Friedhard Kiekeben

ACRYLIC RESIST ETCHING

Metal Salt Etching - Etching without Acid

The Metal Salt etching processes outlined here have undergone thorough safety assessments and chemical analysis by two professors of chemistry at RIT,NY, Dr Paul Craig, and Dr Paul Rosenberg, who recommend the use of these processes in Keith Howards new book 'The Contemporary Printmaker'. The electro-etching expert Cedric Green also endorses the new Metal Salt Etching system as a replacement for acid etching.

In Acrylic Resist Etching metal plates are etched in metal salt solutions rather than acids. Since the first publication of the Edinburgh Etch process in 1997 I have been able to further develop, test and refine a complete range of new metal salt etching processes for all metals commonly used in intaglio printmaking, and for sculptural plate making. The system comprises specific metal salt solutions for the fast and accurate erosion of copper, brass, zinc, steel, and aluminium. All of the etching processes given below are compatible with the entire range of acrylic resist mark making methods such as hard ground, stop out, aquatint etc. The benefits of this new etching methodology over the traditional acid etch approach are compelling, both in safety terms and regarding the superior quality of bitten work. Metal salt etching comprises two basic kinds of process: The Edinburgh Etch and The Saline Sulphate Etch. The Edinburgh Etch (© F.K. 1997), suitable for copper, brass and steel, consists of solutions of ferric chloride and citric acid, while the The Saline Sulphate Etch (© F.K. 2002), designed for biting zinc, steel, and aluminium consists of a solution of copper sulphate and sodium chloride. Due to their low hazard rating, the metal salt etching methods are both suitable for use in a professional printmaking environment as well in an artist's personal studio.

Cause and Effect

Traditional acid etching processes produce significant amounts of toxic fumes. In the commonly used nitric acid etch, for example, the nitrous gases produced are suspected of causing eye, nerve, lung and kidney damage, as well as impotence and genetic defects; in contact with chlorine-based cleaning products nitric can even turn into mustard gas! In industry today, regulations prohibit the use of nitric acid without fully extracted and filtrated glove units similar to those used in the nuclear industry. Regrettably, despite these facts many artists, workshops, and printmaking departments maintain that their existing measures provide adequate protection.

Safe and Simple

By contrast, the Metal Salt Etching system is free from harmful gas emissions……No new printmaking process, however safe or simple would be worth its salt if the results did not equal or exceed those produced by traditional means. Perhaps the most exciting fact about the Edinburgh Etch and the Saline Sulphate Etch is that the results are startlingly good – biting plates quickly and cleanly.

The Edinburgh Etch

The Discovery of the Edinburgh Etch

My aim in developing the new Edinburgh etching solutions was to harness the eroding power of the metal salt ferric chloride fully. In the course of my research I approached the issue of activating the ferric etch from a new angle, searching for additives to ferric chloride which might be able to dissolve the sediment as it is produced. After experimenting with a variety of possible substances I tried a new kind of non-toxic additive normally more associated with food rather than etching - citric acid. It turned out that a citric acid solution mixed at a certain ratio with a ferric chloride solution not only speeds up the bite of ferric but produces an entirely new kind of mordant with outstanding biting properties. Different kinds of metal require a different mix of this mordant I then called 'the Edinburgh Etch'. On copper, brass, and mild steel I found the unique property of the Edinburgh etch to be consistent throughout: the etch process takes place with the utmost precision and without the build-up of sediment typically associated with unmodified ferric chloride. The crucial catalyst contained in the Edinburgh Etch, citric acid, is widely available from larger chemical suppliers and suppliers to the food industry. This white powder ordinarily finds its way into cakes or fizzy lemonade rather than into an etching tray. It should be obtained as 'anhydrous citric acid'. Its handling and storage it is about as non-toxic as a chemical could be. Do however wear a dust mask and goggles when dispensing the fine powder. Anhydrous citric acid powder in the UK is now available both from chemical and printmaking suppliers. The Edinburgh Etch can be used both in etching tanks or in a flat tray. Contrary to the traditional ferric chloride etrch which requires for the plate to be turned upside down plates can even be etched face up as with a conventional acid solution, since no crystalline sediment impedes the biting process.

