Experiment 10

Electroplating Experiment for Fun

Introduction

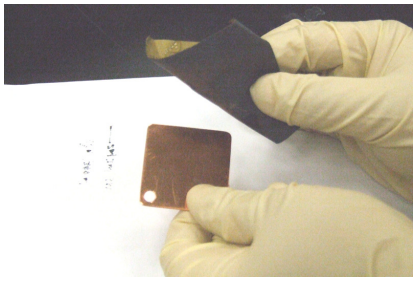
Electroplating is a common industrial process. By applying an electric current, a layer of metal such as copper or nickel can be deposited onto a conductive object. In this experiment, a 9-V battery is used as the energy source to drive the electroplating process. A copper plate and a graphite rod are used as the cathode and anode in the process, respectively. Nickel ion solution is used as the electrolyte. Under the influence of the battery, positively charged nickel ion can migrate to the cathode, pick up electrons and deposit on the surface of copper electrode. To create a special feature onto the metal surface, prior to the electroplating process, the students can draw a picture on the copper plate with an oil-based marker. Since the ingredients of the marker ink do not conduct electricity, nickel ions will not deposit on the trail of the drawing. After removing the ink pattern by acetone, an electrically plated product with artistic input from the students can be produced.

To make the activity more educational, a simple treatment method for the metal plating solution will be introduced. Metal ions in industrial wastewater must be removed first before its discharge. This can be achieved by mixing the wastewater with coagulant and flocculant. A coagulant is a substance that causes a liquid to coagulate to form solid or semi-solid materials, while a flocculant is a substance which promotes the clumping of particles. Both the coagulant and the flocculant react with the wastewater to form settleable-sized flocs, which are allowed to settle and collected as sludge at the bottom of the container.

Procedure

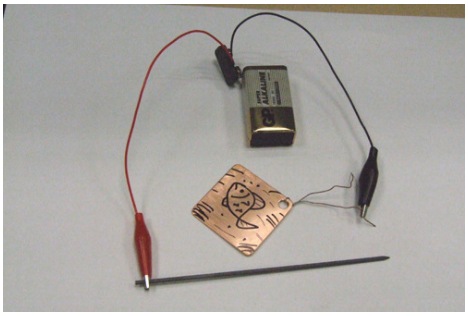
Conducting the electroplating experiment

1. Clean the surface of a copper plate with sand paper to remove metal oxide.

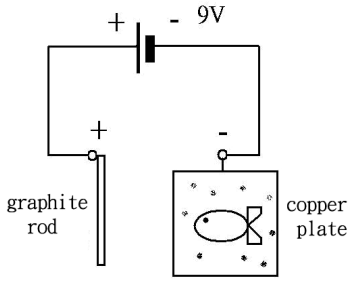


2. Draw a picture according to the student's own design on the copper plate with an oil based marker.

3. Connect the copper plate (used as the cathode) to the negative pole of a 9-V battery and a graphite rod (as the anode) to the positive pole of the battery. The electrical circuit is set up in the manner as shown in the diagram below.



Connecting the electrodes with a 9V battery

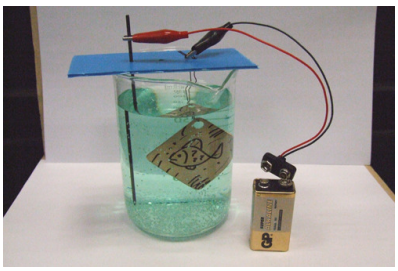


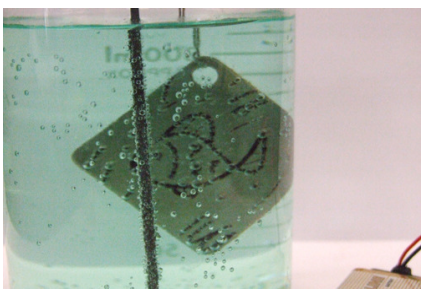
Electric circuit diagram

4. Dilute 20 ml of concentrated nickel plating solution* with de-ionized water to make up to 300 ml of plating solution.

*Prepared by dissolving 2 g $NiCl_2.6H_2O$ in 500 ml of 0.12 M HCl.

