

Metal Etching and Electroplating – A quick guide for SCAdians

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Etching

There are many different chemicals and methods that may be used to etch different metals. In very general and basic terms the process of etching metal is the removal of some parts by applying a chemical corrosive while leaving others untouched by covering with a layer of resistant material.

There are two classes of etching methods: Electrochemical (using chemical reactions) and electrolytic (uses an electric current to accelerate the oxidation process instead of an oxidising chemical).

The Resist

The ability to remove only selected areas from a piece of metal is provided by covering the selected areas with a resistant coating (such as enamel paint, water proof ink or wax). This resistant coating, or “resist”, prevents the etching chemical from coming into contact with the metal and eating it away.

If using enamel paint, make sure that there is a good coverage of paint and it is even. You can also use brown waterproof ink (which is better for writing if you wish to etch calligraphy). Black waterproof ink can be used but provides inconsistent results and the piece will also need to be sanded before use.

Another form of resist is a Dalo (brand name) pen, which has a fine tip for doing one-off work.

Positive Photo Resist

Another (and better) option is Positive Photo Resist. This is sold on with ferric chloride and the ammonium persulphate at Dick Smith's. It is a spray that is used to coat the piece of metal and then the areas you don't want to etch are covered. You then expose it to a UV source and then put it in a developing solution to complete the reaction.

The real joy with this is that you can design the pattern on a computer and print it in negative to a transparency, tape the transparency to the piece and put the whole lot in the sun.

Method:

- Preparing metal for photo-resist. The metal should be clean, especially from dust and oil. Dust will create balls in the film of photo-resist and oil will cause the resist to bead like water on the metal surface, a frustrating waste of an expensive chemical.
- Exposure times vary. One trick is to create a black spot or corner as an indicator. You can then judge the exposure time as the resist darkens on the unexposed bits. A good sunny day is the best option, unless you can get hold of a UV exposure box with germicidal UV lamps (You must use EYE protection and LOTS of Sunscreen).
- Beware accidental exposure! - Where are you going to apply the resist? Use a tent, or a large box away from light sources. Where are you going to do the application of the transfer? Work this out BEFORE you start application as cleaning off the resist can take some work if you wreck it.
- Removing photo-resist. If you make a mistake, the easiest way to remove the resist is to give it a good exposure and then develop it. It should just fall away. Clean any remaining areas with acetone (paint thinners). Remember appropriate safety with paint thinners!

Selecting the Resist Method

The type of resist you select will vary based on your background and skills. If you have good hand skills and are doing one-off work then a Dalo pen, wax or enamel paint are for you. Building the inverted image for photo-resist takes some thought and the exposure requires care, but it provides for

mass production of the image, which is great for repeated patterns, or large runs of a particular image. Unfortunately unless you can make an image that looks 'hand-drawn' then it will always have that slightly unrealistic computer perfection to it that can sour a lovely piece.

Preparation of metal

Before etching you should lightly sand the metal with fine wet/dry sandpaper to remove any oxidation. This is not vital, but waterproof ink resists won't stick to the metal surface if you don't. If using the enamel paint resist you can skip this stage, but the piece is easier to clean afterwards if it is sanded.

Completion of the metal piece

When you have finished etching, clean the metal surface until all the resist has been removed. The pattern will be visible if the etch has worked. Do not clean or sand too hard or you may remove the etched design! You can use a metal polishing compound, such as Autosol Metal Polish (~ \$8.50 from Supercheap) to make the cleaning easier.

General safety and tips

Work in a well ventilated area or outside as the etching process will produce dangerous and irritating fumes. Ferric chloride also stains.

Wear all appropriate safety gear.

Note: Use an old ice-cream container or similar (not a metal bowl ☺) to do the etching in.

Do not pour these down the sink! – Check that you don't have brass or copper pipes!

Chemicals used for Etching

Ammonium Persulphate

Commonly used for etching brass and copper and is available at Dick Smith's for about \$10.

Ammonium persulphate comes as a powder and you mix a couple of teaspoons with warm (~75° C) water - no need to be exact, it really just needs to be warm water and you can vary the times of immersion, the lower the temperature of the water, the longer the time of immersion.

Immerse the metal in the ammonium persulphate (make just enough to cover the piece) and leave the piece of metal in the etching bath for approximately 10 - 15 minutes. You can't see when it is done so it's a matter of practice to know when the etching is done.

When you think it is done, put it under a tap and rinse it with water to remove the etching chemical. The ammonium persulphate is easier to use as the etch solution goes blue (copper sulphate) and you can see when it is washed away.

Ferric Chloride

Ferric chloride is a strongly acidic chemical and gloves, vapour mask and good ventilation are required.

