Electronic Supplementary Material (ESI) for Environmental Science: Water Research & Technology.

Supporting Information

Carbon Electrodes are Effective for the Detection and Reduction of Hexavalent Chromium in Water

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Impact of citric acid on voltammograms of 200 µM Cr(VI)

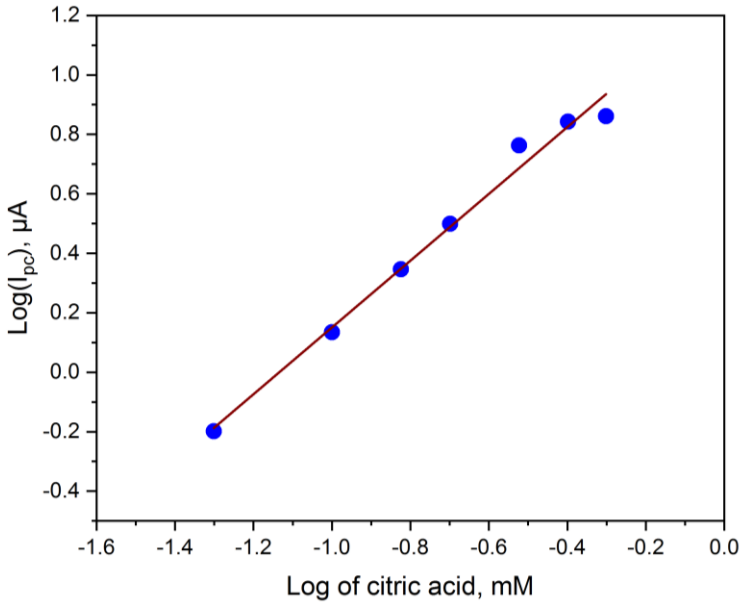

Figure S1. Evolution of cathodic peak current with increasing citric acid concentration in the presence of 200 µM K_2CrO_4 in 1 M KCl in water, pH not controlled. The slope of the linear fit is 1.12 µA/dec with an adj. R^2 value of 0.985. Data collected on 3 mm diameter glassy carbon electrodes.

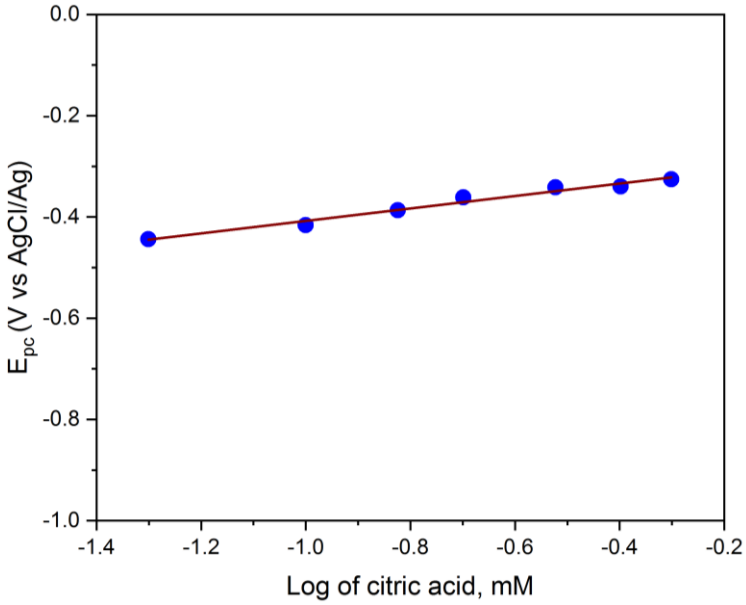

Figure S2. Evolution of cathodic peak potential with increasing citric acid concentration in the presence of 200 µM K_2CrO_4 in 1 M KCl in water, pH not controlled. The slope of the linear fit is 0.123 V/dec with an adj. R^2 value of 0.971.

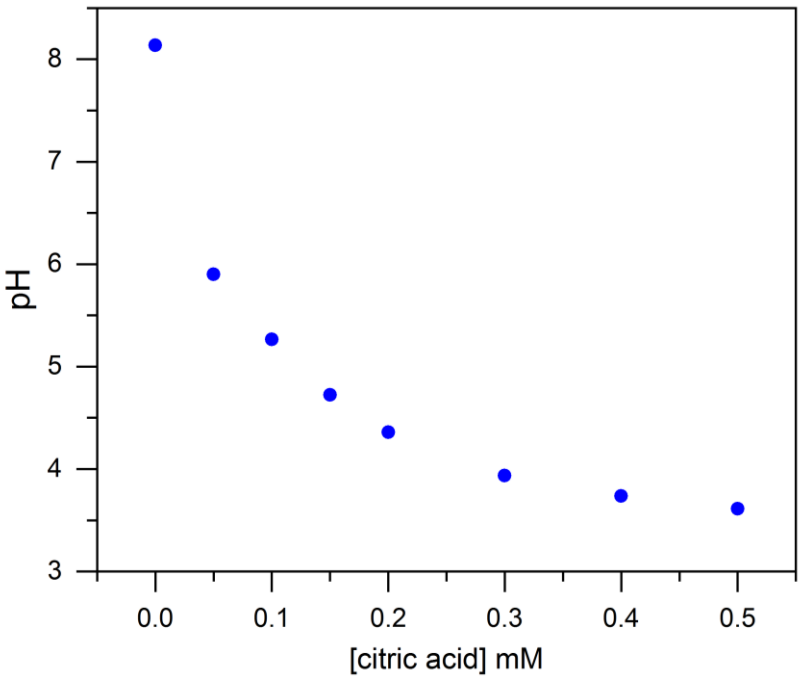

Figure S3. Evolution of pH with increasing citric acid concentration in the presence of 200 µM K_2CrO_4 in 1 M KCl in water, pH not controlled. Concentration of citric acid from 0, 0.05, 0.1, 0.15, 0.2, 0.3, 0.4, 0.5 mM.

UV-vis spectra of K_2CrO_4 and $K_2Cr_2O_7$ at 100 µM total Cr(VI)

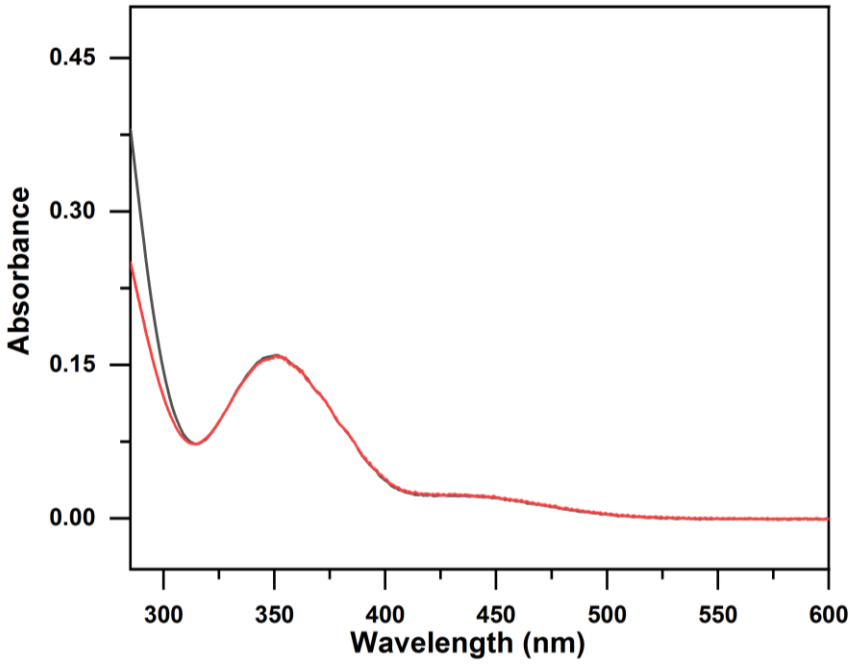

Figure S4. UV-Vis spectra of 100 µM K_2CrO_4 (grey) and 50 µM $K_2Cr_2O_7$ (red) in aqueous solutions in the presence of a 0.1 M citric acid buffer at a pH of 5.00 and 1 M KCl.

