**Experiment # 8**

**Title of experiment:**

Electroplating of metals

**Aim:**

To use electroplating to plate copper metal onto a key.

**Introduction:**

Electroplating is an economically important process, often used to reduce corrosion or improve the appeara of objects. During electroplating a thin layer of a desirable metal is deposited onto another object.

If you have ever purchased inexpensive jewelry with a fine coating of precious metal, then you have witne the end result of electroplating. It's an electrochemical reaction used to put a fine metallic coating on an

object. Aside from making cheap jewelry, electroplating has important uses in the automotive industry chrome plating, and in the electronics industry for optics and sensors.

The process of electroplating began at the beginning of the 20th century and continues to evolve

today. Many common objects such as tin cans are actually electroplated steel with a protective layer o Medical science has experimented with electroplating to create synthetic joints with electroplated coatings,

and new advances in electronics have been made with electroplated materials.

A familiar example of this process is the experiment you will perform in which a key is plated with

copper. The key (called the cathode) is connected to the negative terminal of a battery and is placed in an

electrolyte bath containing copper ions. The positive terminal of the battery is connected to a piece of

copper (called the anode--and often just a copper plate), which is placed in the electrolyte solution. The

copper sheet slowly oxidizes, making copper ions that are then attracted to the key, regaining their lost

electrons and becoming copper metal again, but now in the form of a thin coating

on the key. The battery forces all of this to happen.

A copper-plated key will be prepared using the electroplating technique. In the preparation of the copper-plated key, positive $Cu^{2+}$ ions from the electrolyte bath will become attracted to a key carrying a negative charge. When the $Cu^{2+}$ ions reach the key they will gain electrons and become reduced to form copper on its surface:

$Cu^{2+}(aq) + 2e^{-} \rightarrow Cu(s)$

The copper (II) ions removed from the bath must be replenished; this is accomplished at the anode where a solid copper strip undergoes oxidation:

$Cu(s) \rightarrow Cu^{2+}(aq) + 2e^-$

**Materials:**

- cathode - a key or a steel spoon
- a copper strip --anode
- electronic balance
- electrolytic solution – approx. 50 mL of 2.0 mol/L $CuSO_4$
- battery or power source (9-12 V) DC
- insulated wire leads with alligator clips at both end
- Glass rod that will cross the top of the beaker or jar – and copper wire to suspend the key

**Procedure:**

1. The **key/spoon** must be cleaned prior to electroplating. Prepare by polishing with some sand paper. Wash in distilled water, rinse and dry. Record its mass as in Table 1.

2. Use the copper wire (wrapped around a glass rod) to suspend the **key/spoon** into the empty beaker. Attach one end of a wire lead to the copper wire supporting the **key/spoon** and the other end to the **NEGATIVE** post of the battery or power source.
3. The Cu electrode/ sheet is washed with distilled water several times then dried. Record the mass.
4. Place the copper strip, the anode, into the empty beaker. Attach one end of a wire lead to the copper plate and attach the other end to the **POSITIVE** post of the battery or power source.

5. Carefully pour the 2 mol/L $CuSO_4$ solution into the beaker until it is about two-thirds full.
6. Hook up to the battery /power supply. The **key/spoon** should be wired to the **negative (black) electrode**. The copper strip should be wired to the **positive (red) electrode** of the battery as shown in **Fig. 1**

   **Have your teacher check your set-up before turning on the power supply!**
7. Turn on the power supply and begin timing. (What is the purpose of the power supply?)

8. Use a timer and allow the reaction to continue for **35 minutes**.. Record your observations while electroplating is occurring. After 40 minutes, turn off the power supply.

9. Remove the **key/spoon**, rinse with distilled water and dry well. Record the mass of the anode and cathode after electroplating.

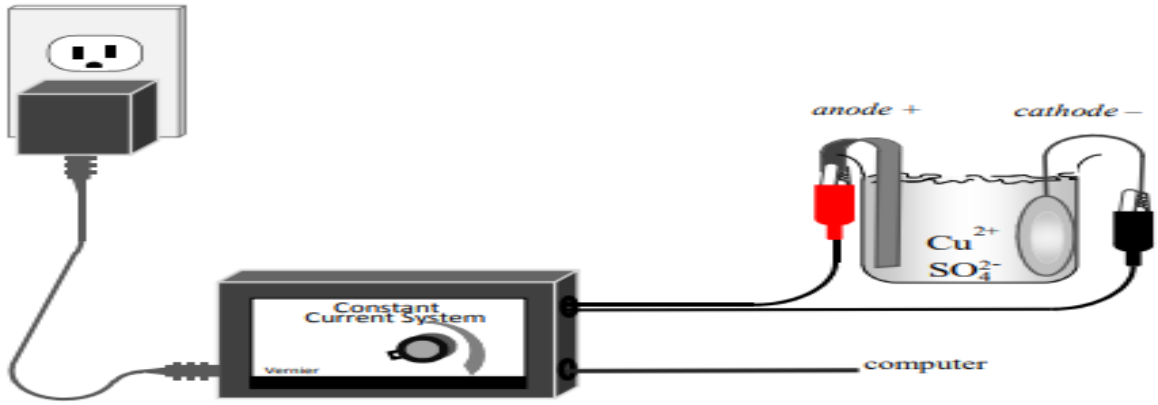
**Results:**

a) Draw a diagram of the electroplating set-up (beakers, metal strip, solutions and wires) and show the electrons flowing from the anode (+) , into the cathode (-). Also show ion movement in the electrolyte bath.

b) Carefully measure and record the new mass of the key in Table 1.

**Table 1:**

| **Item** | mass before electroplating | mass after electroplating | difference in mass |
|---|---|---|---|
| Key | Mg | mg | mg |
| Copper sheet | Mg | mg | mg |




**Report:**

a) How did the key/spoon change after electroplating?

b) How did the copper sheet change after electroplating?

c) Explain, at the molecular level, what caused these changes.

d) How would the concentration of the $Cu^{2+}$, in the solution at the end of the electrolysis compare to its original concentration? Explain.

e) Compare the change in mass of the copper strip with the change in mass of the key. Explain why they should be equal. Account for any differences.

f) Describe, in words, the entire electroplating process for plating copper onto a key as was done in this experiment. Include both the flow of copper ions and electrons through the system.

g) List at least two applications of the electroplating process in everyday life.