Etching in Tanks

A dip-tank represents the best facility for the mechanical removal of the crystalline sediments that ferric chloride generates as it etches metal. Keith Howard's reasonably priced etching tank takes several medium sized plates, and larger tanks can be custom made by most professional acid unit manufacturers, preferably from welded polypropylene. For small-scale work even a square bucket will make a serviceable etching tank, especially if fitted with an aquarium aeration pump. One or several tubes of fish tank 'airline' are fitted to a rod on one or two ends of the tank. The air outlets should point upwards and are connected to a powerful fish tank aeration pump. The powerful stream of bubbles rising on the side of the tank produces a circular flow within the solution which activates the etch mechanically. Aquarium shops also supply small valves which can be inserted in the air line in order to regulate the air flow and the resulting current inside the tank.

It is absolutely essential that different kinds of metal are always etched in different etching facilities, such as in separate tanks or trays. If a metal plate is accidentally placed in the wrong tank or tray this causes electrolytic processes, contaminates the solution, and in the case of a zinc or aluminium plate inserted in a dip tank can even lead to violent chemical reactions.

Ferric chloride is available from most chemical suppliers either as yellow granules or as a saturated solution, both of which are fairly inexpensive, especially if bought in larger quantities. If at all possible the ready made solution should be used, which for its industrial use comes in 25l or even larger containers at about 42 to 48 BE (Baume) density. When ordering ferric it is easiest simply to ask for a 'saturated' ferric chloride solution without referring too much to density scales that the suppliers are unsure about. Remember that liquid ferric is a heavy solution of ferric chloride salt crystals in water; the solution could not go beyond a certain strength (i.e. 48BE) unless the crystals solidify. It is easy to dilute a strong solution with water to obtain a weaker strength, but impracticable to strengthen a ferric solution which is too weak for a good etch from the outset. Even though ferric chloride is relatively safe to use eye protection and gloves must always be worn when handling it.

The saturated ferric solution of about 42-48BE is an ideal base ingredient for making up various mordants needed in the etching workshop. Only in exceptional circumstances (i.e. very delicate etched photo-polymer work) would it be useful to obtain the much more expensive, purer but weaker, laboratory grade ferric, which actually etches less well than the impurer industrial grade. Due to the variable strength of saturated ferric chloride certain adjustments to the mordant recipes given here may have to be made. If, for example, a mix of one part ferric to three parts water does not etch as expected simply reduce or increase the water content accordingly. This, as well fine tuning of the recipe, will entail some testing, but working some things out for oneself is always half the fun of printmaking!

Tip: Eye protection and gloves must always be worn when handling Ferric Chloride.
For reasons of safety and quality use a ready-made ferric chloride solution whenever possible
Before using fresh etching solution take the 'sting' out of it to prevent uncontrolled biting. Either insert a blank piece of metal of the kind that is to be etched in the bath and allow it to completely dissolve, or add a small amount of exhausted mordant to the fresh mix.

Edinburgh Etch for copper

Copper sheets are supplied by printmaking suppliers, or more cheaply by an industrial sheet metal dealer. Industrial copper (and zinc sheets) tend to have a more or less pronounced rolling-texture which may become visible during open biting. In practice this is rarely a problem, and any thickness of sheets ranging from about 0.5mm to 1.2mm, or 0.2in – 0.5 in are suitable for intaglio printmaking. Printmaking suppliers also sell copper sheets of the more expensive 'hammered' variety, as these do not have any rolling texture.

Intaglio marks made with acrylic grounds on copper plates and etched in Edinburgh Etch are of the best possible quality: Lines, textures, and open areas are cut into the metal as with a razor blade, and even the finest detail registers accurately on the bitten plate, which in turn produces a crisp intaglio print.
For large edition sizes of, say 40 to 50 prints professional workshops often have copper intaglio plates steel-faced prior to printing; the electrolytic coating hardens the surface and renders the plate more durable. If, however, an etching project is executed from the outset using brass or steel plates no steel-facing is needed for a large edition, as the plate itself will already have the required durability for a large edition.

In a ferric based etching solution fortified with citric acid copper plates can now be etched face up in a tray. The Edinburgh Etch erodes copper about twice as fast as pure ferric, and the hindrance of sedimentation does not occur.
For this very controlled etch process, which neither generates heat or gas bubbles, a fairly concentrated solution is normally used. The tray method can safely be employed even in an artist's studio lacking ventilation given that basic precautions such as the use of goggles and gloves are followed. Frequent rocking of the tray is not essential to the quality of the etch, but can speed up the biting action. Working with ferric-based mordants does not necessarily require fan assisted fume extraction as long as good general ventilation, such as an open window is ensured. During over 10 years of intensive use of ferric chloride I have however encountered two cases of printmakers who were hypersensitized to the smell of ferric chloride. In rare cases such as these fume extraction and the use of an inorganic respirator are of course mandatory, and preferably an alternative process should be used. The non-sedimenting properties of the Edinburgh etch are enhanced by the use of a dip-tank in which agitation takes place automatically. This results in very speedy biting times for copper plates. For instance a black aquatint, a crisp line, or a well developed open bite ridge are already deeply etched at about 20oC after a 30 - 40 minute immersion in a dip tank aerated with an aquarium pump.
The Edinburgh etch mixture given below is a universal mordant both to be used in flat trays or upright tanks. If no citric acid is available a saturated ferric chloride solution can also be used, but the etch will be slower and somewhat less precise.

