

Large Magneto-Current Effect in the Electrochemical Detection of Oxalate in Aqueous Solution

Haiping Pan¹, Mingkui Wang¹, Yan Shen^{1} and Bin Hu^{1,2}*

1. Wuhan National Laboratory for Optoelectronics, School of Optical and Electronic Information, Huazhong University of Science and Technology, Wuhan 430074, China

2. Department of Materials Science and Engineering, University of Tennessee, Knoxville, TN 37996, USA

AUTHOR INFORMATION

Corresponding Author

* Email: ciac_sheny@mail.hust.edu.cn

1. Experimental methods

All chemicals used in this work were analytical-reagent grade. Solutions were freshly prepared with deionized water before use. A three-electrode configuration was employed in all experiments with two flat Pt foil plate electrodes served as the working electrode and the counter electrode and a Ag/AgCl electrode served as the reference electrode. The electrochemical cell was placed between the two poles of an electromagnet. Both the working and counter electrodes were placed at the central part of the electromagnet poles, where the magnetic field is most uniform. During each measurement, the temperature of the solution in the electrochemical cell was always around room temperature (about 25 °C). Magneto-current (MC) was measured by current change as a function of magnetic field, $MC = (I_B - I_0)/I_0 \times 100\%$, where I_B and I_0 are the current with and without a magnetic field, respectively. The absorption spectra of sodium oxalate solution at different applied electrode potentials were characterized by UV-VIS spectrophotometer SPEKOL 2000, using a spectroelectrochemical cell produced by ALS Company. Electrode potential was supplied and the current was recorded by CHI 750D electrochemical workstation.

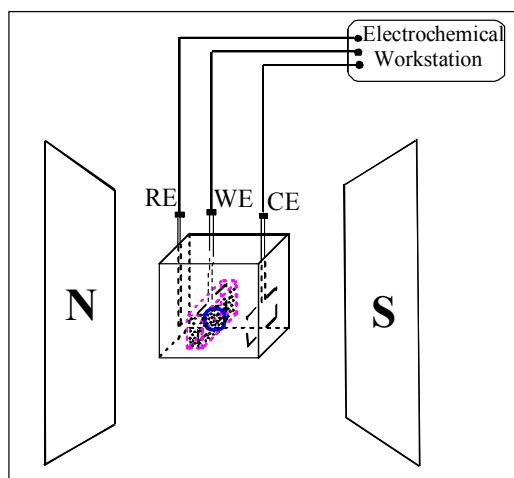


Figure S1. Experimental setup is shown for magneto-current measurements.

2. Supplementary information to exclude Lorentz force and magneto-convection effects.

When the applied electrode potential is set less than 1.1V in 0.1 M oxalate solution, there are current generated by supporting electrolyte-ions migration in the electrochemical cell but no magneto-current is observed (shown in Figure S2a and S2b). According to the cyclic voltammogram of oxalate oxidation, when the electrode potential is less than 1.1V, the oxidation of oxalate hardly occurs but there are ion migration and diffusion in the

electrochemical cells. This result can exclude the Lorentz force and magneto-convection effects in our system because these effects are only related to ion migration and diffusion. However, when applied electrode potentials increase, the oxidation rate of oxalate largely enhances and significant MC is observed (Figure S2c, S2d, S2e and S2f). Thus the magneto-current with different applied electrode potentials further confirms that the magneto-current is generated by the oxidation of oxalate and Lorentz force and magneto-convection effect can be excluded in this system.

