DATE: NAME: CLASS:

CHAPTER 13	Investigation 13.C: Electroplating	BLM 13.4.2
HANDOUT		

You have learned that electroplating is a process in which a metal is deposited, or plated, onto the cathode of an electrolytic cell. In this investigation, you will build an electrolytic cell and electrolyze a copper(II) sulfate solution to plate copper onto the cathode. You will use Faraday's law to relate the mass of metal deposited to the amount of electric charged used.

Question

Does the measured mass of copper plated onto the cathode of an electrolytic cell agree with the mass calculated according to Faraday's law?

Prediction

Predict whether the measured mass of copper plated onto the cathode of an electrolytic cell will be greater than, equal to, or less than the mass calculated using Faraday's law.

Safety Precautions

- Nitric acid is corrosive. Note that the $CuSO_4$ solution contains sulfuric acid and hydrochloric acid. Wash any spills on your skin with plenty of cold water. Inform your teacher immediately.
- Avoid touching the parts of the electrodes that have been washed with nitric acid.
- Acetone is flammable. Use acetone in the fume hood.
- Make sure your hands and your lab bench are dry before handling any electrical equipment.

Materials

- 3 cm × 12 cm × 1 mm Cu strip
- 150 mL 1.0 mol/L HNO_3 in a 250 mL beaker
- deionized water in a wash bottle
- 50 cm 16-gauge bare solid copper wire
- 120 mL acidified 0.50 mol/L $CuSO_4$ solution (with 5 mL of 6 mol/L H_2SO_4 and 3 mL of 0.1 mol/L HCl added)
- fine sandpaper
- 250 mL beaker
- 2 electrical leads with alligator clips
- adjustable D.C. power supply with ammeter
- drying oven
- electronic balance

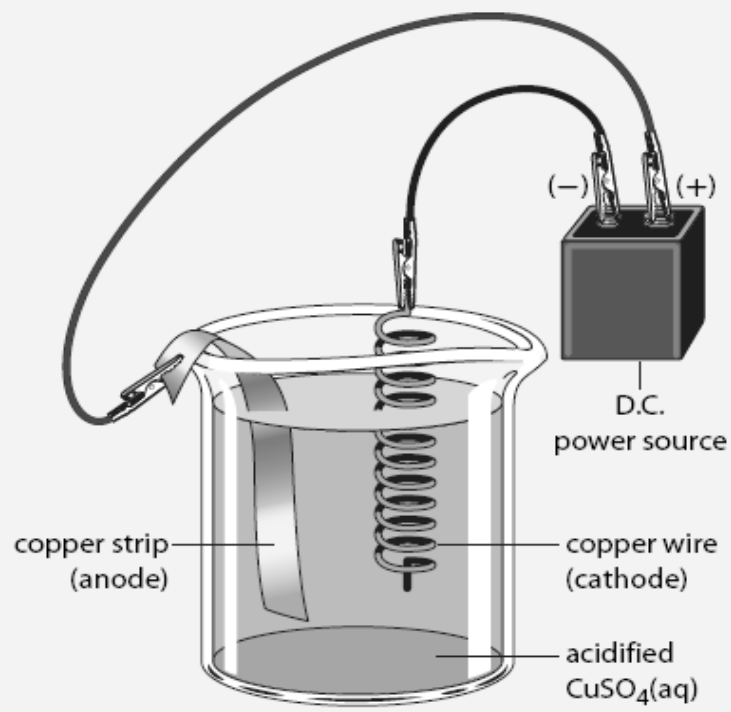
Procedure

1. Clean any tarnish off the copper strip by sanding it gently. Working in a fume hood, dip the bottom of the copper strip in the nitric acid for a few seconds, and then rinse the strip carefully with de-ionized water. Avoid touching the section that has been cleaned by the acid.

2. Place the copper strip in the beaker, with the clean part of the strip at the bottom. Bend the top of the strip over the rim of the beaker so that the copper strip is secured in a vertical position, as shown in the diagram on the next page. This copper strip will serve as the anode.

Investigation 13.C: Electroplating (continued)

3. Wrap the copper wire around a pencil to make a closely spaced coil. Leave 10 cm of the wire unwrapped. Measure and record the mass of the wire. Working in a fume hood, dip the coil in the nitric acid, and rinse the coil with de-ionized water.



4. Use the 10 cm of uncoiled wire to secure the coil on the opposite side of the beaker from the anode, as shown in the diagram. This copper wire will serve as the cathode.

5. Pour 120 mL of the acidified $CuSO_4(aq)$ solution into the beaker. Attach the lead from the negative terminal of the power supply to the cathode. Attach the positive terminal to the anode.

6. Turn on the power supply and set the current to 1.0 A. Maintain this current for 20 min by adjusting the variable current knob as needed.

7. After 20 min, turn off the power. Remove the cathode and rinse it very gently with deionized water. Place the cathode in a drying oven for 20 min.

8. Measure and record the new mass of the cathode.

9. Dispose of all materials as instructed by your teacher.

Analysis

1. Write a balanced equation for the half-reaction that occurs at the cathode.

2. Use the measured current and the time for which the current passed to calculate the amount of charge used.

3. Use your answers to Questions 1 and 2 to calculate the mass of copper plated onto the cathode.

4. Compare the calculated mass from Question 3 with the measured increase in mass of the cathode. Give possible reasons for any difference between the two values.

Conclusion

5. How did the mass of copper electroplated onto the cathode of the electrolytic cell compare with the mass calculated using Faraday's law? Compare your answer with your prediction from the beginning of this investigation.

Applications

6. Suppose you repeated this investigation using iron electrodes and 0.5 mol/L iron(II) sulfate solution as the electrolyte. If you used the same current for the same time, would you expect the increase in mass of the cathode to be greater than, less than, or equal to the increase in mass that you measured? Explain your answer.

Investigation 13.C: Electroplating (continued)

7. Suppose you repeated the investigation with the copper(II) sulfate solution, but you passed the current for only half as long as before. How would the masses of copper plated onto the cathode compare in the two investigations? Explain your answer.

8. Could you build a voltaic cell without changing the electrodes or the electrolyte solution you used in this investigation? Explain your answer.