5. Put two electrodes into the solution and connect the circuit with a 9 V battery.



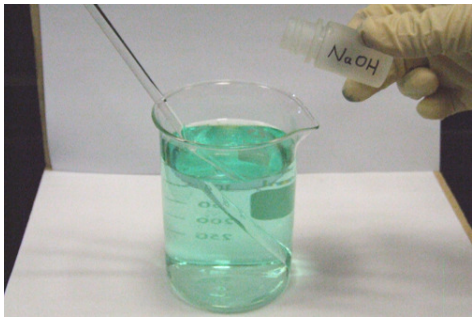


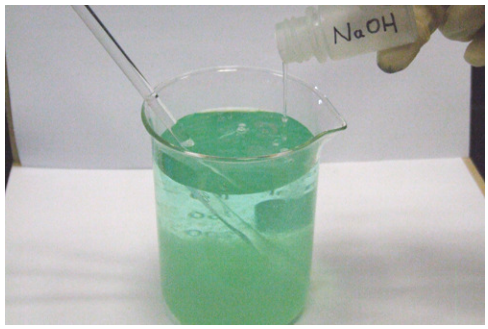
6. Allow the process to run for 10 to 15 min, disconnect the 9-V battery, take out the copper plate and rinse it with sufficient amount of water.

7. Use acetone to remove the marking trail to furnish the end product.

Treatment of the wastewater from the electroplating experiment

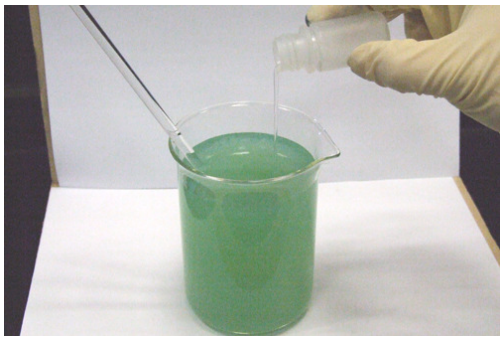
1. Add 10 ml of the coagulant solution (i.e. 1.0 M NaOH solution) into the wastewater to induce the formation of nickel hydroxide precipitate.



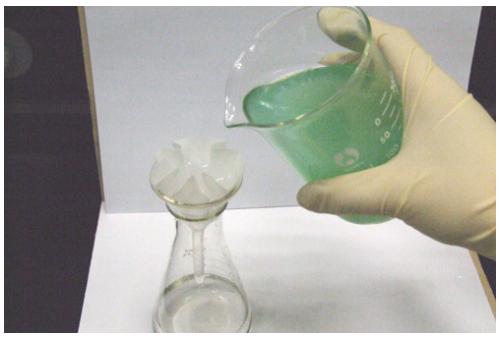


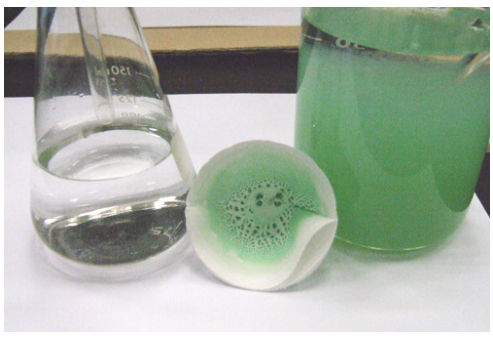
2. Introduce 10 ml of flocculant solution* into the mixture to speed up the rate of sedimentation of nickel hydroxide.

   *Prepared by dissolving 0.5 g of clarifloc-1 (purchased from HKPC) in I L of water.



3. Separate the precipitates by filtration.





Results

Conducting electroplating experiment

1. What ions are present in the electroplating solution?

   _____

2. Give the relevant half reactions occurring at the cathode and anode.

   _____

   _____

3. Record all observations during the experiment.

   _____

   _____

Treatment of the wastewater from the electroplating experiment

1. Why is it important to remove the metal ions first before discharging the wastewater into the environment?

   _____

   _____

2. The treatment method adopted is widely used in the electroplating industry. Discuss the advantages of this treatment method.

   _____

   _____

References

1. T.M. Leung, C.C. Lee and L. Yau, *Physical Chemistry, 2nd edition*, Fillans Ltd, 1987, P179.

2. Industrial studies lab manual 2007, experiment #8, HKBU.