Edinburgh Etch for Copper and Brass

4/5 saturated ferric chloride solution (40%)

\+ 1/5 citric acid solution,
which consists of 3/4 tap water
\+ 1/4 citric acid powder (anhydrous)

in actual quantities this works out, for example at

6l saturated ferric chloride solution (40%)
\+ 1,2 litres of tap water

\+ 400ml citric acid powder (by volume)
(this equals 400g powder)

Fill a bucket with 1,2l of hot water. Gradually add the citric acid powder content while stirring continually. Once this has fully dissolved gradually pour this into the ferric solution and keep stirring until you have produced a uniform liquid. Fill this into the etching tank or tray which is now ready for use.
Try to maintain a reasonable temperature in your etching facility for copper. Good results are ensured at 18 to 20oC, but higher temperatures of up to 30oC can further improve biting times as well as the overall responsiveness of the mordant. This solution is exceptionally long lasting; a tank filling used daily, occasionally topped up to compensate for loss, has been known to remain active for several years without a significant drop in its biting properties. When eventually the mordant acquires a deep olive colour it becomes less active and is then ready for replacement, neutralisation and disposal.
Even during etching Edinburgh Etch trays or tanks can be covered with a lid to prevent evaporation. When not in use etching solutions should be stored in clearly labelled containers, stating the composition of the solution and the kind of metal etched in it. Also place safety notices such as 'corrosive – wear eye protection' on all containers and work areas.

<u>Edinburgh Etch for brass</u>
Brass is a superbly suitable material for intaglio etching and printing. The metal has a golden, mirror-like finish, and usually lacks the more or less pronounced rolling texture known from other industrial sheet metals.
It is often supplied by the same sheet metal merchants that sell copper, and is only marginally more expensive. The Edinburgh Etch approach now allows for this noble metal to be etched as easily as a sheet of copper. Arguably, brass surpasses any other metal in terms of its versatility of marks, its faithfulness to etched detail, and its overall aesthetic expressiveness. Brass can be etched in similar conditions as given for the Edinburgh Etch for copper. The golden aesthetic of this very hard alloy of zinc and copper combines the delicacy of copper intaglio with the robustness of etched steel - like steel its open surfaces display a self texturing effect and due to their hardness plates do not suffer from wear in large editions. Brass plates yield unique textured effects in conjunction with the various acrylic wash and open bite processes, for instance when a combined Hunt Speedball and carborundum wash medium is used.

<u>Backing the Plate</u>
Before a metal plate can be etched the back of the plate has to be covered with an acid resist. Plates etched without this protection erode from the back, and the grounds applied to the front may lift off. A very quick and reliable way to cover the back of an etching plate is by applying sheets of self-adhesive film or strips of parcel tape to it.
The plate is now ready for etching if horizontal trays are used. If the plate is to be etched in an upright dip-tank a handle still has to be attached for lowering the plate into the bath. The handling strip should be longer than the depth of the tank. Before etching inspect the surface of the plate for any greasy deposits and clean if necessary.

<u>Etching safely</u>
Etching should take place in a separate area of the etching workshop, which may be combined with a stripping facility in an overall 'corrosive area'. It is important to keep this space separate from other workshop activities because the handling of acidic and alkaline substances requires extra caution, and a number of safety measures should be observed by users at all times. Artists become very absorbed by their work and are at times less aware of the safety aspects involved in their activity; however, in a corrosive work area adequate protection in the form of acid resistant gloves and goggles, or a visor should always be worn. Also make sure there is clean running water or an emergency eye wash station within reach. Mop up any ferric chloride (or copper sulphate) spills with sodium carbonate and water. When the plate is satisfactorily etched it is rinsed thoroughly under a running tap or hose. Copper and brass plates should also be de-oxidised with a solution of salt and vinegar in water before reapplication of acrylics. Oxidisation is also minimised by blotting and speed-drying plates in hot air. If a plate has reached the reclaiming stage it can be transferred into the

stripping solution straight after rinsing to take the acrylic ground off. Any backing should be removed prior to printing.
Safety Note: All metal salt solutions in dip tanks and etching trays should be covered up or filled into sealed containers when not in use. This minimises cross-contamination between different solutions as well as evaporation, thus extending their useable life.

