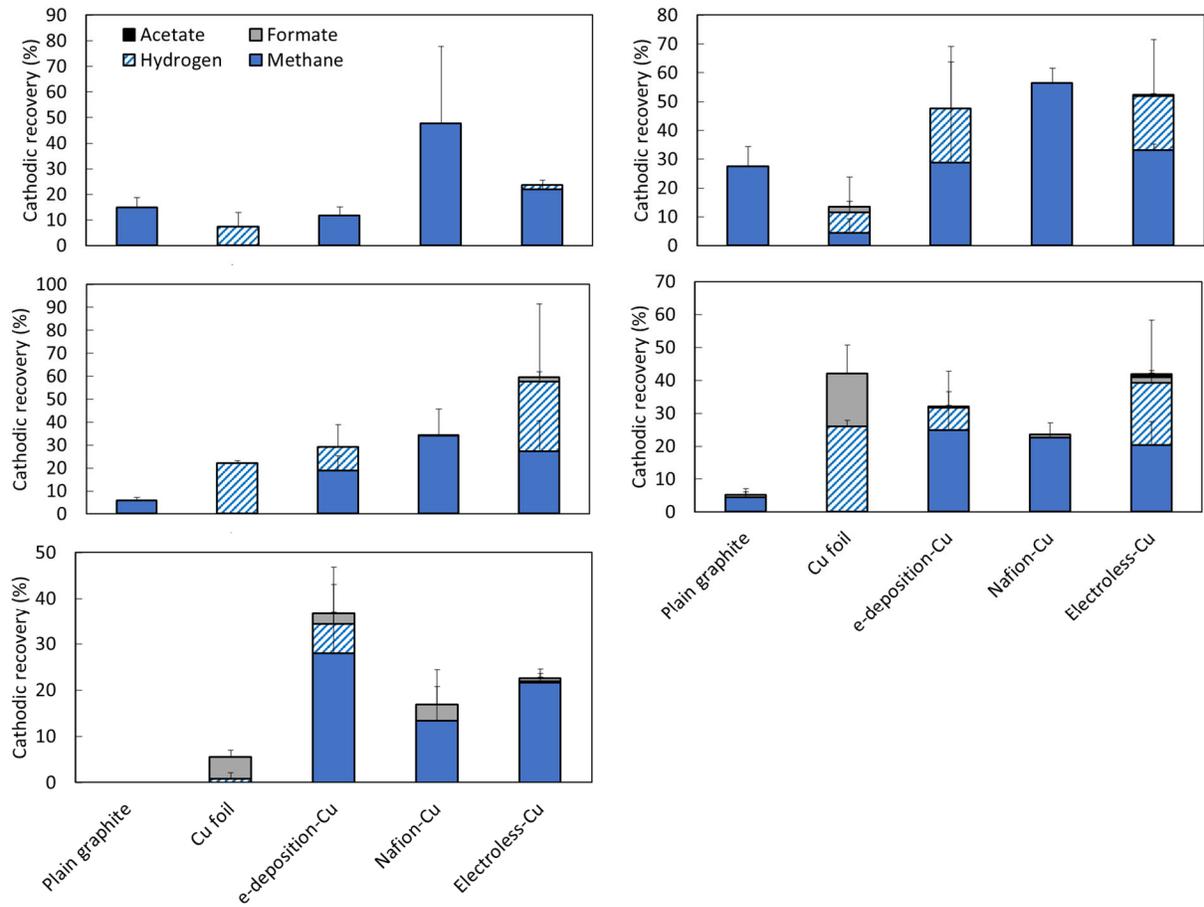


Fig. S7. Cathodic recovery based on biogas and VFA productions at the end of each cycle

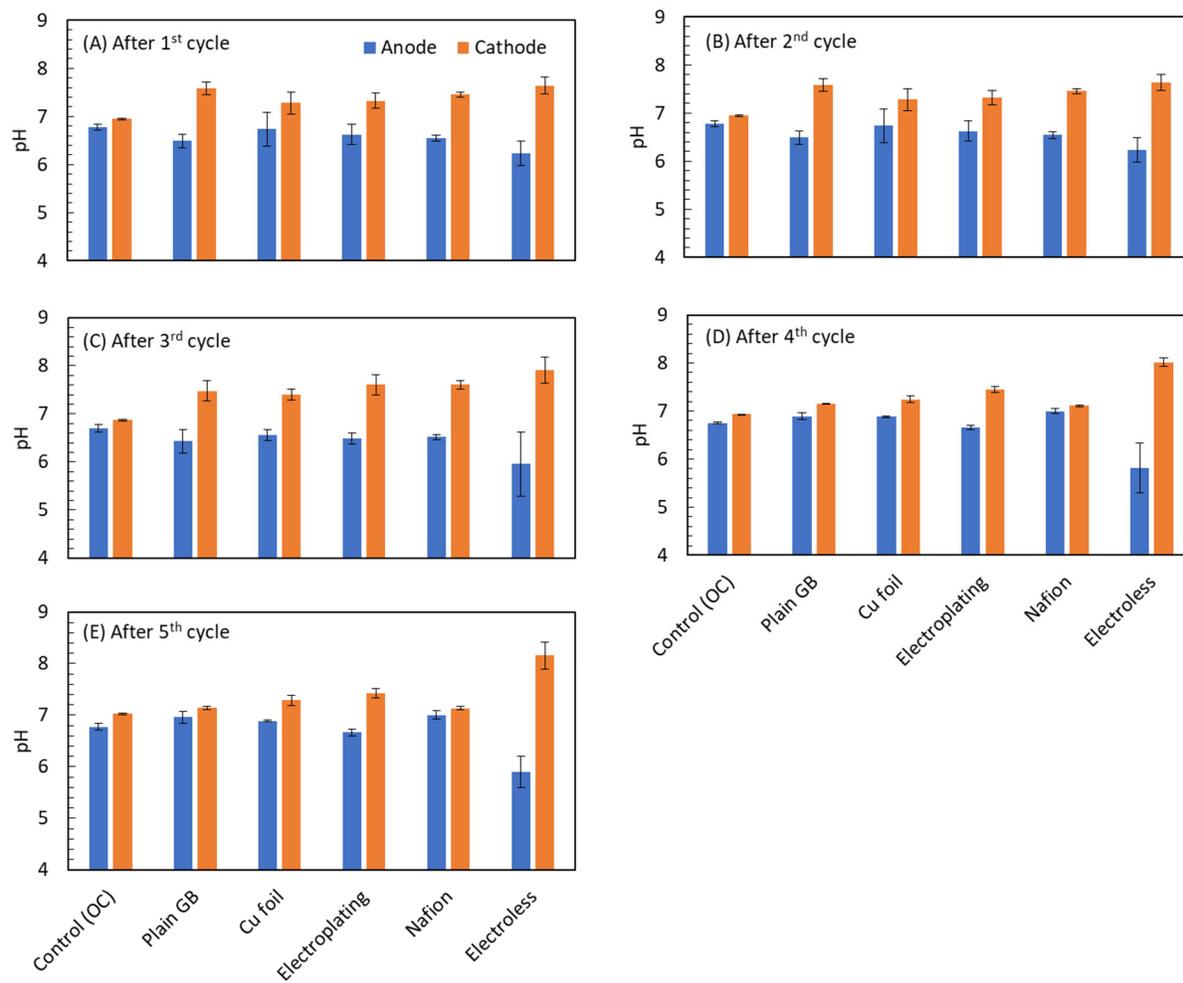


Fig. S8. pH of anolyte and catholyte at the end of each cycle

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