Electronic Supplementary Material (ESI) for RSC Advances.

Supporting Information

Impact of the Choice of Buffer on the Electrochemical Reduction of Cr(VI) in Water on Carbon Electrodes

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Variable Scan Rate Studies in Malate Buffer

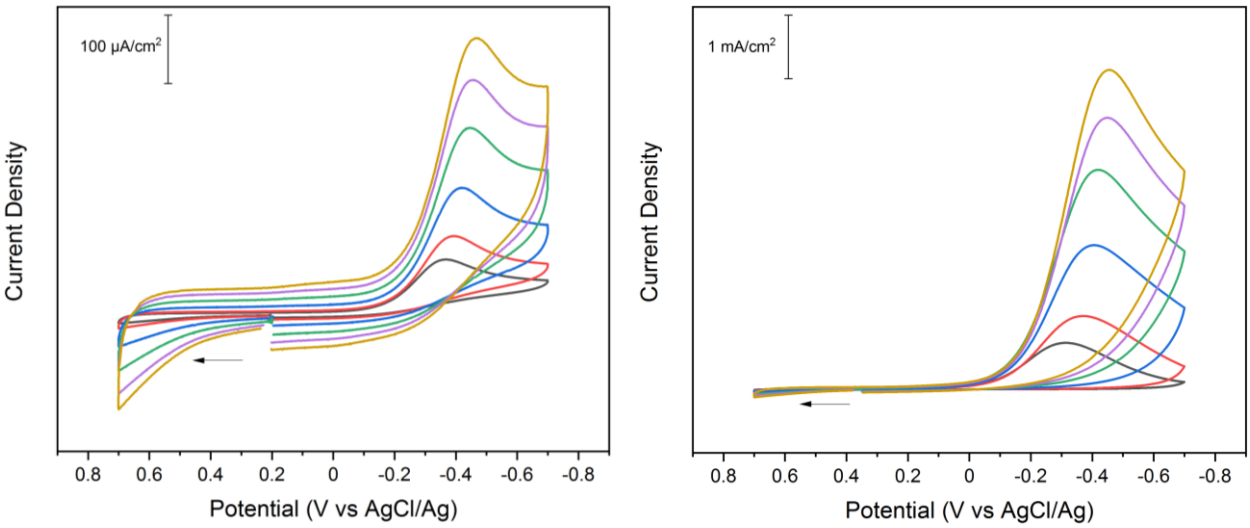


Figure S1. Cyclic voltammograms of 0.20 mM (left) and 7.00 mM (right) K_2CrO_4 added to a 0.10 M malate buffer at pH 4.75. Data collected with 1.00 M KCl at scan rates of 0.05 (black), 0.10 (red), 0.25 (blue), 0.50 (green), 0.75 (purple) and 1.00 (yellow) V s^{-1} on 3 mm diameter glassy carbon working electrodes.

Variable Scan Rate Studies in Succinate Buffer

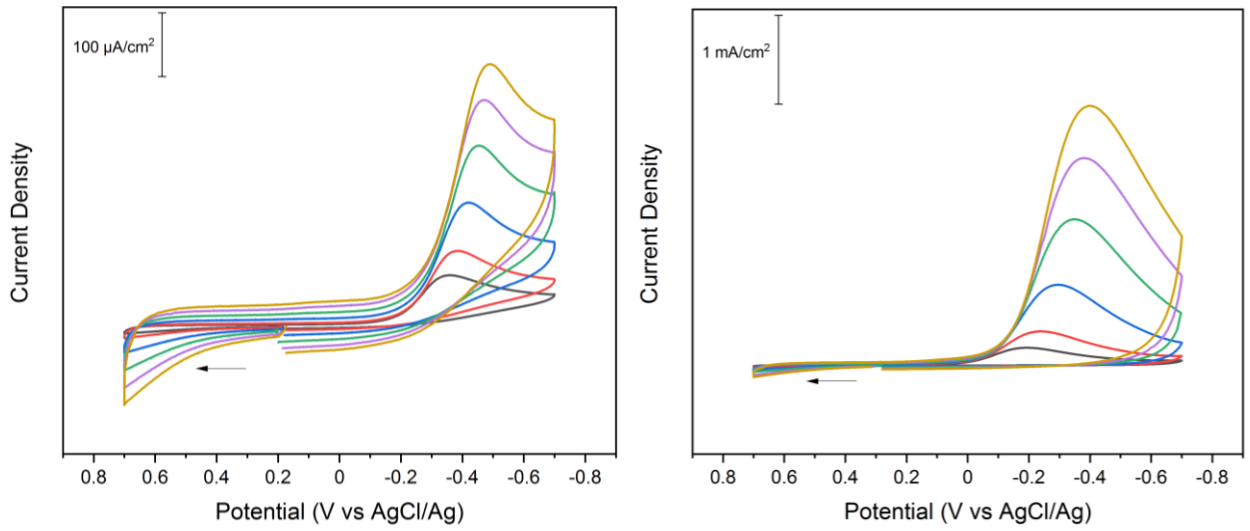


Figure S2. Cyclic voltammograms of 0.20 mM (left) and 7.00 mM (right) K_2CrO_4 added to a 0.10 M succinate buffer at pH 4.75. Data collected with 1.00 M KCl at scan rates of 0.05 (black), 0.10 (red), 0.25 (blue), 0.50 (green), 0.75 (purple) and 1.00 (yellow) V s^{-1} on 3 mm glassy carbon working electrodes.