Impact of citric acid on UV-vis spectra of 200 µM Cr(VI)

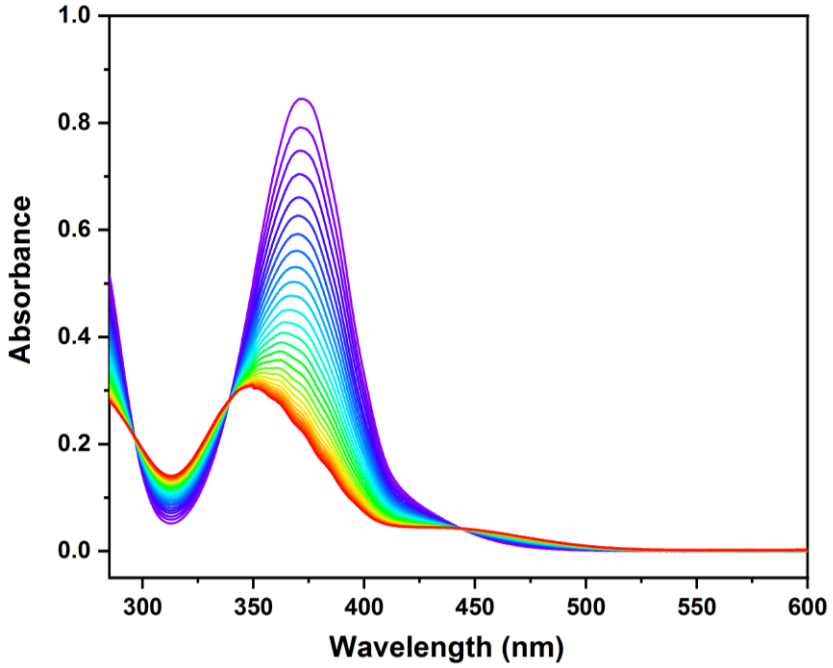

Figure S5. Evolution of the UV-Vis spectrum of an aqueous solution of 200 µM K_2CrO_4 with sequential 5.2 µM additions of citric acid. Starting volume 2 mL and ending volume 2.027 mL. Data shown is corrected for dilution.

Citric Acid (µM)	pH
0	7.322
5.2	7.077
10.4	6.993
15.6	6.867
20.8	6.774
26.0	6.713
31.2	6.596
36.4	6.510
41.6	6.451
46.8	6.387
52.0	6.291
57.2	6.221
62.4	6.130
67.6	6.095

Citric Acid (µM)	pH
72.8	6.025
78.0	5.944
83.2	5.878
88.4	5.775
93.6	5.706
98.8	5.629
104.0	5.552
109.2	5.437
114.4	5.375
119.6	5.295
124.8	5.176
130.0	5.096
135.2	5.045
140.4	4.955

Table S1. Evolution of pH in an unbuffered aqueous solution of 200 µM K_2CrO_4 with sequential 5.2 µM additions (1 µL) of citric acid.

Impact of [Cr(VI)] on voltammograms of citric acid at pH 4.75

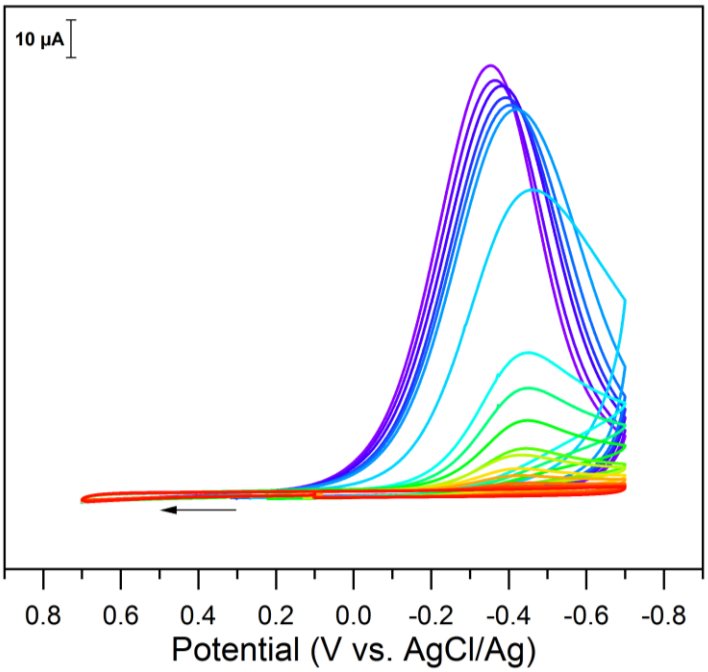

Figure S6. Representative cyclic voltammograms of 0.025 to 12 mM K_2CrO_4 in a 0.1 M citric acid buffer at pH 4.75 with 1 M KCl as the supporting electrolyte. Concentration of Cr(VI) from red to purple: 0.025, 0.05, 0.1, 0.15, 0.25, 0.3, 0.5, 0.75, 1, 3, 5, 6, 7, 8, 10, 12 mM. Data collected on 3 mm diameter glassy carbon electrodes.

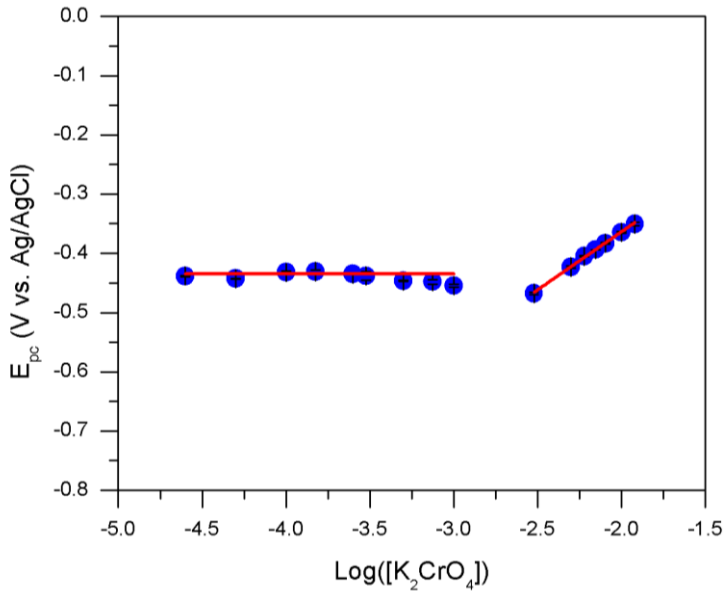

Figure S7. Evolution of the cathodic peak potential for 0.025 to 12 mM K_2CrO_4 titrated in a 0.1 M citric acid buffer at pH 4.75 in water with 1 M KCl as the supporting electrolyte. Red lines added to guide the eyes and define the two regimes.

