Lab: Electrolytic Cells: Electroplating

When two dissimilar metals are placed together in an electrolyte and connected by means of a conducting wire, electric current is generated. This is the basis of an electrochemical cell.

In an electrolytic cell, non-spontaneous oxidation-reduction reactions are made to occur by the application of an external voltage. The source of this voltage may be an external power source, forcing electrons on to an electrode and thus resulting in the reduction of some species in the electrolytic solution.
In this case, metals are "plated out" on the cathode. This is the principle used in industry for electroplating. The object to be plated is made the cathode , while the anode is made of the metal used for plating.
For good deposition on it, the cathode must be free from grease, and the correct plating solution and current density must also be carefully considered. In this experiment, you will explore some simple means of plating one metal onto another.

Objective

- To use an electrolytic cell to electroplate an object with copper or zinc.

Apparatus and Materials

DC power source or 6 V battery, Strips of copper, zinc (about 2cm × 6cm)
Two 250 cm^3 beakers, 2 copper coins or small brass objects, 3 copper connecting cables,
2.0 mol dm^{-3} sodium hydroxide, NaOH, 2.0 mol dm^{-3} $HNO_{3\,(aq),}$ Conc. ammonia solution, NH_3,
Copper plating solution, 0.1 mol dm^{-3} copper (II) sulfate, Electrode support,
Zinc plating solution, 0.1 mol dm^{-3} zinc sulfate, Propane, acetone, C_3H_6O, Wash bottle of distilled water

Safety

1. Copper and zinc plating solutions are poisonous. Do not spill. They must be disposed of properly according to your teacher's direction.
2. Sodium hydroxide and sulfuric acid are corrosive. Avoid any spill.
3. Concentrated ammonia is very irritating to the eyes. Avoid any fumes and wear safety goggles.
4. Propanone is poisonous and flammable. Do not use near sparks or flames.
5. Beware of possible electrical shock in this experiment.
6. Return ALL plating solution to your teacher for proper disposal.

Procedure

Part I: Electroplating of Zinc

1. Obtain about 200 cm^3 of zinc plating solution in a clean, dry 250 cm^3 beaker.

2. Clean the copper electrode (or a brass object or a copper coin) with dilute $NaOH_{(aq)}$, then rinse with dilute $HNO_{3\cdot(aq).}$ Rinse with distilled water and then with propanone. DO NOT TOUCH this electrode with your fingers as a greasy print will prevent the ions from plating. Handle by the edges only. This electrode will serve as the cathode.

3. Suspend the copper cathode, the object to be plated by a wire wound around a glass rod which is resting across the top of the beaker; and a zinc electrode (the anode) in the beaker of plating solution by means of an electric holder. Be certain that the object to be plated is completely submerged.

4. Connect the electrodes as shown in Diagram below. Adjust the power supply to give a current flow of 0.50 A and allow the electrolysis to proceed for about 20 minutes.

5. Disconnect the power supply. Remove the copper cathode, wish with distilled water and then with propanone. Record the changes observed in the color and appearance of the electrodes. Dispose of plating solution according to your teacher's instructions.

Part II: Electroplating with Copper

1. Obtain about 200 cm^3 of copper plating solution in a 250 cm^3 beaker.

2. Repeat procedure 2 to 5 above, using a copper strip for the anode, (note the copper plating works best if the voltage is really low, just turn the dial until it just starts to register on the meter).

Data Analysis

1. Explain why some of the plating does not seem to adhere well to the object.

2. List some of the possible sources of the error.

3. Write the balanced equations for the reactions involved in the plating reactions.

4. List all the cell reactions in the experiment.

5. Calculate the mass and thickness (cm) of the copper plate on your object if a current of 1 Amp was allowed to flow for 3 minutes. Assume that your object was a rectangular solid that was 2 cm on an edge and of negligible thickness.

Conclusion