Neutralisation and Disposal
A simple gravity-fed siphon pump is ideal for transferring the solution from the tank into plastic storage containers. The best way to dispose of spent etching solutions is to take them to a chemical disposal company. Some local authorities may also permit the disposal of ferric / Edinburgh Etch solutions down the drain if they have been properly neutralised, and highly diluted. To neutralise an Edinburgh Etch or ferric chloride solution add a strong sodium carbonate solution gradually to this; (you may also use a used stripping solution as the neutralising agent). In a harmless fizzing reaction carbon dioxide is produced. Allow this to settle before adding more sodium carbonate. Once the solution no longer fizzes when soda ash is added neutralisation is complete. This can be confirmed by a pH test showing a pH value of seven. After that dilute with plenty of running water and discard. The innovative design of a combined corrosive area with ferric based etching unit and an alkaline stripping unit has the added advantage of being self-neutralising during operation. As plates are etched and stripped both acidic and alkaline residues are flushed into the drainage system, thus leading to a natural neutralisation.

The Saline Sulphate Etch

The new Saline Sulphate Etch for zinc, aluminium, and steel is ideal for those etchers to whom the creative possibilities of these silvery-grey metals are of particular appeal. All three metals are widely available from sheet metal dealers or printmaking suppliers and are relatively inexpensive. Intaglio text books often list the relative softness of zinc and its slight effect on some colour etching inks (especially yellow) as a drawback, but in practice this is outweighed by the many unique pictorial possibilities of this shiny metal. Many printmaking suppliers stock the printing industry grade zinc, which has a backing and is harder, but the inexpensive titanium roofing zinc is also a popular choice. The Saline Sulphate Etch for zinc also works equally well for biting mild steel and aluminium plates and all three metals can be etched in the very same solution.

The Saline Sulphate Etch for zinc works very well for straight tray etching and does not require additional measures such as heating or aeration. A copper sulphate solution as a safe mordant for zinc, (the ‘Bordaux Etch’), was first suggested by Cedric Green in response to a number of safety concerns about the use of nitric or ferric as a mordant for zinc. During three years of comparative trials I found that a copper sulphate based etchant is indeed superior to any other solution both in terms of its safety and its creative possibilities within contemporary etching.

A straight copper sulphate solution does make a good mordant for zinc but etching is somewhat slow and the solution becomes exhausted quickly. Similar to my thinking behind the Edinburgh Etch, I looked into ways in which the pseudo-electrolytic eroding potential of copper sulphate could be fully harnessed. I reasoned that as with ferric quite possibly the chemical ‘hydrolysis bond’ formed between the metal salt and water might account for a loss of reactivity.

I found this confirmed in recent tests. These showed that a solution made up from equal parts of copper sulphate and sodium chloride (i.e. cooking salt) activates the etch by diminishing the hydrolysis bond. This ‘Saline Sulphate Etch’ for zinc is three times more active than a straight copper sulphate solution, whilst producing a very crisp etch without the more settled sedimentation and surface roughness of the Bordeaux Etch. During biting a coppery sediment of metal hydroxides and oxides continually floats to the surface, thus keeping the bitten work from clogging up. Etching can also be aided by occasionally brushing the plate surface with a soft brush. Delicate marks such as a spray aquatint or soft ground should however be etched without brushing. The solution works more effectively if floating solids are regularly skimmed off with a brush or a strainer and removed from the bath - this keeps the solution from turning alkaline and extends its useable life.

Making up the Saline Sulphate Etch for Zinc, Aluminium and Steel

The Saline Sulphate Etch is made up from copper sulphate and cooking salt crystals, which readily dissolve in water. This process works at its best if quantities and ratios given below are adhered to fairly accurately. It is recommended to use 'anhydrous copper sulphate' supplied reasonably priced in larger quantities by a chemical wholesale dealer. Do not use agricultural supplies as these often contain impurities. As with most etching chemicals, specifically ask for 'production' or 'industrial grade' copper sulphate rather than 'laboratory grade', since this is a lot more expensive.
Wear gloves, dust mask, and goggles when handling the crystals to avoid touch or inhalation of dust particles. Once the solution is made up it is quite safe to use with the customary etching precautions.

