

Anodising aluminium

Part One

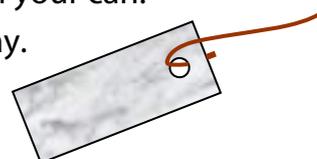
Your piece of aluminium has to be really clean for the process to work.

Ordinary cleaning is not enough.

Special chemical cleaning is needed (we will have to do this bit for you).



Job 1 Using the scissors, cut out a piece of aluminium from your can. Watch out for sharp edges! About 5 cm × 2 cm is okay. Make a hole in the strip at one end. Bend one end of a length of copper wire to make a hook, and put it through the hole.



From now on, only hold the aluminium using the wire – not your sticky paws!

Job 2 Fill a large beaker about $\frac{3}{4}$ full with distilled water (not tap water). Take your beaker and the piece of aluminium to the fume cupboard.



Ask one of the teachers for help now.

Job 3 Ask one of the teachers to process your aluminium for you. We will do the following things for you:

- dip the aluminium in sodium hydroxide solution at 50 °C for about 10 seconds
- rinse it in some distilled water
- dip it in nitric acid at room temperature for about 3 seconds
- rinse it again in the distilled water
- put the clean aluminium into your beaker of distilled water for you to carry back to your bench.



The two substances needed to clean the aluminium are dangerous:

- 1.5 M sodium hydroxide solution at 50°C – corrosive
- 3 M nitric acid at room temperature – also corrosive.

You need to be more experienced to handle them.

You are now ready for Part Two of the process

Anodising aluminium

Part Two



Aluminium has a thin layer of aluminium oxide on it.

Aluminium oxide will soak up dyes for permanent colouring.

To get deep colours, we need to make a really thick layer of aluminium oxide. We can do this using electricity – a process called **anodising**.

Job 1 Get your gloves on – you are going to use a piece of lead and sulfuric acid.



Thread a piece of copper wire through the hole in the lead. Make sure that there is a good electrical connection by twisting the wire tight.

Job 2 Now you have to set up the anodising cell. Put the 500 cm³ beaker on top of some paper towels. Lay the glass rod on top of the beaker.

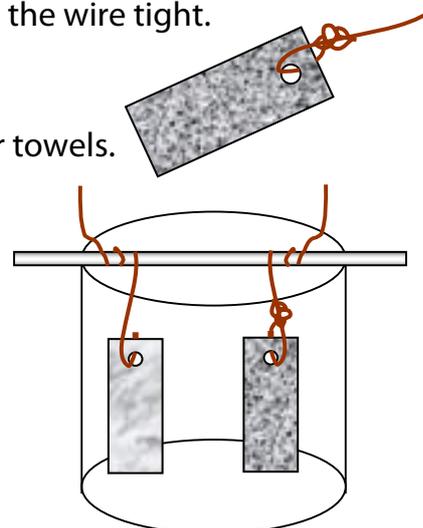
Hang the piece of lead from the rod using the copper wire:

- the lead should hang just above the bottom of the beaker
- make sure that some copper wire sticks up from the rod.

This will let you make an electrical connection.

Do the same thing with your cleaned aluminium strip but:

- don't touch it with your hands
- don't let it touch the piece of lead.



Job 3 You are now ready to start anodising. For it to work, you must complete the electrical cell with sulfuric acid (this will conduct electricity between the lead and aluminium).

Carefully pour sulfuric acid into the beaker. You need just enough to:

- cover most of the lead, and
- cover most of the aluminium strip (but leave about 1 cm above the surface).



Plug one wire into the negative terminal of the power pack.

Connect the crocodile clip from this wire to the copper wire on the piece of lead.

Plug the other wire into the positive terminal of the power pack.

Connect the crocodile clip from this wire directly to the top of the aluminium strip.



Ask one of the teachers to check your work. You must **not** switch on without permission.

You are now ready for Part Three of the process

Anodising aluminium

Part Three

Job 1 Cover the beaker with a piece of paper towel.
During anodising, a light spray of acid is produced because of gas bubbles formed at the metal electrodes. The paper towel reduces the risk of this causing harm or damage.



To start the anodising, turn on the power supply and adjust the voltage to about 15 V. The process will take about 30 minutes. Perhaps time for a break?

Job 2 After 30 minutes, turn down the voltage. Turn off the power pack.
Remove the crocodile clip from the aluminium strip.
Carefully lift out the aluminium strip using the copper wire hook.

Wash the strip in distilled water and store it in a beaker of distilled water.

Job 3 You are now ready to colour the aluminium strip. Try one colour first, because you can be more artistic with another strip later.

To colour the strip, you just put into the dye of your choice:

- leave the strip in the dye for 10 minutes, but move it about a bit every minute
- after 10 minutes, remove your aluminium strip from the dye solution
- put it on a watch glass, then wash it under a running tap to get rid of excess dye.