Effect of pH

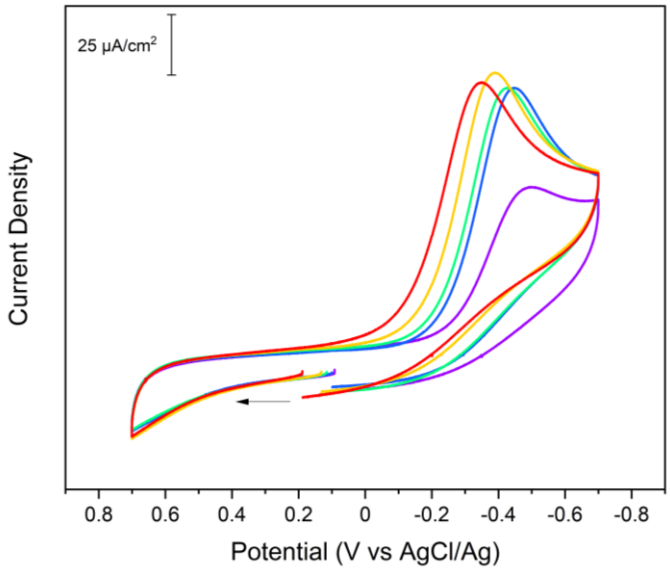


Figure S3. Cyclic voltammograms of 0.20 mM K_2CrO_4 added to a 0.10 M malate buffer at pH values of 3.75 (red), 4.25 (orange), 4.75 (green), 5.25 (blue), and 5.75 (purple). Data collected with 1.00 M KCl at scan rates of 0.10 V s^{-1} on 3 mm diameter glassy carbon working electrodes.

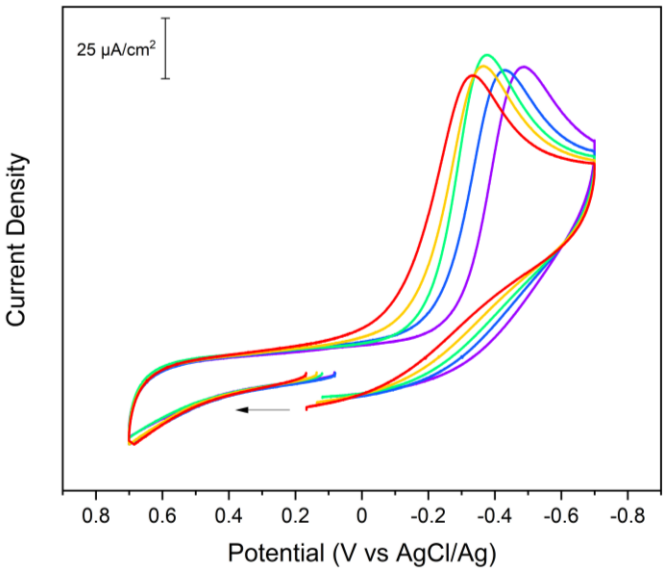


Figure S4. Cyclic voltammograms of 0.20 mM K_2CrO_4 added to a 0.10 M succinate buffer at pH values of 3.75 (red), 4.25 (orange), 4.75 (green), 5.25 (blue), and 5.75 (purple). Data collected with 1.00 M KCl at scan rates of 0.10 V s^{-1} on 3 mm diameter glassy carbon working electrodes.

Effect of Buffer Strength

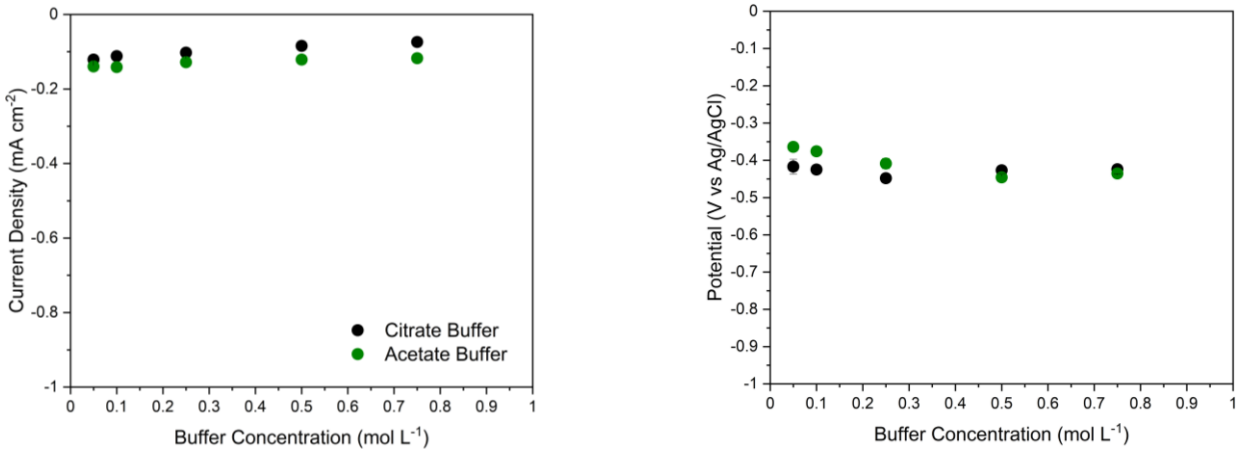


Figure S5. Reduction peak current density (left) and potential (right) values plotted as a function of buffer concentration for 0.20 mM K_2CrO_4 added to a 0.10 M citrate (black) or acetate (green) buffer at pH 4.75. Data collected with 1.00 M KCl at scan rates of 0.10 V s^{-1} on 3 mm diameter glassy carbon working electrodes.