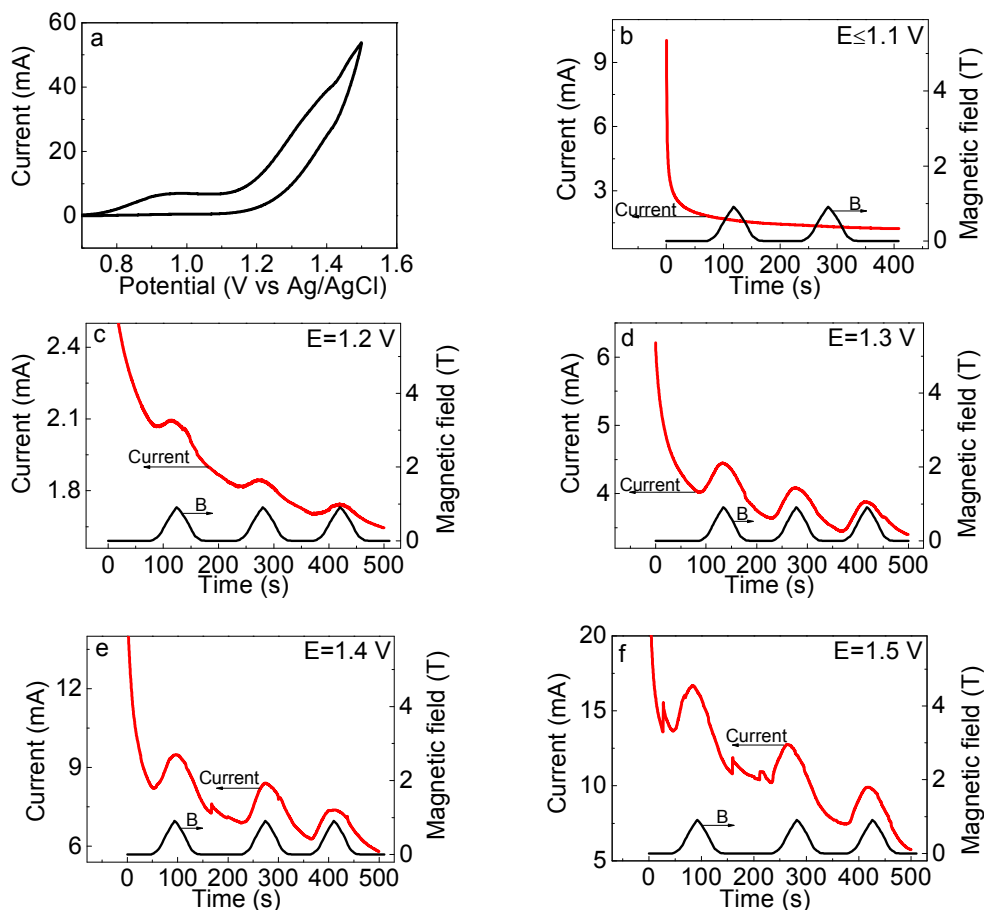


Figure S2. Cyclic voltammogram (a) and the current-time characteristics before, during and after the application of a magnetic field are shown at 1.1V (b), 1.2V (c), 1.3V (d), 1.4V (e) and 1.5V (f) applied electrode potentials. The solution contains 0.1M $\text{Na}_2\text{C}_2\text{O}_4$ and 0.1M NaH_2PO_4 dissolved in water.

3. Cyclic voltammograms for different concentrations of oxalate.

The cyclic voltammograms suggest that the oxidation rate of oxalate increases as applied electrode potentials and the concentration of oxalate increases.

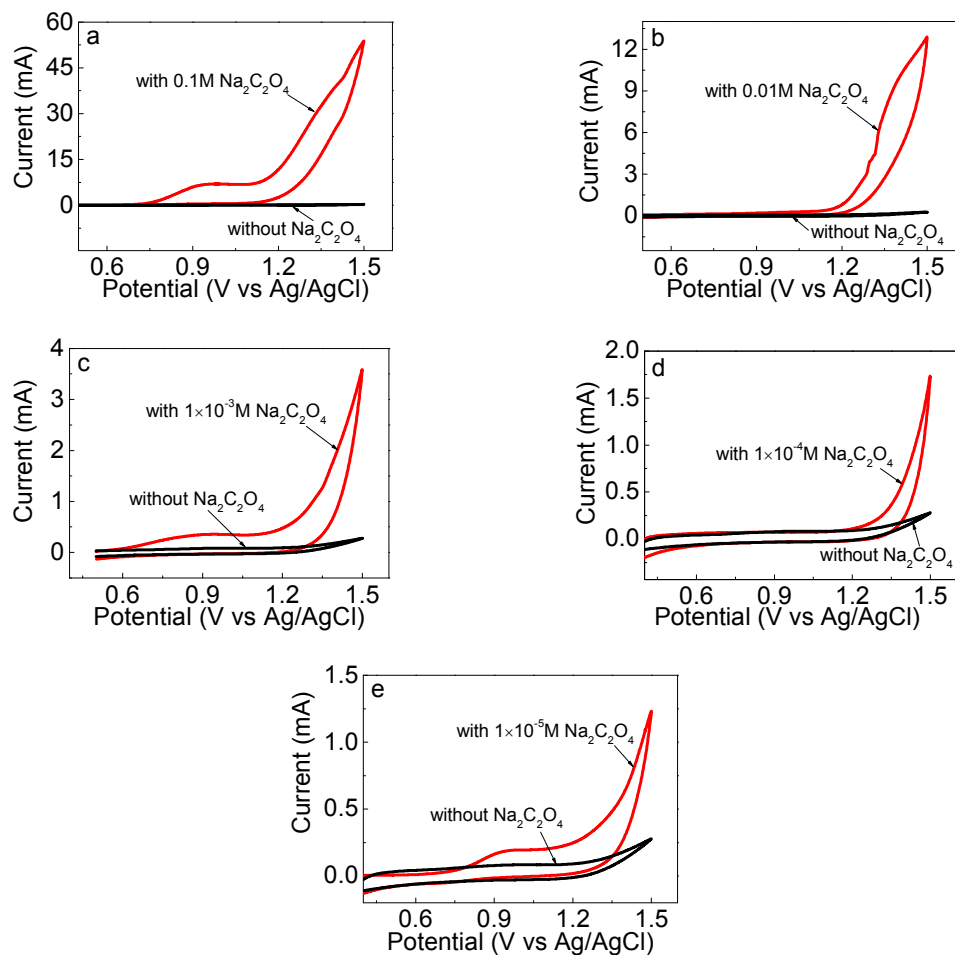


Figure S3. Cyclic voltammograms (red line) for different concentrations of sodium oxalate solution. (a) 0.1 M $\text{Na}_2\text{C}_2\text{O}_4$; (b) 0.01 M $\text{Na}_2\text{C}_2\text{O}_4$; (c) 1×10^{-3} M $\text{Na}_2\text{C}_2\text{O}_4$; (d) 1×10^{-4} M $\text{Na}_2\text{C}_2\text{O}_4$; (e) 1×10^{-5} M $\text{Na}_2\text{C}_2\text{O}_4$. The black line is the cyclic voltammogram in the absence of $\text{Na}_2\text{C}_2\text{O}_4$ in the same supporting electrolyte.