UNIVERSITY OF BIRMINGHAM

Previously we tried electrochemistry, passing current through steel pins to generate hydrogen and oxygen. However, we also changed the chemistry of the electrodes to make iron oxide or 'rust'. Depending on the electrolyte solution we use, we can change the reaction to make something more useful, such as protecting metals from corrosion by plating them.

Experiment

This activity investigates electrochemistry and electrode potentials via electroplating to produce brass alloy from copper coins.

Equipment:

- 250ml beaker
- Bunsen burner, tripod and gauze
- Pair of tongs
- Glass stirring rod
- Top-pan balance
- 24g sodium hydroxide (NaOH)
- 5g zinc powder (Zn)
- 100ml distilled water
- Dilute sulphuric acid
- A number of 2 pence coins (cleaned with a little wire wool)

BEFORE WE START… Some health and safety.

A video of this demo is available at: http://bit.ly/1JB9c29. It uses chemicals that have CLEAPSS hazcards relating to NaOH (Corrosive), Zn (Highly flammable, dangerous to the environment*), hydrogen gas (extremely flammable).

*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 sulphuric acid and washing the resulting zinc sulphate solution down the sink.

Preparing the sodium zincate solution.	Dissolve 24g of NaOH in the water in a 250ml beaker, stirring continuously. The exothermic reaction produces a corrosive solution. Heat the solution to boiling point on a Bunsen burner to produce a highly corrosive sodium zincate solution. Turn the Bunsen off! Add 5g of zinc powder carefully. The solution will fizz as some of the zinc dissolves forming sodium zincate and giving off hydrogen*. *Reaction is $Zn(s) + 2NaOH(aq) + 2H_2O(l) \rightarrow Na_2[Zn(OH)_4](aq) + H_2(g)$
Turning copper to 'silver'.	Drop the coin into the hot solution so that it makes contact with the powdered zinc at the bottom. Leave the coin until it is plated with a shiny coat of zinc*. This may take 2 minutes. Remove the plated coin with tongs and rinse it under running tap water. Show the 'silver' coin to the audience. *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: $[Zn(OH)_4]^{2-}(aq) + 2e^- \rightarrow Zn(s) + 4OH^-(aq)$
Turning 'silver' to 'gold'	Using tongs, 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. Brass, an alloy, is formed by between 18% and 40% of zinc migrating into the surface layer of the copper. This gives a gold appearance to the coin.

Further Thoughts

- Why would you want to plate some metals? Decoration (jewellery)? Corrosion resistance (food containers)?
- Repeat the experiment using tin powder, or granules instead of zinc. The coating process is identical but slower (> one hour) because tin has a much less negative electrode potential than zinc. The resulting coin has a dull bronze appearance.
- Try weighing the coins before and after coating to find the mass of zinc added.