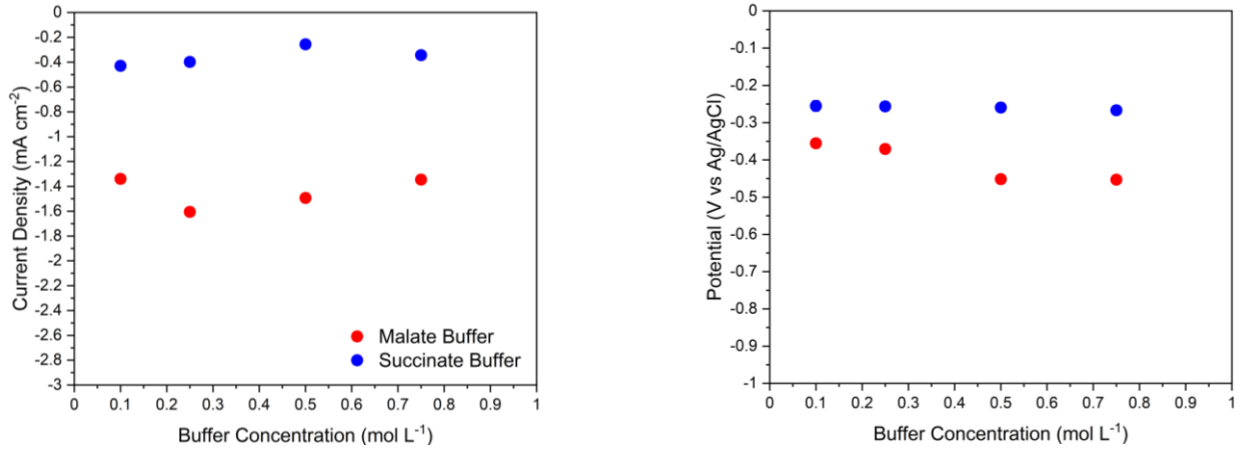


Figure S6. Reduction peak current density (left) and potential (right) values plotted as a function of buffer concentration for 7.00 mM K_2CrO_4 added to a 0.10 M malate (red) or succinate (blue) buffer at pH 4.75. Data collected with 1.00 M KCl at scan rates of 0.10 V s^{-1} on 3 mm diameter glassy carbon working electrodes.

Effect of Electrolyte

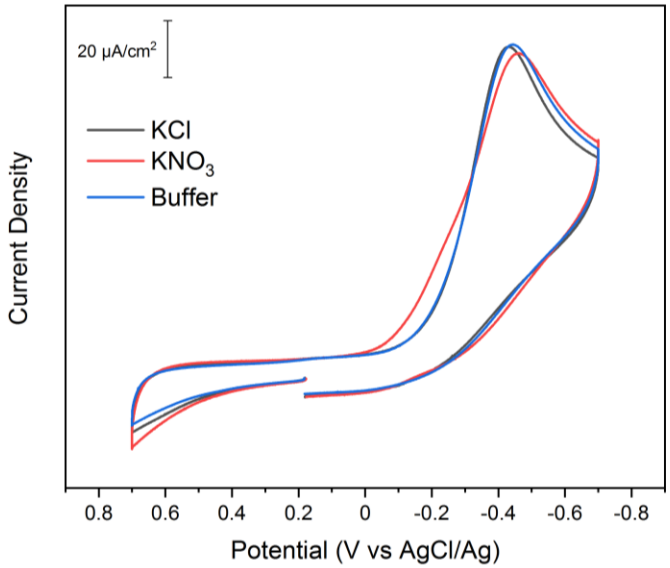


Figure S7. Cyclic voltammograms of 0.20 mM K_2CrO_4 added to a 0.10 M citrate buffer at pH 4.75. Data collected with 1.00 M KCl (black), 1.00 M KNO_3 (red), or without added electrolyte (blue) at scan rates of 0.10 V s^{-1} on 3 mm diameter glassy carbon working electrodes.

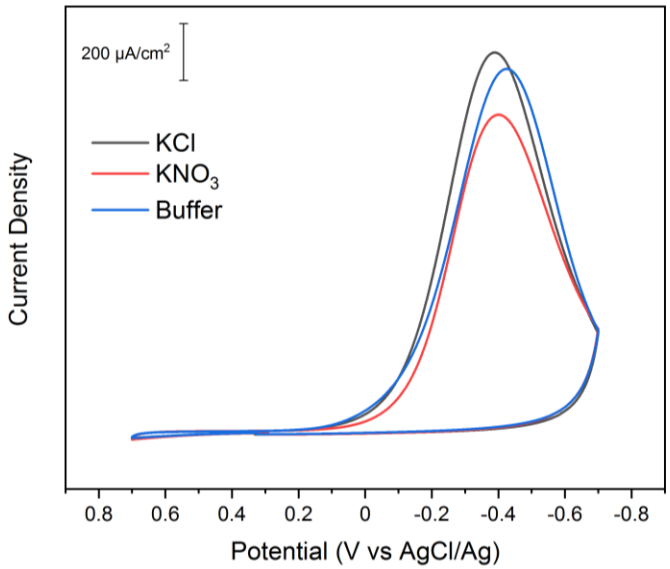


Figure S8. Cyclic voltammograms of 7.00 mM K_2CrO_4 added to a 0.10 M citrate buffer at pH 4.75. Data collected with 1.00 M KCl (black), 1.00 M KNO_3 (red), or without added electrolyte (blue) at scan rates of 0.10 V s^{-1} on 3 mm diameter glassy carbon working electrodes