Effect of pH on Cr(VI) detection and reduction

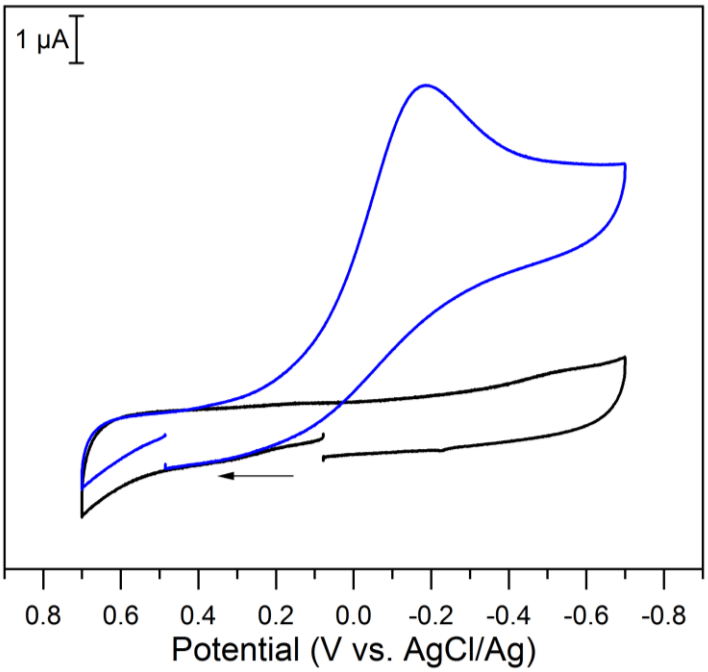

Figure S8. Representative cyclic voltammogram of 0.1 M citric acid buffer at pH of 2.25 in water with KCl as the supporting electrolyte in the absence (black) or presence (blue) of 200 µM K_2CrO_4. Data collected on 3 mm diameter glassy carbon electrodes.

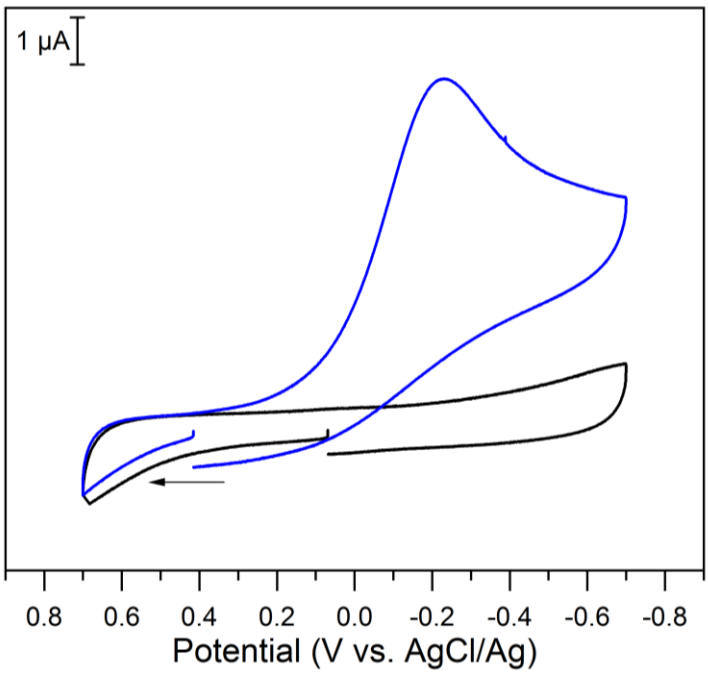

Figure S9. Representative cyclic voltammogram of 0.1 M citric acid buffer at pH of 2.50 in water with KCl as the supporting electrolyte in the absence (black) or presence (blue) of 200 µM K_2CrO_4. Data collected on 3 mm diameter glassy carbon electrodes.

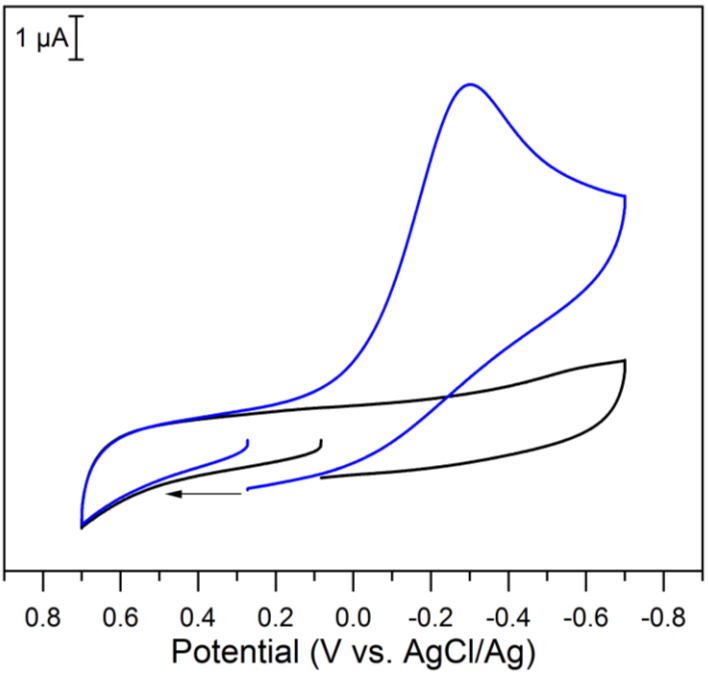

Figure S10. Representative cyclic voltammogram of 0.1 M citric acid buffer at pH of 2.75 in water with KCl as the supporting electrolyte in the absence (black) or presence (blue) of 200 µM K_2CrO_4. Data collected on 3 mm diameter glassy carbon electrodes.

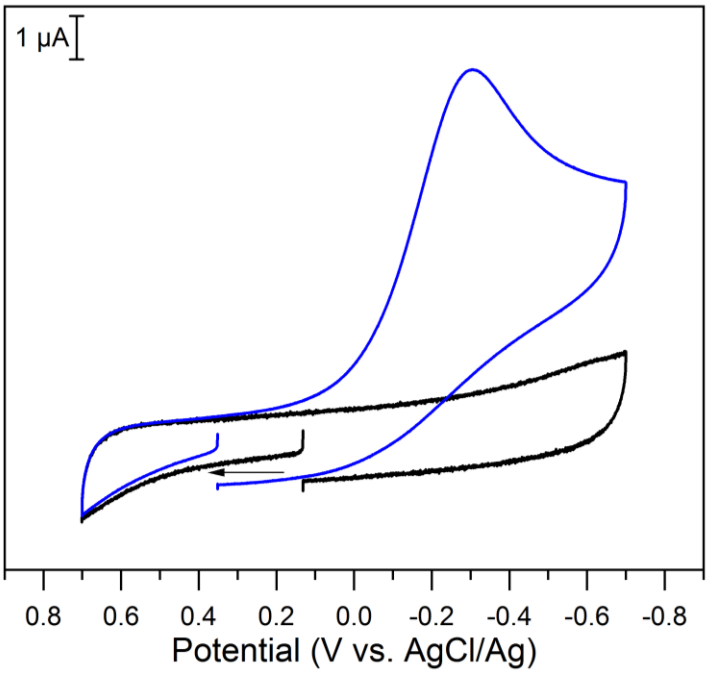

Figure S11. Representative cyclic voltammogram of 0.1 M citric acid buffer at pH of 3.00 in water with KCl as the supporting electrolyte in the absence (black) or presence (blue) of 200 µM K_2CrO_4. Data collected on 3 mm diameter glassy carbon electrodes.

