Electro-Etching with a Plating Rectifier

by Nona Boatright

Please respect the inherent dangers of both chemicals and electricity! I cannot be responsible for accidents. Please label all containers with the chemicals they contain. I gathered information about this process from numerous sources, and have listed several references at the end of this document.

I love the electro-etching process, especially for silver, because it avoids the nasty nitric-acid bath, and it also allows the dispersed silver to be reclaimed. Silver particles are attracted to the cathode, but they do not firmly attach. They are easily scraped off of the cathode, and the remaining particles can be filtered out of the electrolyte. The resulting silver flake can be sold as scrap. Copper particles firmly adhere to the copper cathode.

Another wonderful thing about electro-etching is that the electrolyte isn’t depleted with use. Each etch requires about the same amount of time for a given design and a given voltage. (The amount of exposed metal changes for different designs, which will vary the time needed to etch.) An acid bath generally becomes weaker with every use, lengthening the time required for each subsequent etch.

Another advantage of electro-etching is that the walls of the etch are quite straight. The electric current removes the metal in a straight line from anode to cathode. However, the etch is somewhat deeper right next to the resist. The edges etch faster than the central regions.

Requirements

Electro-etching is a reverse-plating process, also called “electrostripping.” The required tools are a power source, a suitable container, a suitable electrolyte, a metal cathode, and a clean metal anode (work-piece to be etched). It is advantageous to heat the electrolyte (warm but not hot), but not necessary. Agitation of the solution is helpful also, but it can be accomplished with occasional stirring. The power source can be an electronic power supply,
a car battery, or even household batteries (such as “D-cells”).

Electronic enthusiasts (who etch custom printed circuit boards (PCBs)) often use long, thin rectangular etching tanks about the size and shape of a cereal box. Printmakers often use similar containers, but the dimensions can be very wide and tall, to etch large sheets of copper. Electronic and printmaker suppliers both sell plastic etching tanks, but good-quality plastic storage containers can be used. Electronic suppliers also sell other accessories for etching: aquarium heaters (encased in glass), aquarium thermometers, aquarium water pumps to circulate the etchant with bubbles, and various resists (including PnP Blue). Printmaking suppliers sell a wide range of resists and several sizes of etching tanks.

**Equipment**

My power supply is a plating rectifier that I bought at Rio Grande (made by PEPE Tools). It is 12 volts and 25 amps, and has a current-limiting safety feature. I use a 600ml Pyrex beaker to hold the electrolyte. I warm and circulate the electrolyte using a magnetic stirrer that I bought used on eBay. I use a candy thermometer to monitor the temperature. The largest work-piece that I etch in the 600ml beaker is about 3.5 x 2.25-inches. I usually etch a 3 x 2-inch work-piece; smaller in silver for less waste. A larger beaker can be used, or a rectangular etching tank can be used for larger pieces.

The work-piece is attached to the power supply with a solid-copper alligator clip (see Supplies). I soft-solder (lead-free) the alligator clip to a thick copper wire, and bend the wire so that it hangs over the side of the beaker. (The alligator clip can be firmly crimped onto the copper wire with pliers instead of soldering.) I protect the alligator clip from etching with “Liquid Electrical Tape” or a liquid-rubber-tool-grip known as “Plasti Dip.” The alligator clip ceases to function after about three etch sessions, so I make several up at a time. The work-piece hangs from the alligator clip on the inside of the beaker, and the copper wire bends over the edge and outside the beaker, and accepts the power-supply connector.

Other people connect their work-piece to the power supply in other ways, such as brazing a copper wire to the back, or soft-soldering a copper wire to the back, or cutting the work-piece so that it has extra metal to extend out of the etching tank. The object is to complete an
electrical circuit, with electrolyte bridging the gap in the middle.

The positive (Red) power-supply connector is attached to the extension of the work-piece, which becomes the anode.

The cathode is either copper or fine silver (for my purposes). The metal can be quite thin, because the surface area is the important factor. The face of the cathode should be as large as the work-piece, or larger (in height and width).

My copper cathode was cut from 28-gauge (0.3mm) metal, and is about 2.25-inches wide. I bent my copper cathode over the Pyrex beaker, which works well to hold the cathode upright and straight. I cracked a glass beaker bending the metal though. My fine silver cathode is the same thickness and width, but it is propped upright using clips. (A brazed copper extension at the top of the silver cathode would probably work well.)

The negative (Black) power-supply connector is attached to the cathode. (I marked the cathode with a negative sign (–) so I won’t forget which connector to attach.)

Electrolytes
There appear to be a number of electrolytes which work very well (salt-water, Sparex, water with lemon juice, various acids and some metal salts). The recipes I am using (below) came from Dauvit Alexander (see Literature). They may both work well without the addition of acid, but I haven’t tried it. I’m still using my original electrolytes.

<table>
<thead>
<tr>
<th>Work-Piece (Anode) (+)</th>
<th>Cathode (–)</th>
<th>Electrolyte</th>
</tr>
</thead>
<tbody>
<tr>
<td>Silver (Fine or Sterling)</td>
<td>Fine Silver</td>
<td>Silver Nitrate: 0.5 grams; Nitric Acid (~65%): 0.33ml (= 7 drops); in 500ml distilled water</td>
</tr>
<tr>
<td>Copper or Brass</td>
<td>Copper</td>
<td>Copper Sulphate: 50 grams; Sulfuric Acid: 1.5ml (= 30 drops); in 500ml distilled water</td>
</tr>
</tbody>
</table>

Beaker containing silver nitrate solution. Top photo shows silver particles attracted to the cathode. Bottom photo is a top-down view. White capsule is a magnetic stirring rod. White fluff is silver particles from etched work-pieces.
Process

I use four volts (4v) to etch both copper and silver, over the course of two to five hours. I adjust the rectifier controls for about 1 amp (as high as possible while maintaining the stabilizing current directed toward the positive). (I don’t know what that means exactly, but it works so I keep doing it.) The higher the power, the faster the etch occurs, and the faster the resist fails.

