

ELECTROPLATING OF METALS

LAB ELC 2

INTRODUCTION

Oxidation-reduction (redox) chemistry occurs in two types of electrochemical cells: electrolytic and galvanic. In electrolytic cells, a voltage source provides the electrical energy that produces chemical change. In galvanic cells, a chemical reaction occurs spontaneously, without an external source of electrical energy. The batteries that power our flashlights, hand-held electronic games, and cars are common examples of galvanic cells. Recharging a battery is an electrolytic process that uses an external source of electrical energy to reverse the direction of the reaction.

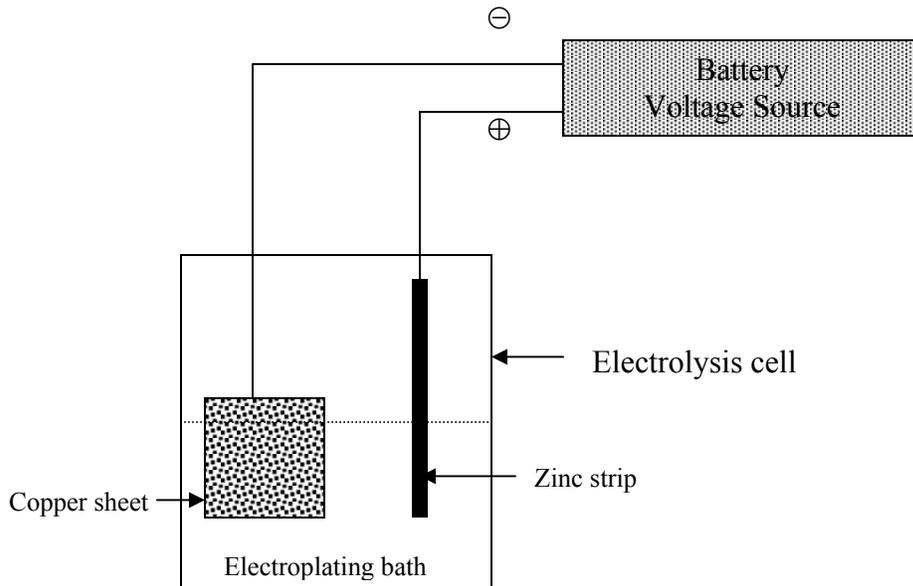
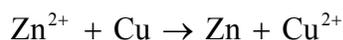
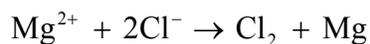


Figure 1

Electroplating is another electrolytic process. During electroplating, a metal ion is reduced to its elemental form to coat, or plate, a surface on the cathode, the electrode connected to the negative terminal of the voltage source. The electroplating bath contains the metal ion to be reduced, as well as other ions to support the flow of electrons during electrolysis. While reduction of the metal occurs at the cathode, oxidation is simultaneously occurring at the other electrode, the anode, which is connected to the positive terminal of the voltage source. Figure 1 shows a diagram of the electroplating apparatus used in this experiment. The reaction that occurs in this electrolytic cell is:

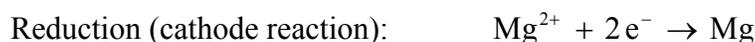
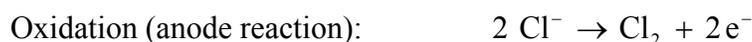


Another example of a reaction used in an electrolytic cell is:

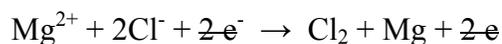


This process is used to commercially produce magnesium metal. In this reaction, magnesium gains electrons and is reduced, while chlorine loses electrons and is oxidized. As in all redox reactions, this process can be represented by two half reactions. Half reactions are the two chemical equations that separately represent the oxidation and the reduction processes involved in an overall redox reaction.

The half reactions for this process are written as follows:



When combined, these half-reactions produce the chemical equation for the complete oxidation-reduction process:



Electrode Features in an Electrolytic Cell

	Charge	Process Occurring
Anode	Positive	Oxidation
Cathode	Negative	Reduction

PURPOSE

The purpose of this experiment is to make a copper ornament plated with zinc, introducing the procedure of electroplating zinc onto copper. It also investigates the oxidation-reduction reaction involved in this process.

EQUIPMENT/MATERIALS

4 cm sq. piece of copper sheet with hole	Zinc strip
10 cm piece of heavy copper wire (bare)	250 mL beaker
Clear nail polis	“C” or “D” battery and battery holder
Zinc plating solution	Wire leads with connecting alligator clips
Cotton swabs	Steel wool
Isopropyl alcohol	Clear acrylic spray paint

SAFETY

- Always wear an apron and goggles in the lab.
- Avoid inhaling the fumes from the paint.

PROCEDURE

1. Rinse the copper with water and dry it, then polish it with steel wool. Once it is polished, rinse it with a little water and then dry it.
2. Insert a 10 cm piece of copper wire through the hole in the copper, and then bend it into a hook, making sure the wire and copper square make contact.
3. Decide upon a design. Carefully use the nail polish to make the design on the copper square. Allow the nail polish to dry.
4. Clean the exposed copper surface with a cotton swab dipped in isopropyl alcohol. Do not touch this area once cleaned.
5. Put enough zinc plating solution into a 250 mL beaker so that the design on the ornament will be covered when submerged.
6. Insert a zinc strip into the plating solution along one side of the beaker. Bend the zinc over the lip of the beaker to hold it in place.
7. Connect one wire lead from the zinc to the positive terminal of the battery.
8. Connect the other wire lead from the negative terminal of the battery to the copper wire attached to the ornament.
9. Insert the ornament into the zinc plating solution on the opposite side from the zinc strip, with the design facing the zinc strip.
10. Periodically remove the ornament to examine the progress of the zinc plating.
11. When the desired effect has been obtained (usually just a few seconds), remove the ornament from the solution, disconnect the battery, and gently rinse the ornament. **DO NOT RUB!** The zinc will come off if you do so.
12. Allow the ornament to dry. Remember not to rub the zinc off.
13. Hang the ornament from a ring on a ring stand under the fume hood. Place a layer of paper towels on the area underneath.
14. Spray both sides of the ornament with clear acrylic paint. Avoid inhalation of the fumes. Let the ornament dry.
15. Clean up.

References:

Wellesley College Chemistry Home Page.

http://www.wellesley.edu/Chemistry/Chem&Art/Topics/Metals/pdf_files/echemjewels02.pdf (accessed June 2003), Electrochemistry: Electroplating, Coloring, and Etching of Metals.

http://www.jozie.net/JF/HS_Chem/Laboratory/ElectroplatingZinconCopper (accessed May 2003), Electroplating Zinc on Copper.

ANALYSIS SHEET

Name _____

Name _____

Period _____ Class _____

Date _____

ELECTROPLATING OF METALS

ANALYSIS

1. Identify the anode and the cathode in this experiment. At which does oxidation occur? Reduction?
2. Write balanced half-reactions for the processes occurring at the copper ornament and the zinc strip.
3. How would the mass of the copper ornament after completion of the electroplating process compare to the mass of the copper sheet prior to beginning the process? How would the mass of the zinc strip have changed? Why?
4. Compare the concentration of the zinc ion, Zn^{2+} , in the solution at the end of electrolysis to its original concentration.
5. What would happen if the wires were switched?