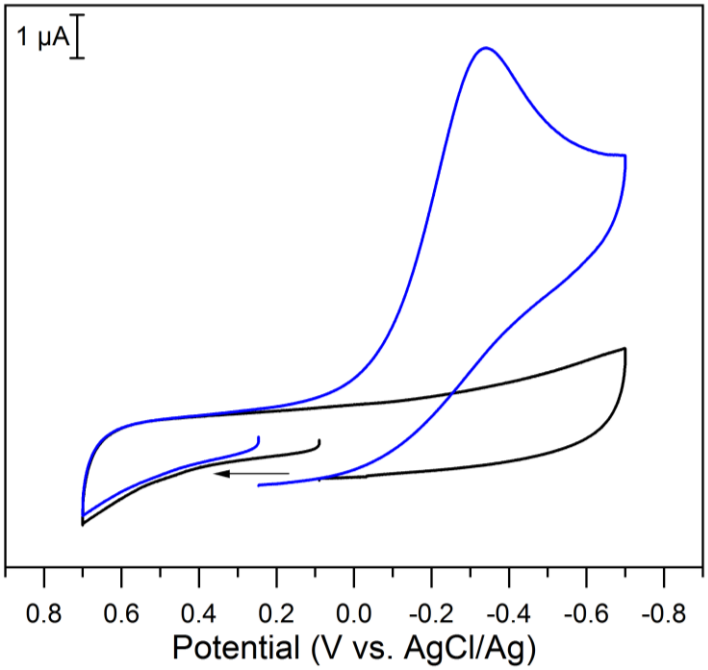

Figure S12. Representative cyclic voltammogram of 0.1 M citric acid buffer at pH of 3.25 in water with KCl as the supporting electrolyte in the absence (black) or presence (blue) of 200 µM K_2CrO_4. Data collected on 3 mm diameter glassy carbon electrodes.

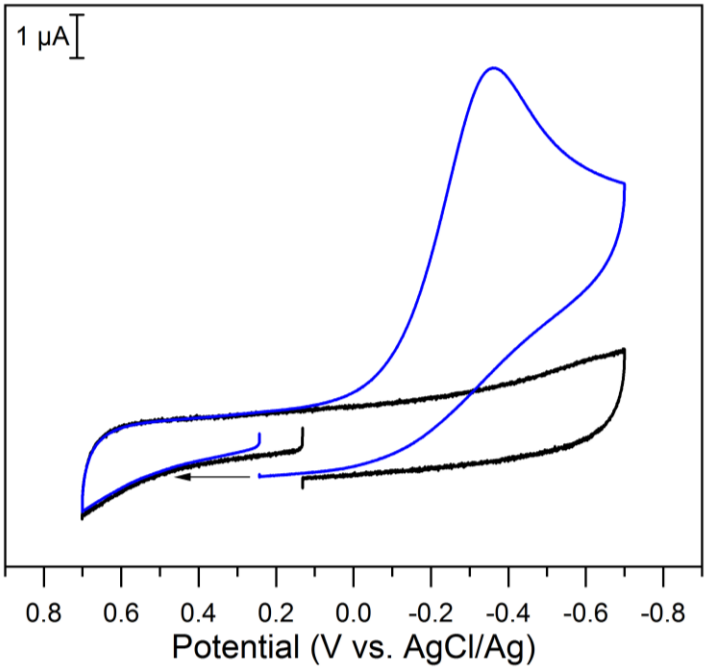

Figure S13. Representative cyclic voltammogram of 0.1 M citric acid buffer at pH of 3.50 in water with KCl as the supporting electrolyte in the absence (black) or presence (blue) of 200 µM K_2CrO_4. Data collected on 3 mm diameter glassy carbon electrodes.

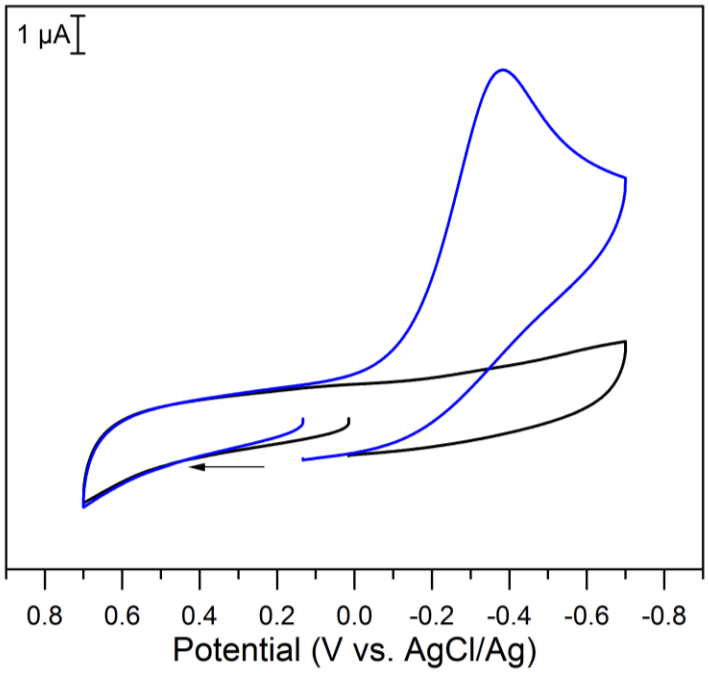

Figure S14. Representative cyclic voltammogram of 0.1 M citric acid buffer at pH of 3.75 in water with KCl as the supporting electrolyte in the absence (black) or presence (blue) of 200 µM K_2CrO_4. Data collected on 3 mm diameter glassy carbon electrodes.

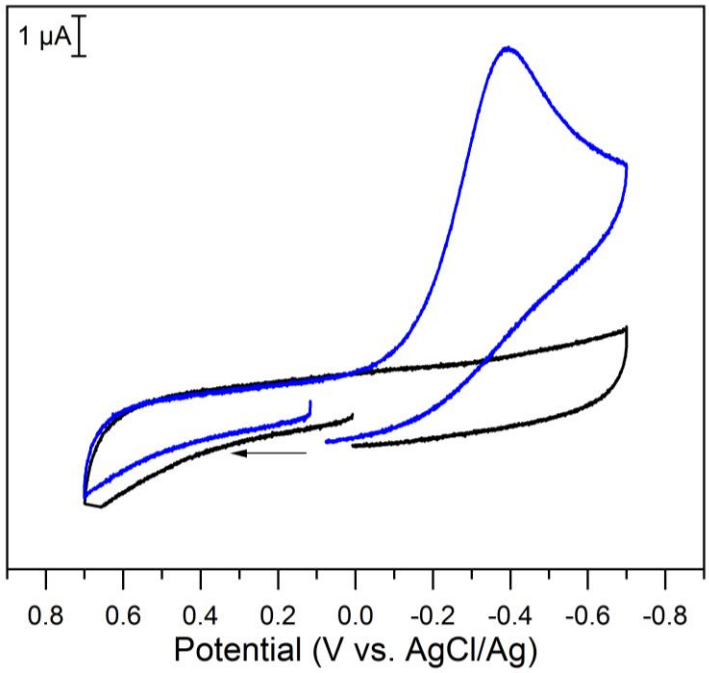

Figure S15. Representative cyclic voltammogram of 0.1 M citric acid buffer at pH of 4.00 in water with KCl as the supporting electrolyte in the absence (black) or presence (blue) of 200 µM K_2CrO_4. Data collected on 3 mm diameter glassy carbon electrodes.