Variable Scan Rate Studies in Citrate Buffer

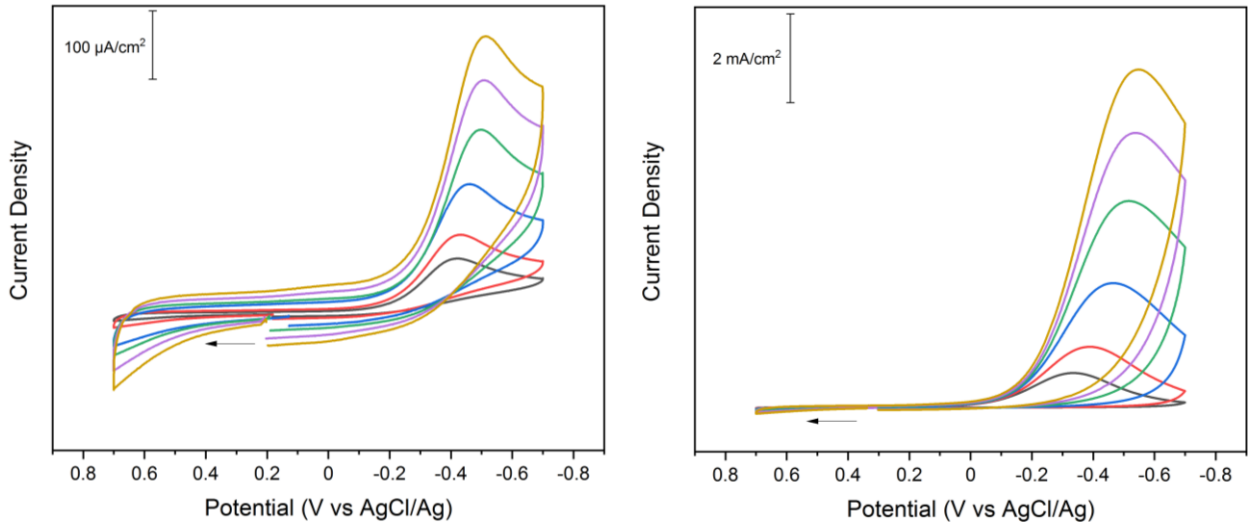


Figure S9. Cyclic voltammograms of 0.20 mM (left) and 7.00 mM (right) K_2CrO_4 added to a 0.10 M citrate buffer at pH 4.75. Data collected with 1.00 M KCl at scan rates of 0.05 (black), 0.10 (red), 0.25 (blue), 0.50 (green), 0.75 (purple) and 1.00 (yellow) V s^{-1} on 3 mm diameter glassy carbon working electrodes.

Variable Scan Rate Studies in Acetate Buffer

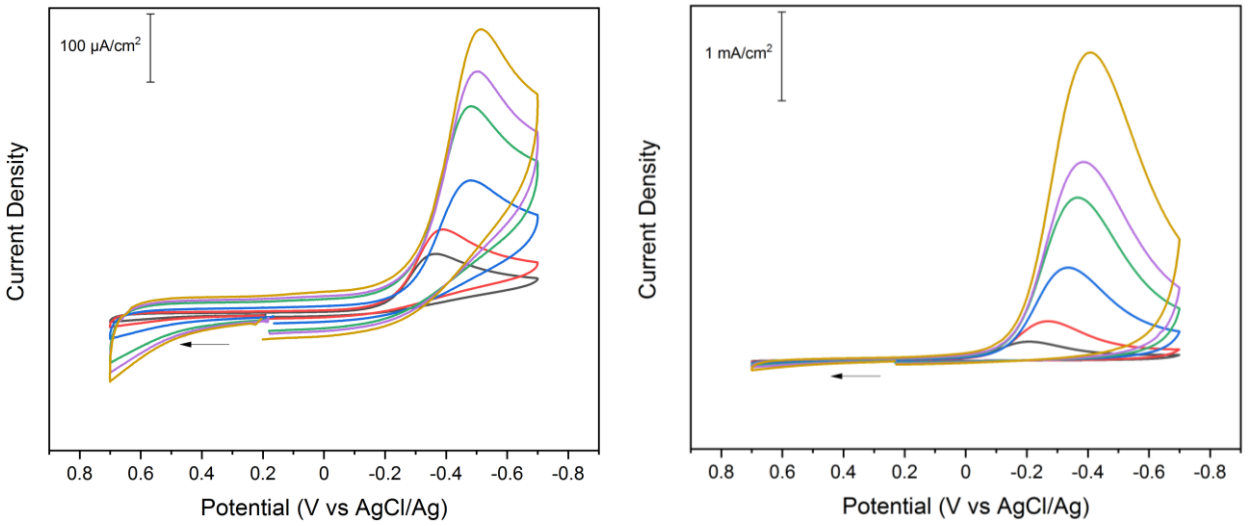


Figure S10. Cyclic voltammograms of 0.20 mM (left) and 7.00 mM (right) K_2CrO_4 added to a 0.10 M acetate buffer at pH 4.75. Data collected with 1.00 M KCl at scan rates of 0.05 (black), 0.10 (red), 0.25 (blue), 0.50 (green), 0.75 (purple) and 1.00 (yellow) V s^{-1} on 3 mm diameter glassy carbon working electrodes.

