

Silver & Gold Pennies

Kitchen Table Demonstrations

The Rundown

Time: 20-30 minutes

Content: electrochemistry, galvanization, metals, alloys

Safety Concerns: Flammable, corrosive NaOH(aq)

Materials Availability: Zinc dust and sodium hydroxide are necessary for this demo. All other materials are common. Some experiments have shown that zinc can be replaced by galvanized iron nails and sodium hydroxide can be replaced by Drano.

For thousands of years, some chemists were oftentimes referred to as “alchemists.” Alchemy was a philosophy and a practice up until the early 20th century, which resulted in our knowledge of the basics behind inorganic chemistry. One of the things that alchemists are best known for is their intention to transmute many common metals into precious silver or gold. Wouldn't it have been great if they had found a way to do this? We could all be rich! Although the alchemists never found a way for us to convert common metals into gold or silver, we can make certain common metals appear to be these precious metals through a process called galvanization. Originally, “galvanization” meant the administration of electric shocks. It was named this in honor of Luigi Galvani, an Italian physiologist who studied the effects of electric current on the nervous system of dead frogs. Today, when the term galvanization is used it typically refers to hot-dip galvanization.



Content Application

- Electrochemistry
- Galvanization
- Electrochemical plating
- Metal properties
- Alloys

Enduring Understandings

- Many metals easily oxidize upon exposure to oxygen in the air.
- Galvanization occurs by a process of electrochemical plating involving oxidation and reduction.



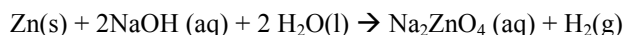
Chemistry

Electrochemistry is a branch of chemistry that involves chemical reactions between an electron conductor (metal) and an electrolyte (species in solution). Chemical reactions such as these can result in galvanization of a metal through the process of electrochemical plating.

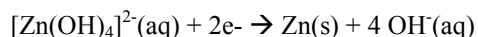
Galvanization is a term that is used today most often as a general name for the coating of one metal with another by electrochemical means.

Electrochemical plating is a more accurate and more technical name for the process of galvanization.

In this demonstration, a copper penny will be galvanized with zinc by electrochemical plating. To begin this process, zinc powder is dissolved in hot sodium hydroxide solution to form sodium zincate:



When a copper penny is added to this solution, the copper-zinc contact results in the migration of the zincate ions to the surface of the penny where they are reduced to silver-colored zinc metal, which in turn coats the copper penny:



It is believed that the reducing agent in this process is zinc itself. When this “silver penny” is heated, the zinc coating mixes with the copper to form brass alloy, which has a gold color.



Materials

- 2-3 grams zinc powder
- 3M NaOH (aq)
- Bunsen burner
- Wire gauze pad
- Ring stand
- 3 clean pennies
- crucible tongs
- Steel wool



Safety

- Goggles – In case of exposure to the Bunsen burner flame or the sodium hydroxide.
- Sodium hydroxide (NaOH) is very corrosive. It is a skin and eye irritant. Do not come into direct contact with this chemical.



Procedure

Setup



Figure 1

1. Set up a heating apparatus as shown in Figure 1.
2. Polish/clean each penny with steel wool.

Part One – Silver Penny

3. Place about a 1-2 gram sample of zinc powder into beaker containing 50 mL of 3M NaOH (aq) and mix.
4. Heat this solution over a Bunsen burner (Figure 1) until it begins to boil.
5. Remove the beaker from the heating apparatus, and place two of the three pennies into the solution so that they do not touch one another. Allow the pennies to sit in the beaker for 5-10 minutes (until they turn completely silver).
6. Remove the pennies from the beaker using tongs. Rinse them in water and allow them to dry.

Part Two – Gold Penny

7. Using tongs to hold the penny, gently heat one of the two silver pennies in the coolest part of a Bunsen burner flame.
8. Remove the penny from the flame immediately when you see it change color.



Disposal

- The excess sodium hydroxide/zinc solution can be discarded down the drain once diluted.



Student Participation and Follow-Up

Suggestions:

1. While the demonstration is taking place, have the students write down observations about what happens during each part.

Try the following follow-up activities:

1. Discuss some of the practical real life applications of galvanization. Examples could include plating jewelry, making counterfeit money or jewelry, plating metals such as iron, copper, or steel with zinc in order to prevent corrosion of the plated metal.