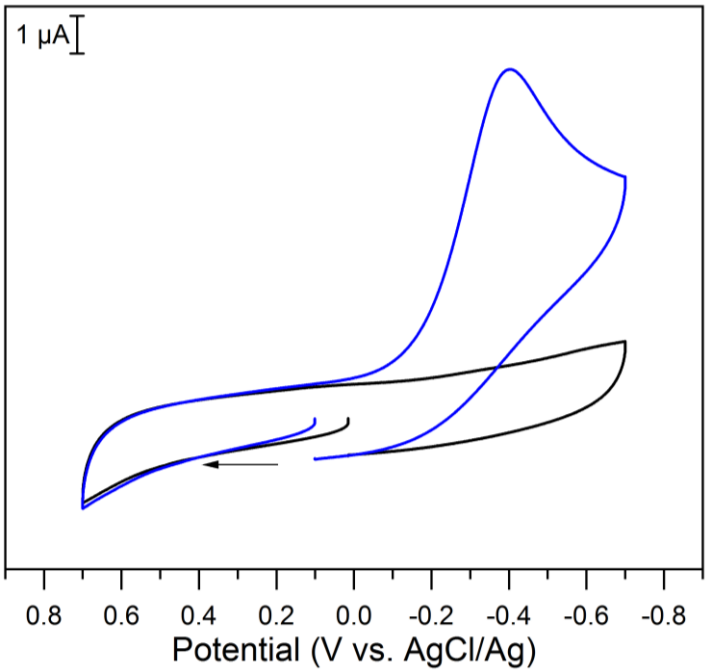

Figure S16. Representative cyclic voltammogram of 0.1 M citric acid buffer at pH of 4.25 in water with KCl as the supporting electrolyte in the absence (black) or presence (blue) of 200 µM K_2CrO_4. Data collected on 3 mm diameter glassy carbon electrodes.

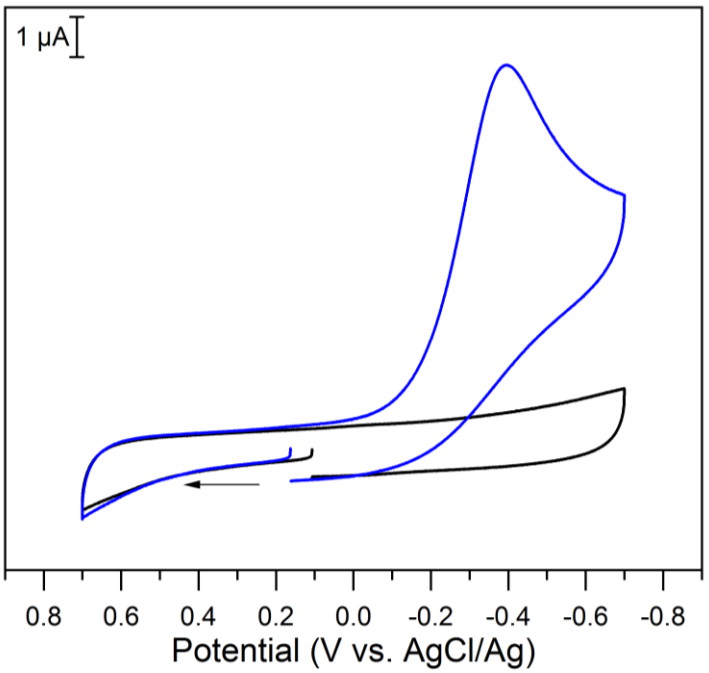

Figure S17. Representative cyclic voltammogram of 0.1 M citric acid buffer at pH of 4.50 in water with KCl as the supporting electrolyte in the absence (black) or presence (blue) of 200 µM K_2CrO_4. Data collected on 3 mm diameter glassy carbon electrodes.

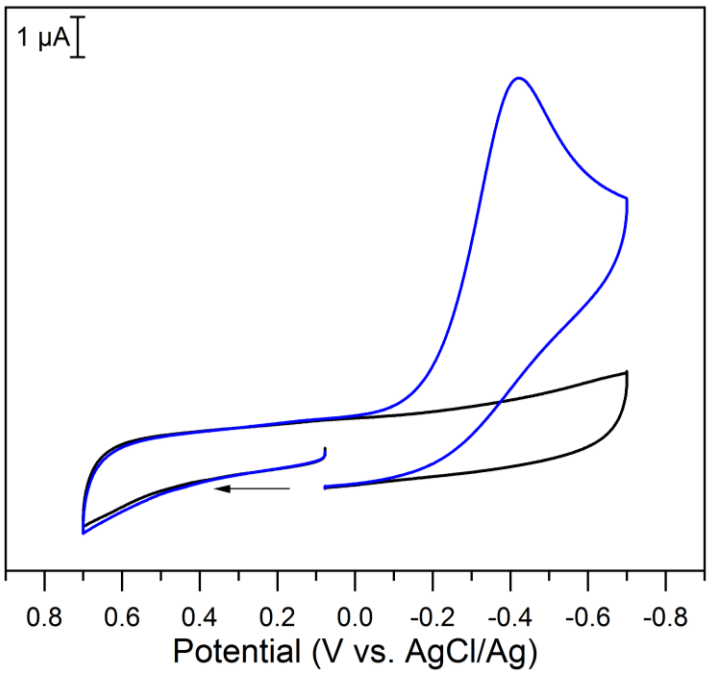

Figure S18. Representative cyclic voltammogram of 0.1 M citric acid buffer at pH of 4.75 in water with KCl as the supporting electrolyte in the absence (black) or presence (blue) of 200 µM K_2CrO_4. Data collected on 3 mm diameter glassy carbon electrodes.

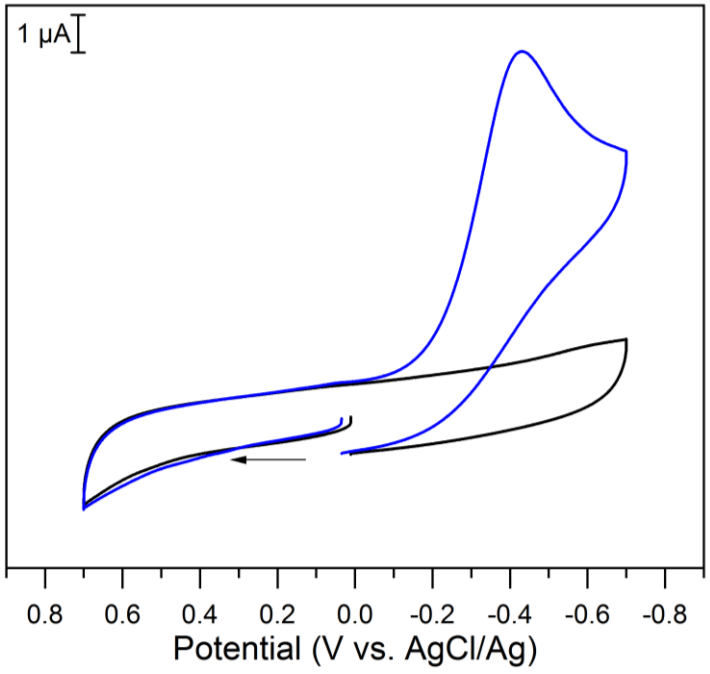

Figure S19. Representative cyclic voltammogram of 0.1 M citric acid buffer at pH of 5.00 in water with KCl as the supporting electrolyte in the absence (black) or presence (blue) of 200 µM K_2CrO_4. Data collected on 3 mm diameter glassy carbon electrodes.