Saline Sulphate Etch for Zinc, Aluminium and Steel

	75 gms	copper sulphate
+	75 gms	sodium chloride (salt)
+	1 litre water	

(multiply these quantities by the same factor to make up larger amounts)

Disposal
A spent solution, which is transparent, can be neutralised with sodium carbonate, diluted with plenty of water and then discarded. The surplus crystalline residues will remain at the bottom of the tray when the liquid is carefully decanted into another vessel.
These can then be collected and kept in a container. Once this is filled to the top with solid metal compounds it should disposed off as dry chemical waste, but can also be recycled.

The Orono Ground / Soft and Hard Ground (simplified)

The Orono soft ground is a resist development by Friedhard Kiekeben made in collaboration with Prof. Susan Groce at the University of Maine, Orono, USA. It has very good acid resistance and can be used in the same manner as a traditional wax soft ground; i.e. for transfer drawing as well as for textured impressions. It is also valued by many printmakers as a roll-on hard ground which accommodates very detailed and wax-like drawing properties. The Orono ground was developed as a more universally applicable alternative to Keith Howard's original acrylic soft ground, which remains a viable option for the soft ground technique on copper plates. The primary benefits of the modified process lie in its fast drying time, its enhanced acid resistance, its variable thickness, and suitability to the entire range of metal salt etching processes. The variables of the Orono ground can be individually adjusted to suit the artist's needs; for instance an increase in the binder content will result in greater acid resistance, while an increase in the retarder content will extend the working times of this soft ground. The mixture described here gives extremely good reproduction of imprinted details on any kind of metal. Comparative tests carried out at the University of Maine showed it to be superior to the conventional wax based method, both because it works well in a thick or a thin layer and responds quickly and accurately to the corroding mordant. The Orono soft ground consists of two main components. The first of these two components is the soft ground binder mix, which needs to be made up from four ingredients (see below), and can then be stored in sealed containers. The other component is Graphic Chemical water based block printing ink, such as the Peacock Blue which ensures good roll-ability of the Orono Ground.

Ingredients:

A) Rolling Base
- Graphic Chemical water based block printing ink
  (as a stiff rolling base)

For best visibility on the plate I prefer using Peacock Blue ink, but other varieties also work.

B) Binder Mix

The Orono ground as published since 1998 necessitates the use of a number of products such as retarders and thickeners. Instead of these, water based screen printing medium / paste can be used very successfully to give an ink–like consitency and to extend drying times of the ground.

The simplified Soft Ground Binder Mix is made in the following way:

- mix 50% Lascaux Varnish clear gloss 1 (575) 2060 with 50% water based screen printing paste / medium

Making up the soft ground

The soft ground should be mixed from the two base components prior to use; once mixed it should be used within the next half hour or so. In its mixed state, it does not keep well, so do store the components in separate containers. The mixing method is similar to the mixing of printing inks. Mixing takes place on a clean slab with a long palette knife. Firstly, spread out a good amount of the block printing ink on the slab (3 parts). Then add a slightly smaller amount of the soft ground base (2 parts) , and thoroughly work the two components into one another until a thorough blend has been achieved. The soft ground is now ready for rolling onto a de-greased plate, which can also be slightly sanded. A thinner layer will ensure the register of even the finest imprinted detail, but a thicker layer - which also has good detail reproduction- ensures maximum acid resistance, and is best for a deeper etch. Refer to Keith Howard's explanation of soft ground drawing and impressions methods are also suitable for application using the Orono ground. *Useful Tip: An ink roller used for the Orono ground should be soaked in detergent solution immediately after use to prevent hardening of its delicate surface.*

1 PART LASCAUX VARNISH 2060 OR GOLDEN GAC 200
1 PART WATER BASED SCREEN PRINTING PASTE
3 PARTS GRAPHIC CHEMICAL WB RELIEF INK

Acrylic Hard Ground / Floor Finish

This is the cheapest and most commonly used acrylic hard ground option.
Keith Howard's liquid hard ground method using acrylic floor varnish is easy to adapt when the Us product 'Future' is unavailable. In most European countries a product called 'KLEAR' - made by Johnson's Wax - is widely available which makes a very good substitute.
Metal plates to be coated with KLEAR are best evenly sanded and de-greased before application of the ground. The usual method of flow-application is used, but the thinner consistency of KLEAR necessitates two thin, successive coats of varnish to be flowed on rather than one. After flowing on a coat of varnish this is allowed to drain off for about 30 – 40 seconds, then the plate is placed on a flat surface or in a drying cupboard. The second coat is applied in the same fashion once the first coat has dried.
Coat I consists of pure KLEAR acrylic floor varnish;
do not mix Coat I with other ingredients to retain maximum acid resistance
Coat II_ is made up as follows: add indian ink or black airbrush ink to KLEAR until the liquid looks opaque; do not add too much ink as this may affect acid resistance. A black drawing surface can also be obtained by adding about 25% of the Golden Acrylics stop out solution, or by apinting he plate coated with KLEAR with black gouache.