To seal your aluminium strip, put it in a beaker of boiled water from the kettle for 10 minutes. The dye is now permanently sealed into the aluminium oxide layer.

Be creative!

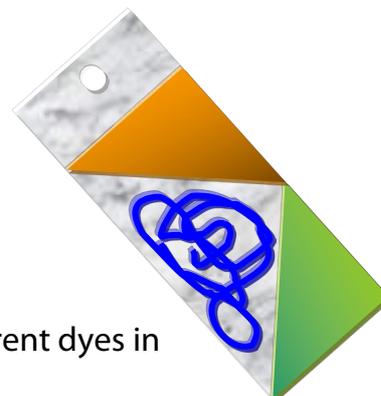
Now you know how to prepare and dye the aluminium, you can let your imagination loose.

Things you could try include:

- cutting out different shapes of aluminium to anodise
- using more than one dye
- trickling dyes over the surface
- dabbing dyes onto the surface

... and for the really adventurous ...

- sealing corners separately with boiling water, and using different dyes in between to get shading effects.



Anodising aluminium

Teacher Guide

Contents

- Activity notes
- Student checklist
- Technician notes

Activity notes

There are several methods for simple anodising of aluminium. We use a lead cathode with a copper wire already soldered on, but you can use a large piece of aluminium instead. Preparation and patience is important - if students rush the cleaning and anodising stages, they get a poor result. We find that many drinks cans have a thin plastic coating on the inside. This can be removed using wire wool, or left in place if only one side is to be dyed.

The cleaning stage is handled by teachers or sixth form helpers, as the reagents involved are not suitable for younger students. It is possible to clean the aluminium using a hot detergent solution instead, but we found that the results were less satisfactory. Once cleaned, the aluminium must not be touched with bare fingers.

During anodising, a fine spray of acid may be produced, so it is important to keep the beaker lightly covered by a paper towel. The first run is often the best in our experience, largely because the students concentrate and follow their instructions carefully. Later, they are tempted to rush the process - they turn up the voltage too high and reduce the run time. As a result, the metal can break at the surface of the acid, and they get a poor uptake of dye. Good students spot a faint pink or purple colour in the acid during anodising. We think this is due to traces of manganese in the alloy used in drinks cans.

Some of the best results have come from simple dyes, such as diluted fountain pen ink. Red ink gives particularly beautiful effects. Some clothes dyes also work well, especially Kingfisher Blue and Emerald Green. Orange and red dyes seem to give poor results (only a patchy sludge colour), so use fountain pen inks for these colours. A nice 'gold' colour can be obtained by making an aqueous solution of ammonium ethanedioate and iron(III) chloride (use approximately equal masses - harmful).

aluminium sheet 

Beware of sharp edges and corners.

lead metal 

Harmful if swallowed or inhaled. Wear gloves and avoid raising a dust. May be of concern to pregnant women.

1 M sulfuric acid 

Irritant to the eyes and skin. Avoid skin contact and wear eye protection.

3 M nitric acid 

Corrosive. Wear chemical-resistant gloves and splash-proof goggles.

1.5 M sodium hydroxide 

Corrosive. Wear chemical-resistant gloves and splash-proof goggles.

Anodising aluminium

Student checklist

Check that you have the following things.

- 2 × 250 cm³ plastic beakers glass rod
- watch glass
- power pack
- 2 × 10 cm lengths of copper wire
- 2 × electrical leads with crocodile clips
- lead or aluminium sheet, 2 cm × 5 cm
- aluminium drinks cans
- fine steel wool
- paper towels
- wash bottle containing distilled water
- 250 cm³ of 1 M sulfuric acid 

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Technician notes

Per group of students

2 × 250 cm³ plastic beakers

glass rod

watch glass

power pack

2 × 10 cm lengths of copper wire

2 × electrical leads with crocodile clips

lead sheet, approx. 2 cm × 5 cm [or aluminium sheet]

aluminium drinks cans (washed)

fine steel wool

paper towels

wash bottle containing distilled water

250 cm³ bottle of 1 M sulfuric acid, labelled '1 M sulfuric acid – Irritant'

In the fume cupboard

200 cm³ of 1.5 M sodium hydroxide in a 250 cm³ beaker, labelled '1.5 M sodium hydroxide – Corrosive', and placed in a water bath at 50 °C

200 cm³ of 3 M nitric acid in a 250 cm³ beaker, labelled '3 M nitric acid – Corrosive'

distilled water in a labelled beaker, with spare water

In the lab

Assorted water-soluble clothes dyes or diluted fountain pen ink in covered 500 cm³ beakers – keep in a water bath at 50 °C

kettle

scissors

distilled water

nail, wooden block, hammer