Ferric chloride is very effective for etching steel, brass and copper. It can easily be purchased from Dick Smiths for about \$10. It etches better when slightly warm and agitated (Use an fish tank air pump system).

The Ferric chloride comes as a liquid. Don't dilute it or it won't work as well. Suspend the piece of metal in the ferric chloride with the design facing down. This makes for easier removal of the products of the chemical process (cupric chloride and a solution of ferrous chloride).

Use enough of the ferric chloride to cover the piece of metal and leave about 10 - 15 minutes. When you think it is done, put it under a tap and rinse it well with water to remove the etching chemical.

The dangers of etching zinc plates with ferric chloride

Etching zinc plates in ferric chloride produces bubbles of hydrogen gas **that are explosive**. They also produce an uneven etch, so removal by a soft instrument (feathers have been used) is required.

A deposit of iron is also produced and forms a crust over the etched surfaces. This crust is abrasive and its removal can damage the etched surface.

The spent solution contains zinc chloride. This is more toxic and corrosive than ferric chloride.

Copper Sulphate

Copper sulphate is used to etch mild steel (not stainless) and zinc plates. The solution is very much safer to handle than ferric chloride, and a zinc plate can be etched without the production of any bubbles of gas, although gloves should be worn to avoid skin contact.

For etching mild steel plates (iron - not stainless steel) adding an equal quantity of sodium chloride (common salt) solution is more effective than pure copper sulphate, which has a tendency to 'plate' the steel and stop the etch. The salt/copper sulphate mixture works equally well with zinc.

Warming the solution to about 36⁰C and agitating (a fish tank air pump works well) will speed up the process. An insoluble powdery deposit of copper is produced which is very easy to remove by brushing with a feather or a soft brush in a flat tray.

This mixture of salt and copper sulphate will also etch aluminium with the addition of sodium bisulphate.

The other advantage is that the initially blue solution remains quite transparent, and turns gradually colourless as it is exhausted, and the progress of the etch can be very easily seen in a tray by the formation of the deposit.

Acids

SAFETY NOTE 1: Have all your safety protocols in place and every piece of your safety gear on or handy. Always have plenty of water available for dilution, and basic solutions like a saturation solution of baking soda ready to hand to neutralize acids that get in the wrong place.

SAFETY NOTE 2: The acid gets poured in the diluting water, never the water into the acid. As acid mixes with the water, it reacts with it in an exothermic reaction sufficient to make small quantities of water flash into steam and splash the acid out of the container. The same thing goes on with dripping acid into a big container of water, but the water carries all the heat that's formed comfortably away, so you can arrive at the desired strength without a foaming mess.

Many dilute acids are used for etching, mainly hydrochloric acid, nitric acid or 10% - 25% sulphuric acid. If you want a deep etch, acid etching is going to be slow. Diluted sulphuric acid is a better solvent for steel than concentrated acid.

Electrolytic Etching and Electroplating

(From the Armour Archive)

Etching:

Table Salt

Water

Plastic Container

Car Battery Charger

an automotive light bulb

A scrap of metal
Etch Resist (See above)

Method:

- Fill the plastic container with warm water and 2 tablespoons of salt per litre of water.
- Stir until the salt is dissolved.
- Place a plate of scrap metal into the salt water (the electrode), and attach this plate to the negative terminal of the car battery charger (this connection should be above the water line).
- Attach the positive terminal of the charger to one of the connections on the light globe.
- Attach a wire from the other connection of the light globe to the piece to be etched and immerse it in the saltwater solution. Bubbles will begin to form around the electrode and the light globe will glow (see below).
- Periodically pull the piece to be etched from the water and check your progress. Wipe any oxides from the surface. It would appear that there is a relationship between the speed of the etch and the voltage, the higher the voltage, the quicker the piece is etched. For general etching purposes however a 12-volt battery charger is more than adequate.
- Oxides from the etched piece can be removed using vinegar and a rag.

Electroplating

- Move the etched piece to the negative terminal with the etch resist still in place.
- Place a copper plate on the terminal attached via the light bulb to the positive terminal.

The etched surfaces will be plated with a thin layer of copper.

Note: The current won't pass through the system if the connection through the fluid is poor, voltage is low etc. The light globe indicates whether there is sufficient current for the process to work. If the light globe is on it means that there is enough current. If the light is off then remove oxides from the etched piece with vinegar, check the power source etc.

Gold and Silver

Unfortunately it's not possible to directly plate gold onto steel (gold and iron don't combine on the atomic level - When the armourers of old used mercury/gold amalgam they first coated the surface of the iron with solution of copper so the gold would stick.).

Firstly plate with copper, which increases the conductivity of the etching surface. Next, plate with nickel, to give it a hard surface to plate to (also makes it more scratch resistant), then plate with your choice of precious metal.