Variable Scan Rate Studies in Propanoate Buffer

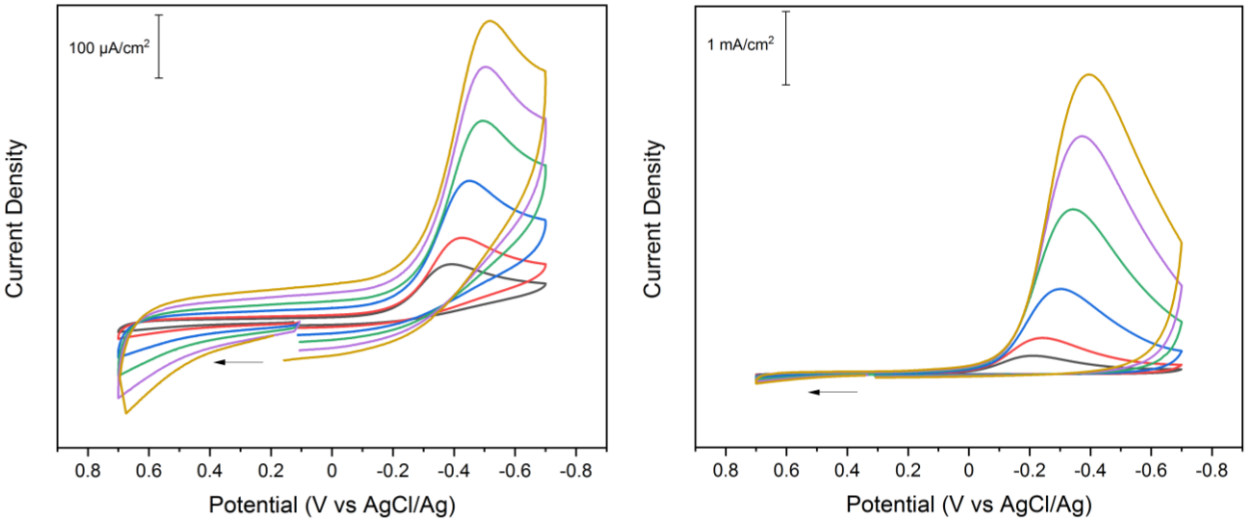


Figure S11. Cyclic voltammograms of 0.20 mM (left) and 7.00 mM (right) K_2CrO_4 added to a 0.10 M propanoate buffer at pH 4.75. Data collected with 1.00 M KCl at scan rates of 0.05 (black), 0.10 (red), 0.25 (blue), 0.50 (green), 0.75 (purple) and 1.00 (yellow) V s^{-1} on 3 mm diameter glassy carbon working electrodes.

Variable Scan Rate Studies in Glycolate Buffer

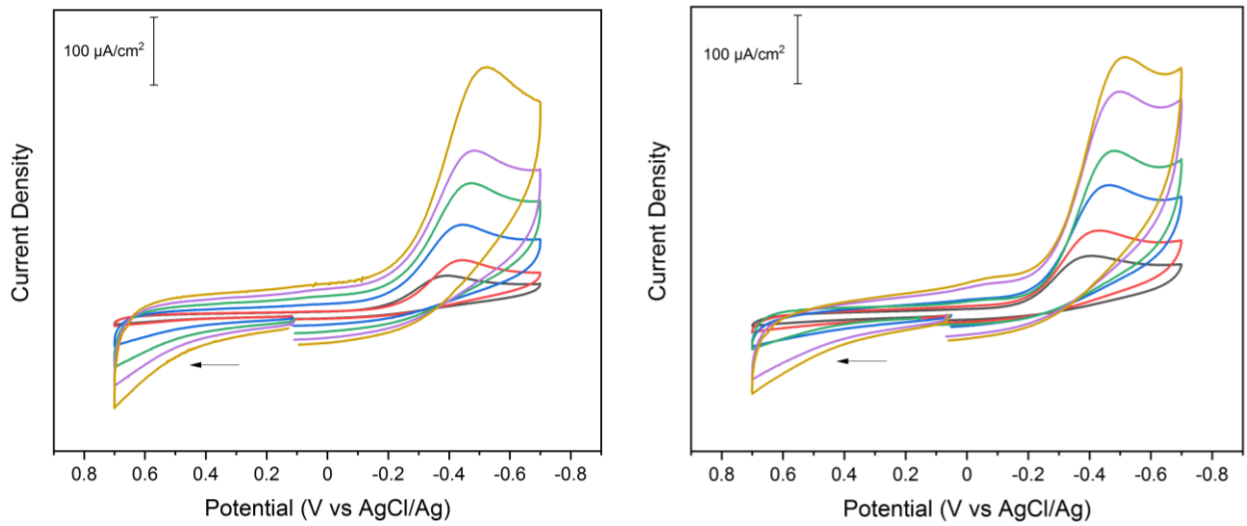


Figure S12. Cyclic voltammograms of 0.20 mM (left) and 7.00 mM (right) K_2CrO_4 added to a 0.10 M glycolate buffer at pH 4.75. Data collected with 1.00 M KCl at scan rates of 0.05 (black), 0.10 (red), 0.25 (blue), 0.50 (green), 0.75 (purple) and 1.00 (yellow) V s^{-1} on 3 mm diameter glassy carbon working electrodes.

Summary Analysis of Variable Scan Rate Data At 0.20 mM Cr(VI)

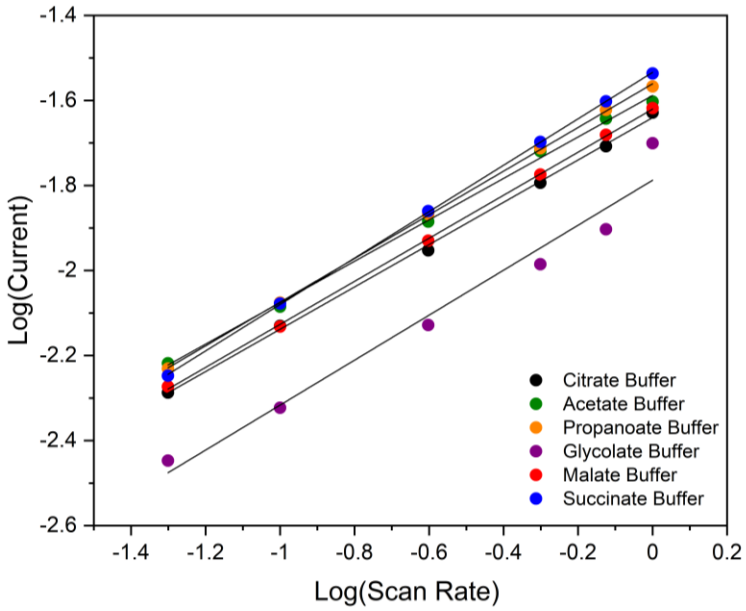


Figure S13. Log of the absolute values of the reduction peak currents (mA) plotted as a function of the log of the scan rate (V s^{-1}) for the reduction of 0.20 mM K_2CrO_4 added to 0.10 M acid buffers at pH 4.75. Malate and succinate data reproduced from figure 2 of the main text. Linear fit parameters given in Table 1. Data collected on 3 mm diameter glassy carbon working electrodes.