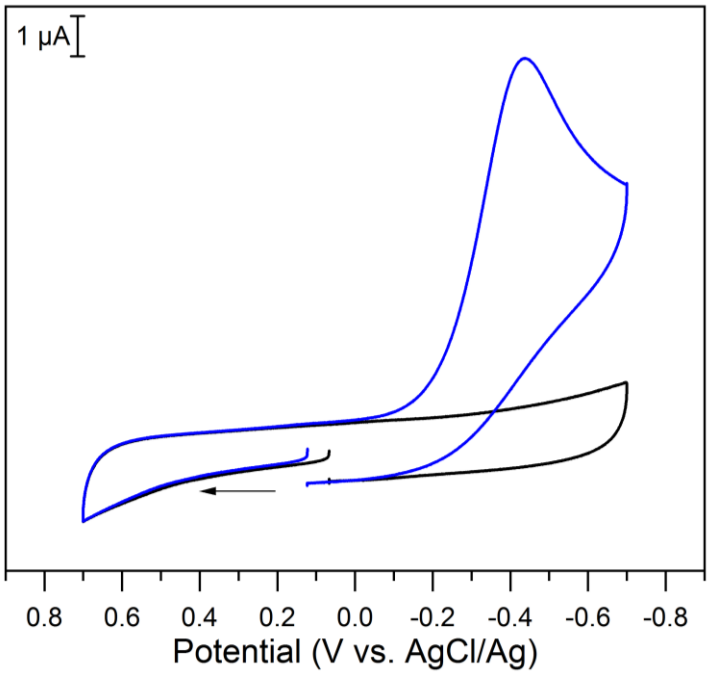

Figure S20. Representative cyclic voltammogram of 0.1 M citric acid buffer at pH of 5.25 in water with KCl as the supporting electrolyte in the absence (black) or presence (blue) of 200 µM K_2CrO_4. Data collected on 3 mm diameter glassy carbon electrodes.

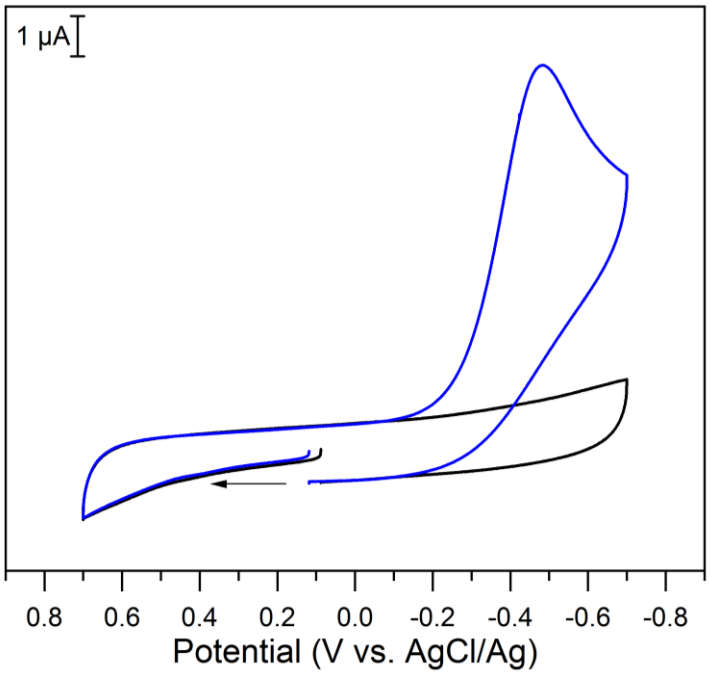

Figure S21. Representative cyclic voltammogram of 0.1 M citric acid buffer at pH of 5.50 in water with KCl as the supporting electrolyte in the absence (black) or presence (blue) of 200 µM K_2CrO_4. Data collected on 3 mm diameter glassy carbon electrodes.

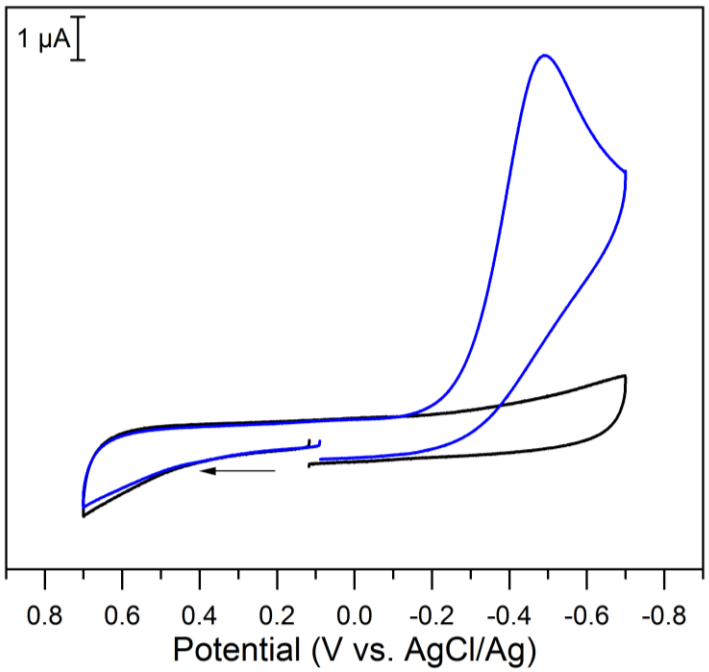

Figure S22. Representative cyclic voltammogram of 0.1 M citric acid buffer at pH of 5.75 in water with KCl as the supporting electrolyte in the absence (black) or presence (blue) of 200 µM K_2CrO_4. Data collected on 3 mm diameter glassy carbon electrodes.

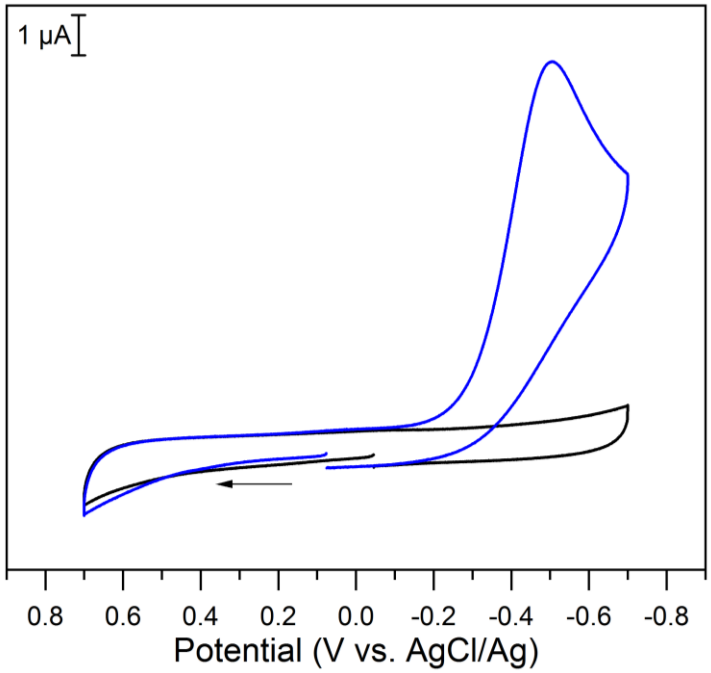

Figure S23. Representative cyclic voltammogram of 0.1 M citric acid buffer at pH of 6.00 in water with KCl as the supporting electrolyte in the absence (black) or presence (blue) of 200 µM K_2CrO_4. Data collected on 3 mm diameter glassy carbon electrodes.