Dauvit Alexander’s instructions use 1.2 volts for silver over a six-hour span and 8 volts for copper over a thirty-minute span (see Literature).

The etch will work faster if the electrolyte is warm. Avoid too much heat, as it may cause failure of the resist. I maintain a temperature of about 100°F. I use the lowest full setting on the magnetic stirrer to keep the solution in motion.

The art to be etched is applied to the work-piece using a resist, which has open areas (exposed metal which will be bitten by the etch), and closed areas (protected from the etch). There are many possibilities for resists. They can be applied as a paint with a brush or pen, applied with heat for toner-transfer methods (products such as PnP Blue), and applied as a photo-sensitive film (such as ImagOn). Photo-process resists can be either positive-developing or negative-developing, which means the black areas of art may process as either open or closed areas of resist. (ImagOn is a negative resist, which means that black areas of art translate to open resist for active etching.)

When I am designing the art, I integrate open areas (bare metal) which will receive the alligator clips. They are also useful to measure the progress of the etch. I usually design the open contact areas at both top and bottom so I can rotate the piece (but I don’t think it’s really necessary). Close the resist on the scrap areas of the work-piece so that the overall etch will occur faster.

The metal should be clean and grease-free before and after applying the resist. Handle the work-piece by the edges, and keep fingers and other contaminates off of the exposed metal surface. Etch the piece soon after applying the resist, within two days, to avoid oxides and contaminates.

Be certain to protect the back of the work-piece with plastic shipping tape (or book tape for larger pieces). Although it will not etch as fast as the front, the back of the work-piece will lose metal in the process if not protected.
While etching, the work-piece can be occasionally stroked with a very soft brush to displace particles on the exposed metal. This keeps the etched surface smooth and shiny. However, a lovely granular texture can be attained by not brushing it at all.

The electrolyte solutions will lose water to evaporation, especially if heated. I add distilled water until the level reaches 500ml, as needed.

Plastic beaker covers keep the electrolyte solutions clean when not in use (Rio Grande #335-094). I store the cathodes in separate containers, and clean them periodically with Penny Brite. I filter the solutions periodically to remove particles of metal and resist. The electrolyte is poured from one beaker into another using a coffee filter in a plastic holder (the Melitta Perfect Brew Filter Cone works very well). With the silver solution, I also scrape off the silver attracted to the cathode into the coffee filter, and then close the filter by folding it, and put it on a paper towel to dry. Once dry, I pick out remaining pieces of resist, and pour the dry silver flake into a container as silver scrap. As Vera suggested, it may very well have a decorative use! (I don’t know if the sterling pieces I etch would adversely affect the purity of the silver flake for enamel decorations.)

Supplies

I purchased the copper sulfate at a science supplier:

I purchased the silver nitrate online also (“normal” purity: 99.9%):

The nitric acid was purchased from Rio Grande as “Etching Mordant for Silver” (#118-107). The small amount of sulfuric acid was kindly provided by my husband.

I bought tools and metals, including my plating rectifier, at Rio Grande:

The solid-copper alligator clips can be purchased from electronic suppliers. They sell “mini-clips” also, but choose solid copper.

Penny Brite can be purchased from:
http://www.thompsonename.com/
http://www.enamelworksupply.com/

Literature

Please note: I don’t understand the electrical processes; and I rely on my husband (the chemist) to help me sort out laboratory issues. I have learned much of what I know from the following sources. The second article referenced below, “Relief Electro-Etching for Champleve Enamelling,” was written by someone who understands electricity very well.
This is the source of my electrolyte recipes:
“Electrolytic Etching,” by Dauvit Alexander
http://wringhim.co.uk/electrolytic_etching.html

This article was written by a member of the British Guild of Enamellers who understands electricity:
“Relief Electro-Etching for Champleve Enamelling,” by R.L. Jackson (the relevant document link is at the bottom of page): http://www.guildofenamellers.org/index.php?option=com_content&view=category&layout=blog&id=11&Itemid=27

“Etching Options for Champleve,” By Coral Shaffer
http://www.ganoksin.com/borisat/nenam/gom-etching-champleve.htm

“Acrylic Resist Etching: Metal Salt Etching - Etching without Acid,” by Friedhard Kiekeben

“Electrolytic Etching of Silver,” by Walther Carpay (translated by Hannah Loeks)

These two sites have a great deal of good information about electro-etching for printmakers:
http://www.nontoxicprint.com/printmakingresources.htm
http://www.greenart.info/guide/printmake.htm

Jewelry Concepts and Technology, by Oppi Untracht, 1985:
“Electrochemical Anodic Etching,” pp. 326-327
“Stencil Etching Metal Sheet using Light-Sensitized Gelatin,” pp. 327-328
Chapter 16: “Metallic Buildup: Electrolytic Molecular Creation of Surface and Form,” (begins pg. 678 and discusses electroplating in detail including equipment and supplies, and also covers electroforming and photo-electroforming)

Grobet Plating Guide:

The Midas Guide to Plating: Rio Grande product #550-289

A set-up for etching brass using a car battery:
http://steampunkworkshop.com/electroetch.shtml

The use of an old stainless steel fish steamer for the anode is interesting:
“Electro Etching of Silver using Ospho Brand Phosphoric Acid,” by John Flynn
http://www.kahiko.com/Electro%20Etch%20Silver.htm
http://www.ganoksin.com/orchid/archive/200505/msg01138.htm

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