Acrylic Hard Ground / Lascaux

Since 1996 I have advocated the use of the Lascaux varnish 2060 as an ideal acrylic hard ground. Since then Lascaux have turned this idea into a dedicated product (Lascaux hard ground); this produces good results but the original 2060 mixture performs even better and is cheaper. The varnish is also certified as being non-toxic.
This acrylic ground has the following benefits: it is easy to use on any type of metal, it can be applied by various means in one single coat, it has almost wax like drawing properties, it strips off easily, (although not as easily as KLEAR) it only requires de-greasing, (but not sanding) of the plate, and has good corrosion resistance.
It also makes a perfect re-working ground, which contrary to the 'Future' or 'Klear' grounds, adheres well to etched surfaces.
The most even hard drawing surface is obtained by spraying a thin, even layer of the ground onto a plate through an aquatint air brush gun. However, the slightly diluted ground can also be brushed

onto the plate with a broad soft brush, or flow coated as with Future or Klear.

<u>Making up the waxy hard ground:</u>

base ingredient - Lascaux clear gloss varnish 1 (575) – 2060,
- add 3 - 8 % water and 1/2 a jar of black airbrush ink per 250ml to make up a black hard ground

<u>Stop-Out varnish</u>

With the new metal salt solutions virtually any acrylic paint product can be used as a stop out or resist for direct mark making. For deep etching it may however be necessary to strengthen the mix through the addition of a strong acrylic medium or binder.

Stop-Out varnish for Direct Mark-Making:

- fill half a jar with Lascaux clear gloss varnish
575-2060
- mix with 50 % of Lascaux Studio acrylic paint black 526, or similar

Stop-Out varnish for Re-Etching:

- use Lascaux clear gloss varnish 575-2060 pure,
- for an opaque ground mix with
10 % Kremer Heliogen green pigment paste or air any acrylic air brush ink

<u>Safe Resist Removal with Washing Soda</u>

The main ingredient of the safest stripping solution is commonly known as washing soda or soda crystals, and its chemical name is sodium carbonate. Smaller quantities of this inexpensive alkaline often used for mundane jobs like unblocking drains can be obtained from most hardware stores, and larger supplies of these crushed crystals are supplied by most local chemical wholesale dealers. Once the sodium carbonate has been dissolved in water it can be filled into a tray or a tank where it provides a good stripping solution for any kind of acrylic ground. A plate covered with hardened aquatint, stop-out varnish, hard or soft ground, or photo-polymer film is immersed in the alkaline bath and left to soak for a certain period of time. A hard ground, a photo-polymer surface, or an aquatint are broken down in just a matter of minutes, while thicker deposits of resist such as stop out varnish may take a slightly longer immersion of 15 to 20 minutes to lift off the plate. Brushing the plate with Ajax (Comet) scourer and rinsing with hot water aids the removal of stubborn residues.

<u>Making up the sodium carbonate solution:</u>
- a dust mask should be worn when handling the soda crystals as they can give off a fine dust which is mildly irritant
- mix warm water with soda crystals at a ratio of about 2 to 3 parts water to 1 part crystals while continually stirring.
replace stripper often to ensure fast stripping times
- wear gloves to prevent de-fatting of your skin.
- the sodium carbonate crystals should be kept in airtight plastic containers to prevent the absorption of moisture

<u>NEW: Marseilles Soap Stripper</u>
This olive oil based soap from the Mediterranean makes an ideal stripping agent for acrylics, and acts as a general paint stripper, paint stain cleaner and non-toxic brush cleaner. Reputedly it was widely used by old masters as a cleaning agent instead of turpentine.

To make up a stripping paste grated flakes of the soap are mixed with hot water at a 1 : 1 ratio. Plates to be stripped are immersed in this solution for at least 10 – 15 minutes, but the paste can also be painted on directly. An even stronger and long lasting stripping solution is obtained by mixing this stripping paste with a strong sodium carbonate solution.

Author's Note:

Over the years the research information contained in these annually updated fact sheets has found its way into many other publications and web sites. This is welcome and intended;
but please do acknowledge my copyright by making reference to authorship, i.e. to 'Friedhard Kiekeben's Innovative Intaglio Fact Sheet 2004' or to my contributions in Keith Howard's books respectively.

