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Anodising Aluminium

1. Introduction

Aluminium is a soft, reactive metal that forms an invisible protective oxide layer on its surface. This natural oxide layer can be replaced by a much harder oxide deposited by a simple electrolytic process. The resulting transparent anodised surface layer can be left as is or dyed using organic dyes and then sealed if so required. The following materials and process can be used for anodising and dyeing small work pieces made in the home workshop. No guarantee is given that the process is fool-proof and works every time! Fortunately, it is possible to remove the anodising and dye and start over again if the dye fails to provide a uniform finish, for example.

Figure 1Figure 1 Centering Microscope a Sample of Anodising

2. Materials

Most of the chemicals required are corrosive and can cause very nasty burns if left on unprotected skin. Wear gloves, eye protection and overalls and have to hand suitable precautions for dealing with spillages. The following materials are required:

1. 10 -15% w/v caustic soda solution for cleaning work pieces or removing poor anodising. Caustic soda is widely available as a drain cleaning agent. The strength is relatively unimportant. The solid and liquid are very corrosive and cause particularly nasty burns. Remember too, always add the solid to water when making up a caustic soda solution.
2. 12% v/v sulphuric acid - this can be diluted down from either concentrated sulphuric acid (Oil of Vitriol) or 'battery acid' which is available in 50% v/v or 33% v/v. Always add acid to water when diluting, otherwise the mix will boil and acid will splatter all over the place! The 12% strength is a compromise between hard anodising (10% v/v sulphuric acid and a surface layer having an open pore structure which will adsorb the dye (15% v/v sulphuric acid).
3. Dylon multi-purpose dye in small round containers, colour of your choice. Using a stainless steel container, the dye is mixed into 1L of soft tap water or deionised water (preferable) brought to the boil for a few minutes and allowed to cool down.

Other aluminium anodising dye stuffs are available. Try www.dyeshop.co.uk. They have obscure colours in stock.

4. Thermometer (0 – 100 deg C) to check temperature of dye solution
5. Lead sheet to make the cathodes – lead flashing is suitable and the cathode surface area needs to be larger than the surface area of the work piece. Two flat pieces wired together on opposites sides of the anodising bath work well.
6. Aluminium wire with which to make electrical contact and to suspend the work piece in the acid bath. Aluminium welding wire is suitable. Strips cut from aluminium drink cans can be used too.
7. Solvent e.g. acetone or white spirit to degrease the work piece
8. Fine wet and dry emery paper and metal polish if required.
9. A polythene container to make the acid bath e.g. 1 litre ice cream tub...
10. A power supply providing 12 – 15 volts and up to 5amps.
11. Multimeter capable of measuring resistance and current up to 10 amps.
12. Plastic gloves, paper towels
13. A solution of sodium bicarbonate to neutralise any acid spills and contents of the acid bath before it is thrown away.

3. Set Up

Firstly, prepare the acid bath by cutting two pieces of lead sheet and bend them to fit over the ends of the plastic container e.g. a 1L ice cream container. Electrically connect the two pieces of lead together with a piece of 5 amp or greater, insulated wire. Connect the negative lead of the power supply to the lead sheets to act as the cathode. Connect the ammeter in series with the positive lead to the work piece (I.e. positive lead of ammeter connected to the power supply positive terminal and the negative lead of ammeter to a wire with a crocodile clip with which to attach to the work piece). This enables the anodising process to be monitored. The operating current will depend on the surface area of the work piece and will fall significantly when the non-conducting, anodised layer has formed and the formation of bubbles on the cathodes and work piece will cease too. Acrid fumes are given off when anodising is taking place and it is highly recommended that the process is performed in a well ventilated area, e.g. outdoors! Remove or cover any pieces of equipment that might be damaged by exposure to acidic fumes or fine droplets emitted from the acid bath.

4. Process

Clean and polish the work piece. I found fine wet emery paper dipped in soap and water best. Brasso can be used to obtain a highly polished surface although I did not find this strictly necessary and it may have been the cause of poor dye take up). When satisfied with the surface finish, dip the work piece in a solvent to clean off any grease. White spirit or acetone are suitable. After which do not touch the cleaned component with your bare fingers – this is important!

Attach a piece of aluminium wire to the work piece (through a hole or around a spigot) and make sure that it makes a good electrical contact. Check with the multimeter.

Dip the work piece in the caustic soda solution for a few minutes. It will effervesce considerably and the vapour given off is pretty noxious too. Remove the work piece and rinse in clean water to remove any remaining caustic soda solution.

Transfer the work piece to the acid bath and attach the crocodile clip (positive) to the work piece (the anode and hence 'anodising'). Check the multimeter/ammeter is working and switch on the current. The current seen will depend on the surface area of the work piece. Bubbles will form on the lead cathodes and around the work piece. When the current falls to and remains at say 200mA, the anodising process is complete. Switch off the current and remove the work piece from the bath, rinse off the acid and immediately transfer to the dye solution. Do not allow the work piece surface to dry before dyeing. If dyeing is delayed, submerge the work piece in a container of clean water.

The dye solution should be heated to between 40 – 50 deg C (in a stainless steel pan) to help the dye particles penetrate the surface pores of the anodised surface layer. Immerse the work piece in the warm dye solution and leave submerged for about 30 minutes and then remove and rinse off the dye and wipe dry. A uniform (e.g. deep black) colour should be apparent. Check for uniformity of the colour and see below for corrective action should the dye fail to take up.

If the dye take up has been satisfactory, place the dyed work pieces in a pan of boiling water for 30 minutes to seal the surface. Leave to cool and remove finished items. Dry and polish with a cloth.

5. Points to Note

Not all aluminium takes up the dye readily. For example, copper containing alloys may not take up the dye. Dye take up may also be affected by type of dyestuff, acid strength, the finish and cleanliness of the work piece and the temperature of the dye solution. It is worth experimenting with samples of the aluminium to be used before commiting the work piece. I found that a good rub with fine grade emery paper wetted with soap and water gave a very satisfactory finish. Scratches present on the surface of the work piece before anodising commences will not be covered or masked by the anodised layer.

Make sure that the work piece makes good electrical contact with the positive supply. Use only aluminium wire to make contact with the work piece. Dye take up may be affected where the aluminium wire makes contact with the work piece.

An anodised surface is non-conducting and this can be ascertained by using a multimeter set on the resistance scale.

A poorly anodised or dyed surface can be removed by returning the work piece to the caustic solution for 30 minutes or so. Remove, rinse and check for removal of the anodising by using the multimeter which should confirm a conducting surface is now present. The surface should be prepared again by rubbing with emery paper and degreasing, followed by a short immersion in caustic soda solution. This recovery process can be repeated several times but do check the work piece for pitting corrosion which may be present.

6. References

MEW Number 106 May/June 2005 Centering Microscope by Dick Stephen
Hemingway Kits: suppliers of Centering Microscope
Electroplating by J Poyner, Number 11 in Workshop Practice Series