Summary Analysis of Variable Scan Rate Data At 7.00 mM Cr(VI)

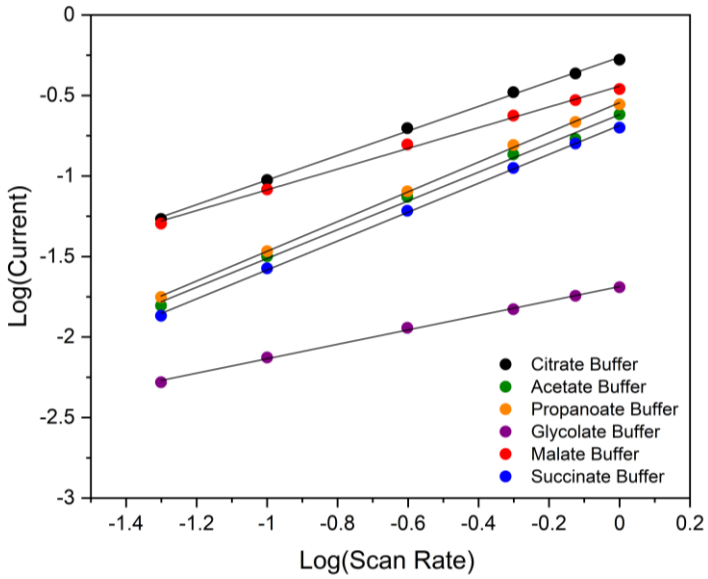


Figure S14. Log of the absolute values of the reduction peak currents (mA) plotted as a function of the log of the scan rate (V s^{-1}) for the reduction of 7.00 mM K_2CrO_4 added to 0.10 M acid buffers at pH 4.75. Malate and succinate data reproduced from figure 2 of the main text. Linear fit parameters given in Table 1. Data collected on 3 mm diameter glassy carbon working electrodes.

Chronoamperometry of 0.20 mM Cr(VI) in Malate Buffer

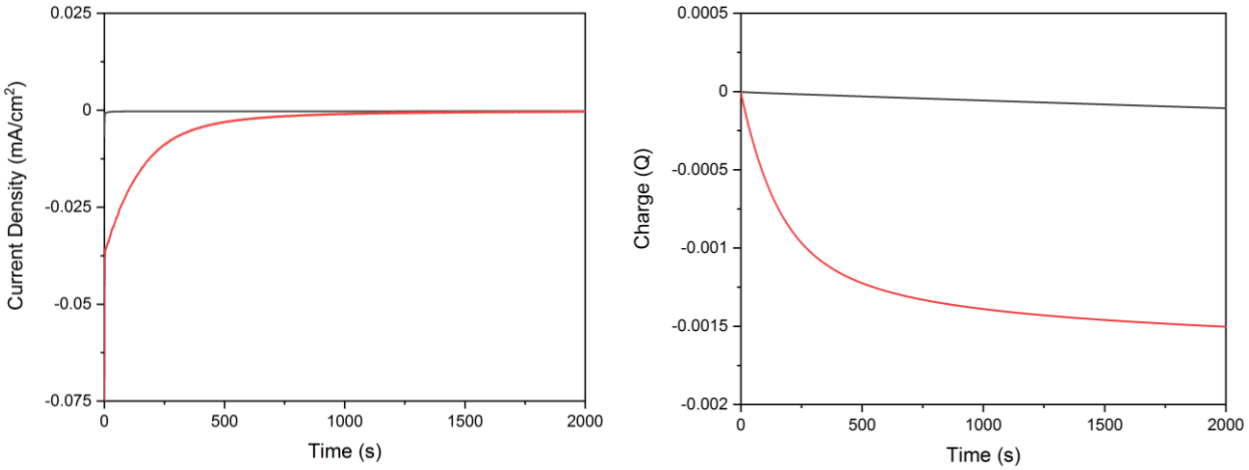


Figure S15. Current density (left) and corresponding charge passed (right) during the reduction at −0.300 V vs AgCl/Ag of 0.20 mM K_2CrO_4 added to a 0.10 M malate buffer at pH 4.75. Data collected with 1.00 M KCl while stirring on a 5 mm diameter glassy carbon working electrode. The black trace is the background in the buffer without the Cr(VI) and collected at the same potential.