INNOVATIVE INTAGLIO **Suppliers**

ImageOn Film, *Intaglio Printmaker, 62 Southwark Bridge Road, London, SE1 OAS*
T 0207 928 2711, also T.N. Lawrence, US: Daniel Smith, Graphic Chemical

Lascaux Varnish, clear gloss 1 (575) - 2060

'waxy' hard ground: add 3 - 8 % water and 1/2 a jar of black airbrush ink per 250ml
(strong resist, easy to strip, very crisp lines / can be painted, poured, or airbrushed thinly)
use to make up stop out (2/3 varnish 1/3 acrylic paint or 1 : 1)
use to make up aquatint ink **-** add appr 5% water and some coloured acrylic airbrush fluid to get colour

UK: A.P. Fitzpatrick, Art Materials Service,142 Cambridge Heath Road, Bethnal Green, London, E1 5QJ, tel 0207 79 00 884; or Gerstaecker, mail order

Hunt Speedball Screenfiller No 4570

use for washes (dilute at least 1 : 6 for dark wash)
use for aquatint without 'sparkling' dots and great tonality

Black Graphic Chemical Relief Ink (water based) for soft ground & washes

True Grain Film, use for making drawn washes etc.; *John Purcell Ltd., London*, or
T.N. Lawrence, mail order tel. 01273 260260

CPS Graphics blue screenprinting degreaser, concentrate (dilutes 1 : 15),
use as methylated spirit substitute for perfect plate degreasing
Screenchem Products Ltd., 5 Telford Place, East lenziemill, Cumbernauld, Glasgow, G 67 2NH, tel.: 01236 733276

Klear floorpolish (UK), Future Floorpolish (US),
use as hard ground, *hardware store*

Etching and Stripping Chemicals

buy from chemical wholesale dealer

such as 'Tennants' , Tel 0161 205 4454 (branches all over the UK))

Sodium Carbonate Powder / Crystals
use as general ImageOn developer and acrylic resist stripper,
small packets from hardware store, large bags from chemical wholesale

Ferric Chloride Solution / 42 - 48 Baume, or 27% - 40%
chemical wholesale, comes in 30ltr. plastic containers

Citric Acid Powder; chemical wholesale, UK also: Intaglio Printmakers,

Copper Sulphate, anhydrous crystals, comes in 25kg bags

Marseilles Soap – use as stripping paste for acrylic grounds.
use grated flakes to mix to a paste with hot water / mail order from:
Nava, Pol. "Los Llanos' S/N, 16194 Pinar de Sabaga, CUENCA, ESPANA

Dr Paul Craig, Associate Professor of Chemistry
Rochester Institute of Technology, New York

Dr Paul Rosenberg, Associate Professor of Chemistry
Rochester Institute of Technology, New York

Art meets Science at RIT

Recently the metal salt etching processes developed by Friedhard Kiekeben have been thoroughly tested by scientists. Dr Paul Craig and Dr Paul Rosenberg, both professors of chemistry at RIT, collaboratively wrote the following recommendation and safety assessment for the Edinburgh Etch and The Saline Sulphate Etch:

The Chemistry of Etching without Acid

In the past**,** metal etching for the purpose of printing or art was typically done with nitric acid, which has harmful vapors and is extremely caustic. In this chemistry lab nitric acid baths are always maintained in enclosed fume hoods with separate ventilation and filtering. Such hoods are often not available in print or art studios. **The Edinburgh Etch** uses a mixture of ferric chloride and citrate, which circumvents the safety hazards associated with nitric acid baths. The etching of copper with ferric chloride has been well-known for a number of years. However, etching is slow and results precipitation on the surface of the copper, probably due to the accumulation of insoluble copper salts (perhaps copper hydroxide) on the surface of the copper. If these accumulate, they interfere with the normal oxidation-reduction reaction between the Ferric (Fe^{3+}) and the metallic copper (Cu^{o}). In the equations shown below for this reaction in water, a positive voltage indicates an energetically favorable reaction.

$$2Fe^{3+} + 2e^{-} \rightarrow 2Fe^{2+} \qquad E_o' = +0.771V$$
$$Cu^{0} \rightarrow Cu^{2+} + e^{-} \qquad E_o' = -0.339V$$
$$2Fe^{3+} + Cu^{0} \rightarrow 2Fe^{2+} + Cu^{2+} \quad \Delta E_o' = +0.432V$$

The Edinburgh Etch adds one new ingredient to the ferric chloride etching bath: citric acid. Etching in this bath is much more rapid and reproducible than the original ferric chloride etch. This can be attributed to two causes:

1. The citric acid will lower the pH of the bath slightly (making it more acidic). Under these conditions, the Cu^{2+} is unlikely to form an insoluble salt (such as copper hydroxide – $Cu(OH)_2$) and thus will be more soluble.
2. The Cu^{2+} will have a tendency to form a complex with citric acid as it is released from the surface of the metal, also increasing its solubility.