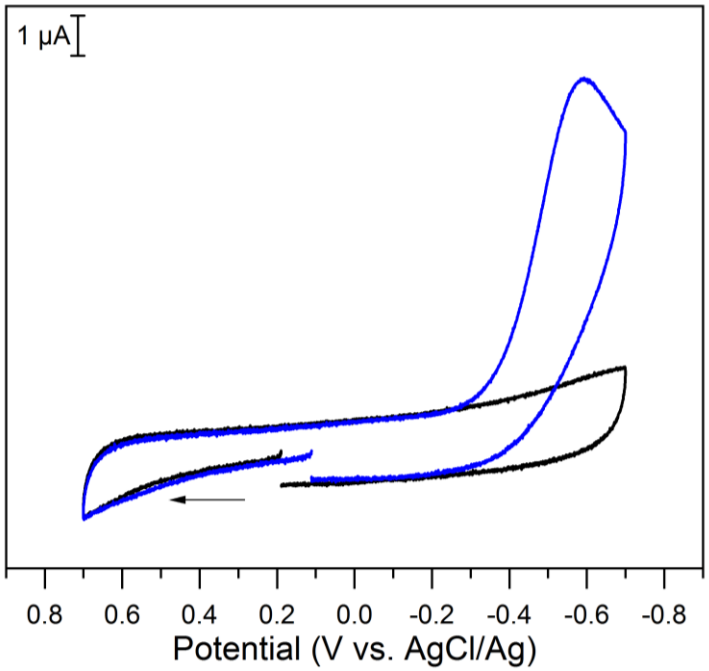

Figure S24. Representative cyclic voltammogram of 0.1 M citric acid buffer at pH of 6.25 in water with KCl as the supporting electrolyte in the absence (black) or presence (blue) of 200 µM K_2CrO_4. Data collected on 3 mm diameter glassy carbon electrodes.

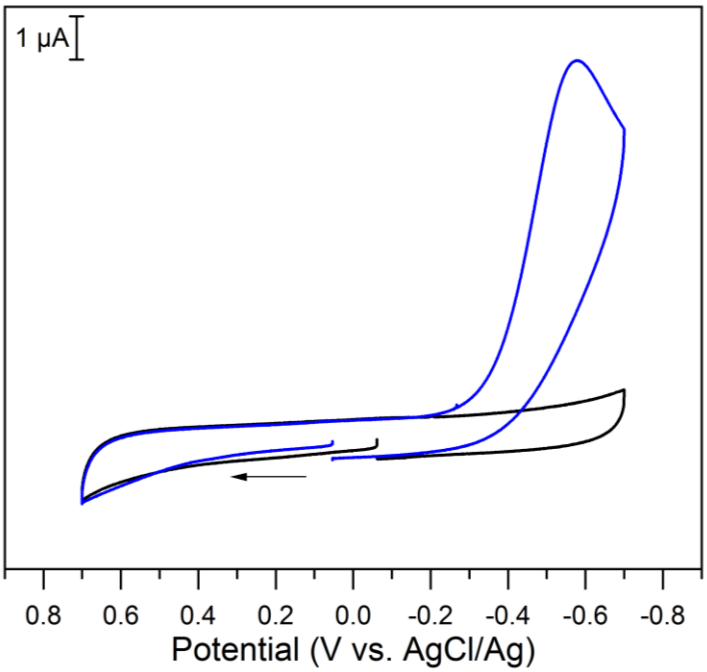

Figure S25. Representative cyclic voltammogram of 0.1 M citric acid buffer at pH of 6.50 in water with KCl as the supporting electrolyte in the absence (black) or presence (blue) of 200 µM K_2CrO_4. Data collected on 3 mm diameter glassy carbon electrodes.

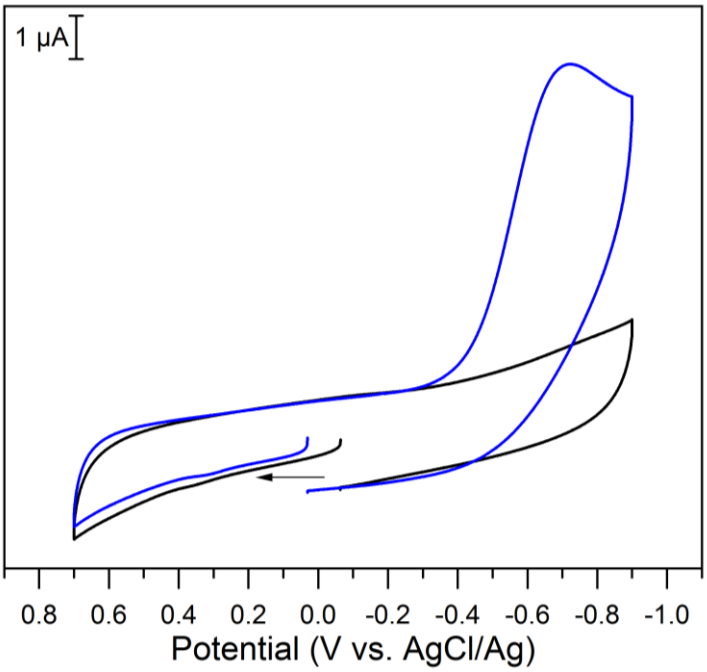

Figure S26. Representative cyclic voltammogram of 0.1 M citric acid buffer at pH of 6.75 in water with KCl as the supporting electrolyte in the absence (black) or presence (blue) of 200 µM K_2CrO_4. Data collected on 3 mm diameter glassy carbon electrodes.

Cr(VI) detection in different water sources at pH 4.75

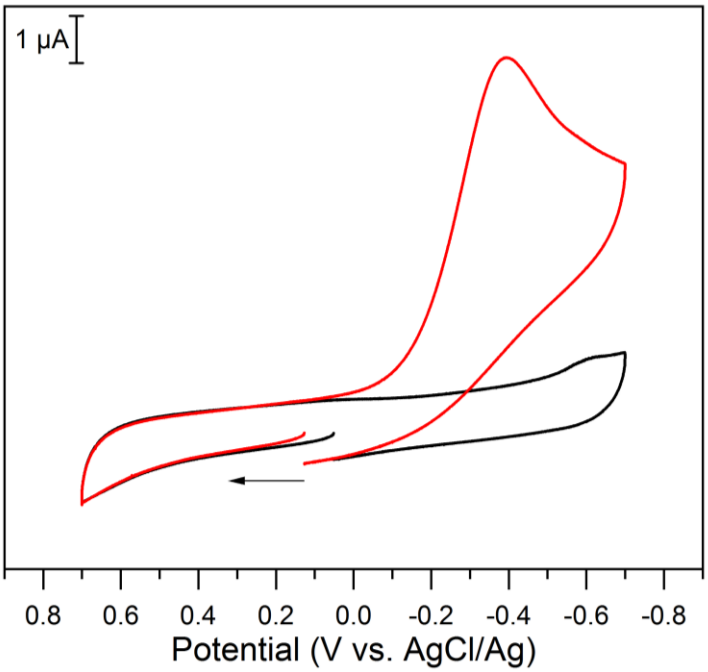

Figure S27. Representative cyclic voltammogram of 0.1 M citric acid buffer at pH of 4.75 in Milli-Q water with KCl as the supporting electrolyte in the absence (black) or presence (red) of 200 µM K_2CrO_4. Data collected on 3 mm diameter glassy carbon electrodes.

