Turning copper coins into ‘silver’ and ‘gold’

Demonstration

A **copper** coin is dipped into a solution of sodium zincate in contact with **zinc** metal. The coin is plated with zinc and appears **silver** in colour. The plated coin is held in a Bunsen flame for a few seconds and the zinc and copper form an **alloy** of **brass**. The coin now appears gold.

Lesson organisation

A simple demonstration involving electroplating and the chemistry of alloys, this is suitable for any age group depending on the sophistication of the theoretical treatment used - if any.

The demonstration takes about 10 -15 minutes.

Apparatus	Chemicals
For each demonstration: **Eye protection: goggles** **Disposable gloves (preferably nitrile)** **Beaker (250 cm^3)** **Bunsen burner (Note 1)** **Tripod and gauze** **Pair of tongs or forceps** **Glass stirring rod** **Access to a top-pan balance**	Sodium hydroxide pellets (CORROSIVE), 24 g Zinc powder (HIGHLY FLAMMABLE, DANGEROUS FOR THE ENVIRONMENT), 5 g Steel wool **(Note 2)** Deionised or distilled water, 100 cm^3 Copper coins **(Note 3)** **Refer to Health & Safety and Technical notes section below for additional information.**

Health & Safety and Technical notes

Read our standard health & safety guidance

Wear goggles and disposable gloves.

Sodium hydroxide, NaOH(s), (CORROSIVE) - Refer to CLEAPSS *Hazcard*.

Zinc powder, Zn(s), (HIGHLY FLAMMABLE, DANGEROUS FOR THE ENVIRONMENT) - Refer to CLEAPSS *Hazcard*. Any remaining finely powdered zinc should not be left to dry because it can ignite spontaneously. Dispose of it by rinsing with water, dissolving in excess dilute sulfuric acid and washing the resulting zinc sulfate solution down the sink.

Hydrogen gas, $H_2(g)$, (EXTREMELY FLAMMABLE) - Refer to CLEAPSS *Hazcard*.

1 Since hydrogen is evolved from a hot solution of zinc in sodium hydroxide, an alternative source of heating is to be preferred, e.g. an electric heating plate. If a Bunsen burner is to be used then it should be turned off before the zinc is added.

2 If steel wool isn't available a proprietary mild abrasive material (for example, ‘Brillo’ soap pads) can be used instead.

3 Copper foil could be used instead, but coins are better since they are everyday articles, and there are bound to be requests from the audience to turn copper into 'gold'. Strictly speaking it is illegal to 'deface coins of the realm', so the law-abiding teacher might prefer to use foreign coins instead. It would be wise under these circumstances to ensure that the plating works, since many other alloys are used in foreign coinage.

Procedure

Before the demonstration

a Dissolve 24 g of sodium hydroxide in 100 cm^3 of deionised/distilled water in a 250 cm^3 beaker, stirring continuously. The solution will get warm and is CORROSIVE.

b Heat the solution to boiling point on a Bunsen burner (caution: the hot solution is HIGHLY CORROSIVE).

c Turn the Bunsen off .

d Add 5 g of zinc powder carefully. The solution will fizz as some of the zinc dissolves forming sodium zincate and giving off hydrogen.

e Clean a ‘copper’ coin with steel wool until it is shiny.

The Demonstration

a Drop the cleaned coin into the hot solution containing sodium zincate and the remaining zinc powder.

b The coin must make contact with the powdered zinc at the bottom of the solution. If necessary use a glass rod to move the coin until this is so.

c Leave the coin until it is plated with a shiny coat of zinc. This will take about 2-3 minutes. Leaving the coin too long may cause lumps of zinc to stick to it.

d Remove the plated coin with tongs or forceps and rinse it under running tap water to remove traces of sodium hydroxide and sodium zincate.

e Show the 'silver' coin to the audience.

f Using tongs or forceps, hold the plated coin in the upper part of a roaring Bunsen flame for a few seconds until the surface turns gold. Turn the coin so that both sides are heated equally. Overheating will cause the coin to tarnish.

g Allow the coin to cool and show it to the audience.

Teaching notes

It may be sensible to carry out a trial experiment before performing the demonstration in front of an audience.

If the mixture of sodium zincate solution and zinc is cloudy, allow to cool, and then filter off the zinc to leave a clear filtrate. Place a small piece of zinc foil in the liquid as a substitute for the powder.

Younger students might want to have their own coins plated.

The theory is as follows:

The reaction between zinc and sodium hydroxide to form sodium zincate is as follows:

$Zn(s) + 2NaOH(aq) + 2H_2O(l) \rightarrow Na_2[Zn(OH)_4](aq) + H_2(g)$

The plating reaction involves an electrochemical cell; it will not take place unless the copper and the zinc are in contact, either directly (as here) or by means of a wire.

The electrode reactions are:

At the zinc electrode: $Zn(s) \rightarrow Zn^{2+}(aq) + 2e^-$
followed by complexing of the zinc ions as $[Zn(OH)_4]^{2-}(aq)$

At the copper electrode: $[Zn(OH)_4]^{2-}(aq) + 2e^- \rightarrow Zn(s) + 4OH^-(aq)$

The coating of zinc gives the impression that the coin is now coated with silver.

On heating the coin in the Bunsen flame, brass is formed by the zinc migrating into the surface layer of the copper. This gives a gold appearance to the coin.

Brass is an alloy of copper containing between 18% and 40% of zinc.

A similar zinc plating process is used industrially, but with cyanide ions rather than hydroxide ions as the complexing agent.

Health & Safety checked, August 2016

Credits
This Practical Chemistry resource was developed by the Nuffield Foundation and the Royal Society of Chemistry.

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