The hazards associated with the Edinburgh etch are dramatically less than those associated with nitric acid. The solution is mildly caustic to the touch and does not emit noxious gases. In fact, the Edinburgh etch could safely be used in an open studio or laboratory, whereas the nitric acid etch can only be safely used with a fume hood. A small amount of hydrochloric acid may be released as the copper complexes with the citric acid. This is highly soluble in water and should not pose any serious risk of acid fumes in the lab. Nonetheless, when the Edinburgh etch is exhausted, it is still recommended that the solution and solids be disposed as chemical waste, rather than washing down the drain into the sanitary sewer system. High concentrations of iron and copper in the sewer system may interfere with normal bacterial recovery of materials in the sewer system.

The Edinburgh etch reacts very rapidly with the copper. In our studio, we etched a clean sheet of copper (20.35 cm x 12.85 cm, 0.5 mm thick, 127.56 grams, including an acrylic backing) until only the backing remained (10.50 g) in 13 hours. This was not a new etching bath – it had been in use for several months.

The Saline Sulphate Etch

The saline sulphate etch is recommended for etching aluminum or zinc. Use of the Edinburgh etch with these metals may result in the release of heat, flammable hydrogen gas and acid fumes. The reaction is comparable to the thermite reaction which is used in munitions. The reaction between iron and aluminum (or iron and zinc) is a very high energy reaction (as indicated by the much higher voltage) and should be avoided

$$2Fe^{3+} + 2e^{-} \rightarrow 2Fe^{2+} \qquad E_o' = +0.771V$$
$$Cu^{0} \rightarrow Cu^{2+} + e^{-} \qquad E_o' = -0.339V$$
$$2Fe^{3+} + Cu^{0} \rightarrow 2Fe^{2+} + Cu^{2+} \quad \Delta E_o' = +0.432V$$

The Saline Sulphate Etch uses the reaction between copper and aluminum, which is quite a bit milder than the reaction between iron and aluminum, as indicated by the lower voltage. The comparable reaction for copper and zinc is also shown.

$$\begin{array}{ll}
3Cu^{2+} + 3e^- \rightarrow 3Cu^+ & E_o' = -0.339V \\
Al^0 \rightarrow Al^{3+} + 3e^- & E_o' = +1.677V \\
3Cu^{2+} + Al^0 \rightarrow 3Cu^+ + Al^{3+} & \Delta E_o' = +1.338V
\end{array}$$

$$\begin{array}{ll}
2Cu^{2+} + 2e^- \rightarrow 2Cu^+ & E_o' = +0.161V \\
Zn^0 \rightarrow Zn^{2+} + 2e^- & E_o' = +0.762V \\
2Cu^{2+} + Zn^0 \rightarrow 2Cu^+ + Zn^{2+} & \Delta E_o' = +0.923V
\end{array}$$

In the absence of sodium chloride, a copper etch of aluminum or zinc is characterized by high levels of insoluble copper hydroxides in the solution, which may clog the etching process, for reasons like those proposed previously for the Edinburgh etch. The chloride in the saline sulphate etch is thought to partially prevent formation of copper hydroxide by competing with the hydroxide ion for binding to the copper. Copper chloride is much more soluble than copper hydroxide.

For the printer or artist, both these systems are mild and much safer than the traditional nitric acid bath for etching of metals, especially is proper precautions are taken when designing the reactions (e.g., no etching of aluminum with ferric chloride) and when exhausted materials are disposed of properly. To the chemist, these are very nice systems, which are highly complex. In the chemistry lab, we usually deal with much more dilute solutions of metal ions and salts than are described here. All would bear some study from the chemistry perspective. The real issues here are competitive equilibria. Chloro and citrate complexes of these metals are playing a major role in these systems. There is not much published information on these systems. There does not appear to be any significant or major chemical hazards associated with the chemical processes employed here, although a reaction between aluminum and iron could get lead to explosive results.

Standard reduction potentials were obtained from Harris, D.C. *Quantitative Chemical Analysis*, 6th edition, W.H. Freeman and Company, New York, 2003.