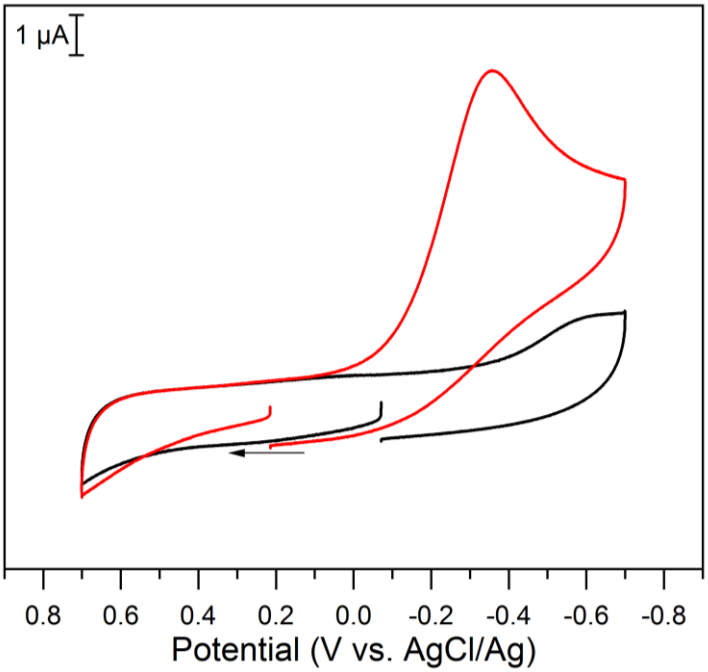

Figure S28. Representative cyclic voltammogram of 0.1 M citric acid buffer at pH of 4.75 in deionized water with KCl as the supporting electrolyte in the absence (black) or presence (red) of 200 µM K_2CrO_4. Data collected on 3 mm diameter glassy carbon electrodes.

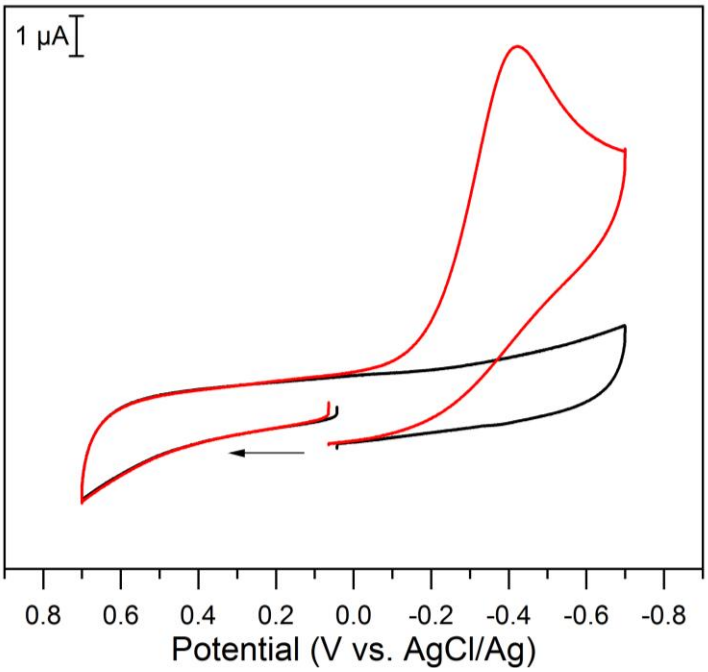

Figure S29. Representative cyclic voltammogram of 0.1 M citric acid buffer at pH of 4.75 in building tap water with KCl as the supporting electrolyte in the absence (black) or presence (red) of 200 µM K_2CrO_4. Data collected on 3 mm diameter glassy carbon electrodes.

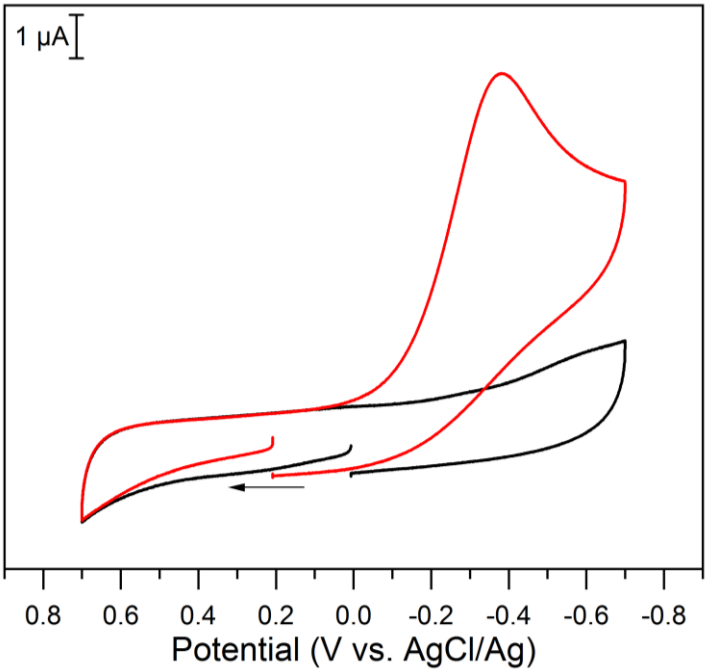

Figure S30. Representative cyclic voltammogram of 0.1 M citric acid buffer at pH of 4.75 in University Lake water with KCl as the supporting electrolyte in the absence (black) or presence (red) of 200 µM K_2CrO_4. Data collected on 3 mm diameter glassy carbon electrodes.

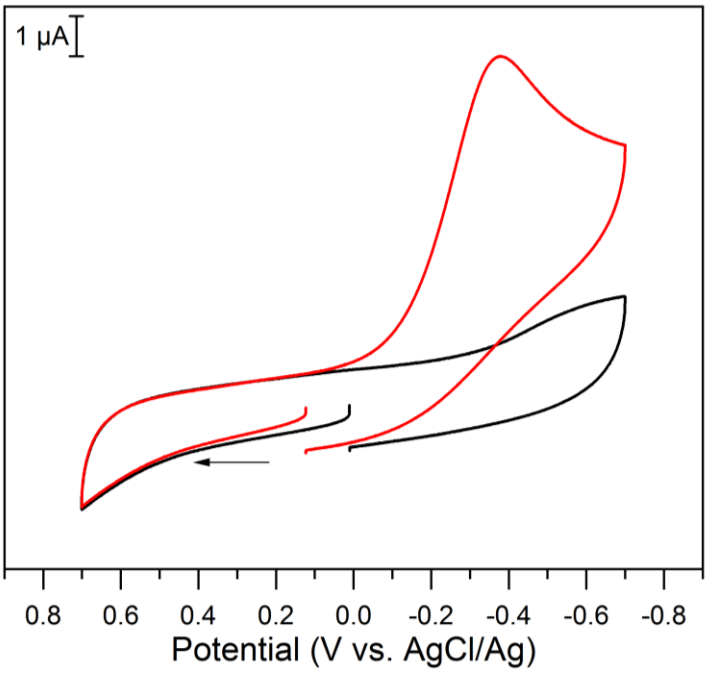

Figure S31. Representative cyclic voltammogram of 0.1 M citric acid buffer at pH of 4.75 in Mississippi River water with KCl as the supporting electrolyte in the absence (black) or presence (red) of 200 µM K_2CrO_4. Data collected on 3 mm diameter glassy carbon electrodes.