Cyclic Voltammetry Basics: Ohm's Law

The Go Direct Cyclic Voltammetry System (CVS) is designed for use with real chemical systems. However, students can also perform a simple experiment with the instrument itself to familiarize themselves with the hardware and software, confirm operation of the unit, and to explore Ohm's law. The experiments described here avoid the added complexity of chemistry and allow students to interrogate the Go Direct CVS directly by engaging the internal resistor.

ESTIMATED TIME

We estimate that this experiment can be completed in one hour.

TIPS

1. In the Electronic Resources you will find PDF and word-processing files of the student experiment. You can print the PDF, distribute it to students electronically, or post the file to a password-protected class web page or learning management system. Edit the word-processing file if you would like to tailor the experiment to suit your equipment and students. Sign in to your account at **www.vernier.com/account** to access the Electronic Resources.

2. Consider having students vary the various parameters in the experiment settings. This is an excellent opportunity to learn about how a potentiostat delivers potential and modulates feedback without the interference of a chemical system.

ANSWERS TO ANALYSIS QUESTIONS

1. The experimental data showed that when 500 mV was applied, a 500 μA response was measured, as shown in Figure 1.

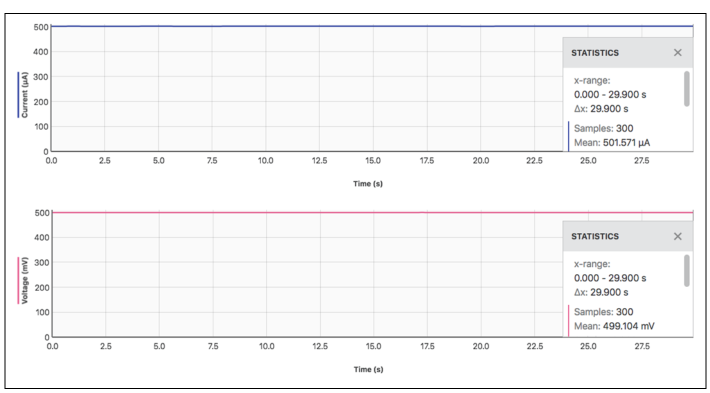

Figure 1

We also know this from Ohm's law:

$$i = \frac{E}{R}$$

$$i = \frac{0.5\ V}{1000\ \Omega} = 500\ \mu A$$

2. The cyclic voltammetry potential waveform set in the software was actually measured by the instrument. As shown in Figure 2, the CVS reports a potential waveform as programmed, starting at –493.5 mV, sweeping positively to 497.4 mV, and returning back to –497.8 mV. Each of these segments are within the tolerance for the system; therefore, the cyclic voltammetry potential waveform set in the software was actually measured by the instrument.

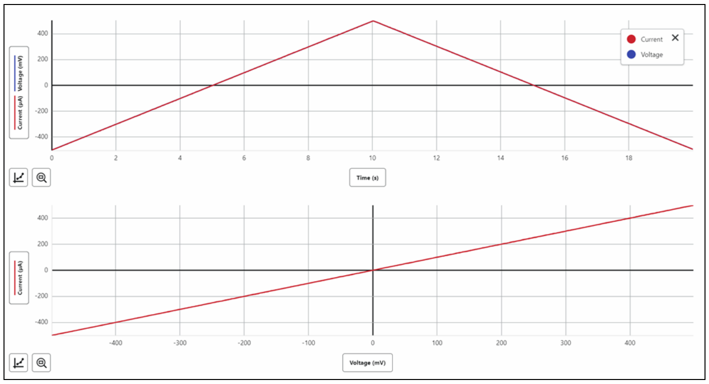

Figure 2

3. The initial and final potential and current agree with Ohm's law, against the internal 1,000 Ω resistor. At the initial potential the CVS reports –499.231 mV and at the initial current the CVS reports –500.546 µA. By Ohm's law,

$$R = \frac{-499.231\ \text{mV}}{-500.546\ \mu\text{A}} = 997.4\ \Omega$$

At the final potential, the CVS reports –495.626 mV and at the final current the CVS reports –496.013 µA. By Ohm's law,

$$R = \frac{-495.626\ \text{mV}}{-496.013\ \mu\text{A}} = 999.2\ \Omega$$

Therefore, within tolerance, the measured value for the internal resistor agrees with what is known and the initial and final potential and current agree with Ohm's law.

4. The slope of the cyclic voltammogram is equal to 1/R as predicted by Ohm's law. Lastly, the slope of the cyclic voltammogram (current *vs*. voltage) can be obtained:
   - Instrumental Analysis: Highlight the CV from initial to switching potential. Click or tap Graph Tools, , and select Apply Curve Fit. Select Linear as the curve fit. Click or tap Apply. The resultant slope will be displayed.
   - LabQuest: Highlight the CV from initial to switching potential. Choose Curve Fit from the Analyze menu. Select Linear as the curve fit, and tap OK. The resultant slope will be displayed.

As shown, the slope is 1.0. Realize, this is in units of μA/mV. When converted to units of A/V (0.0001 A/V), the reciprocal yields 1000 Ω, which is in good agreement with the known value of the internal resistor (1000 Ω), therefore the slope of the cyclic voltammogram is equal to as predicted by Ohm's law.