Chronoamperometry of 0.20 mM Cr(VI) in Succinate Buffer

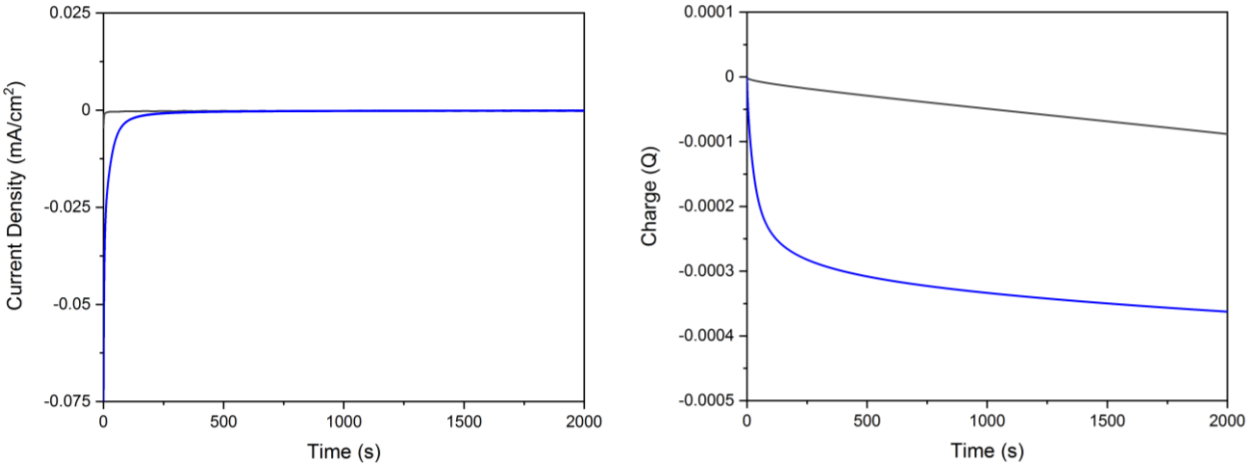


Figure S16. Current density (left) and corresponding charge passed (right) during the reduction at −0.300 V vs AgCl/Ag of 0.20 mM K_2CrO_4 added to a 0.10 M succinate buffer at pH 4.75. Data collected with 1.00 M KCl while stirring on a 5 mm diameter glassy carbon working electrode. The black trace is the background in the buffer without the Cr(VI) and collected at the same potential.

Chronoamperometry of 7.00 mM Cr(VI) in Malate Buffer

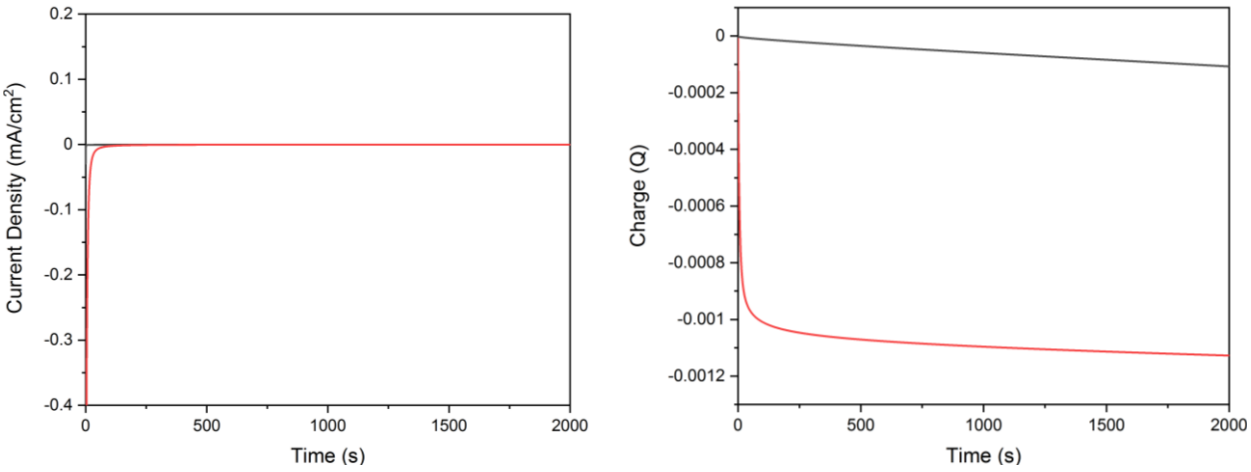


Figure S17. Current density (left) and corresponding charge passed (right) during the reduction at −0.200 V vs AgCl/Ag of 7.00 mM K_2CrO_4 added to a 0.10 M malate buffer at pH 4.75. Data collected with 1.00 M KCl while stirring on a 5 mm diameter glassy carbon working electrode. The black trace is the background in the buffer without the Cr(VI) and collected at the same potential.

Chronoamperometry of 7.00 mM Cr(VI) in Succinate Buffer

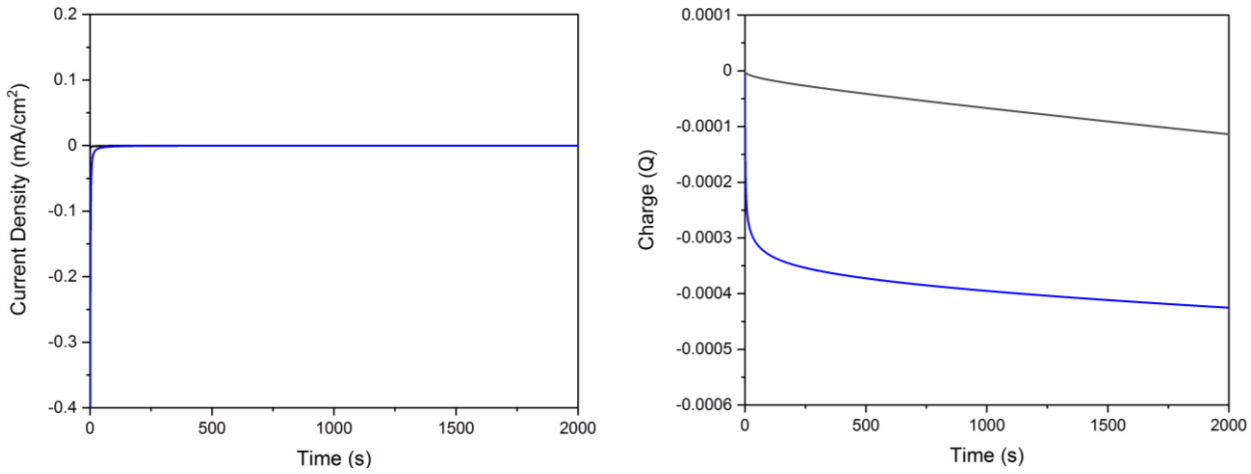
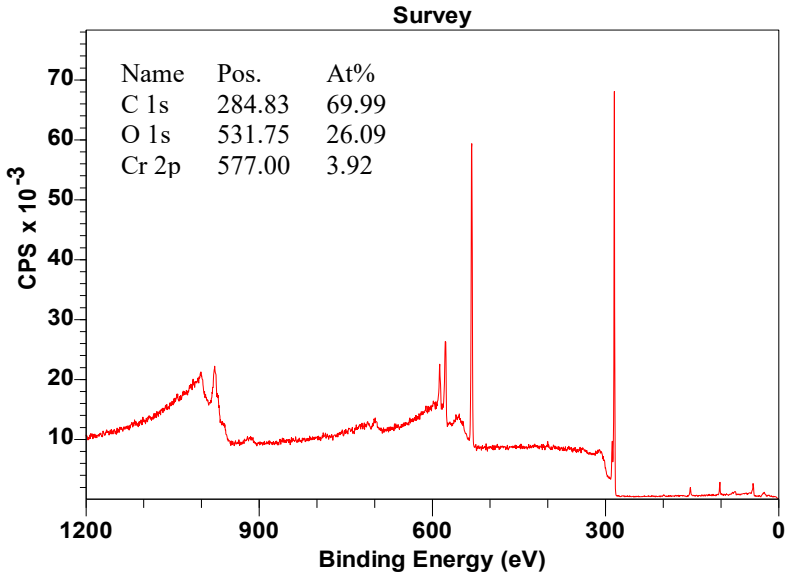


Figure S18. Current density (left) and corresponding charge passed (right) during the reduction at −0.200 V vs AgCl/Ag of 7.00 mM K_2CrO_4 added to a 0.10 M succinate buffer at pH 4.75. Data collected with 1.00 M KCl while stirring on a 5 mm diameter glassy carbon working electrode. The black trace is the background in the buffer without the Cr(VI) and collected at the same potential.

X-Ray Photoelectron Spectroscopy Data

A:



B:

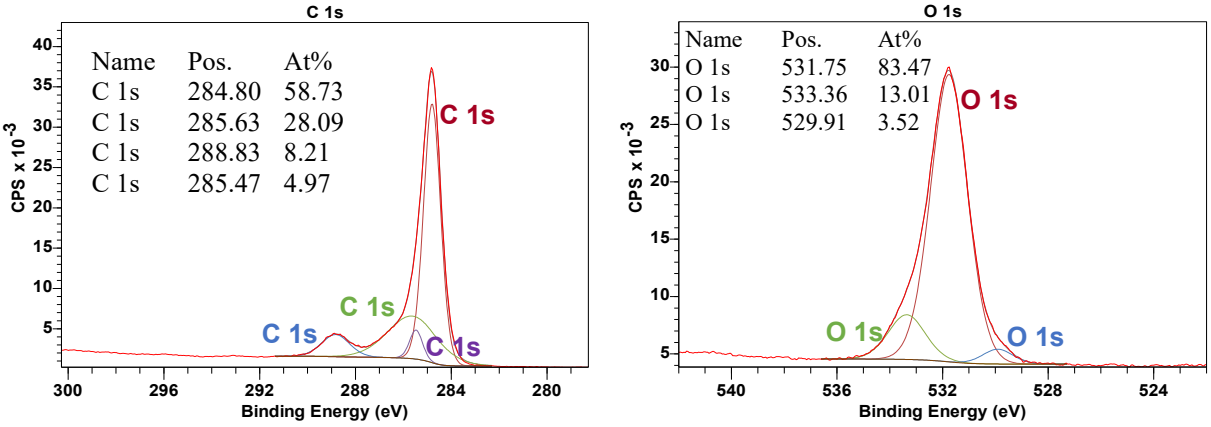


Figure S19. A: XPS wide region survey scan. Data was calibrated to C 1s at 284.8 eV. B: High resolution core scan of C 1s (left) and O 1s (right). High resolution core scan of Cr 2p signals are shown in Figure 5.

Electrode Recyclability Data in Succinate Buffer

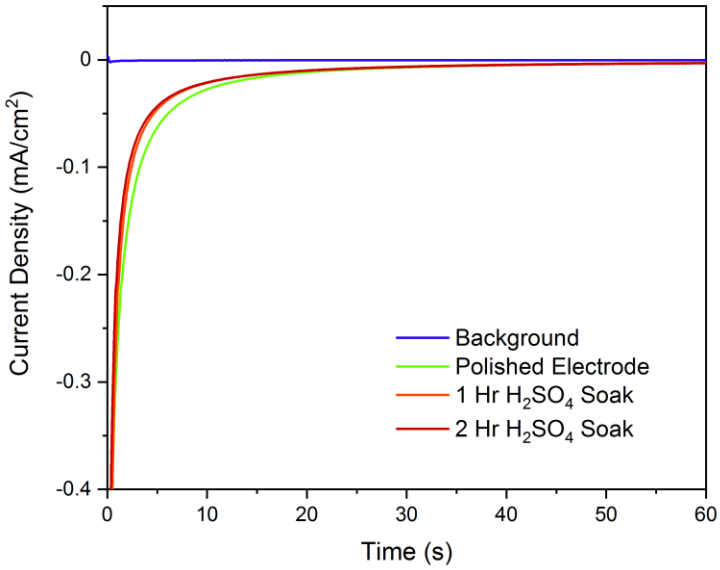


Figure S20. Evolution of current density over time measured during chronoamperometry at −0.200 V vs AgCl/Ag of 7.00 mM K_2CrO_4 added to a 0.10 M succinate buffer at pH 4.75. The electrodes were fouled during the chronoamperometry, then soaked in 0.50 M H_2SO_4 at various time intervals and reused for chronoamperometry. Data collected with 1.00 M KCl while stirring on a 5 mm diameter glassy carbon working electrode. The background trace was collected in the same condition but in the absence of Cr(VI).