Electro-Etched Copper Earrings Workshop

John Fetvedt

www.bijoux-de-terre.com
Electro-Etching

Electro-Etching, also called galvanic-etching, is described by Wikipedia, the free encyclopedia, as “a metal etching process that involves the use of a solution of an electrolyte, an anode and a cathode. The metal piece to be etched is connected to the positive pole of a source of direct electric current. A piece of the same metal is connected to the negative pole of the direct current source and is called the cathode. In order to reduce unwanted electro-chemical effects, the anode and the cathode should be of the same metal. Similarly the cation (the ion with a positive charge) of the electrolyte should be of the same metal as well. When the current source is turned on, the metal of the anode is dissolved and converted into the same cation as in the electrolyte and at the same time an equal amount of the cation in the electrolyte is converted into metal and deposited on the cathode. Depending on the voltage used and the concentration of the electrolyte, other, more complex electrochemical effects can take place at the anode and the cathode but the solution at the anode and deposition at the cathode are the main effects.”

Advantages of Electro-Etching

- The chemicals used for electro-etching are not corrosive like the acids used for most other types of etching. However, most of them are not good for the environment and they need to be disposed of properly.
- Many of the electrolyte solutions used for electro-etching rarely need to be disposed of. They last for years as they do not become exhausted, and do not need to be periodically refreshed.
- Undercutting, or eating back under the resist, is generally far less than with acid etching.
- No dangerous gasses, or fumes, are created during the electro-etching process.
- A wider choice of resists is available because the resist does not have to stand up to a corrosive acid.
- When the same concentration of electrolyte, the same voltage, and the same time is used, an etching is repeatable.
- When silver is etched using cupric nitrate as the electrolyte, all the silver removed from the anode can easily be recovered from the solution.
Safety First

Safety glasses or face mask – Always wear safety glasses, or a face mask, when working near any of the chemicals, both liquids and solids. If any of the solutions are accidently splashed into your eyes, use the eye wash station to thoroughly wash your eyes with water.

Rubber gloves – Always wear rubber gloves when working near any of the chemicals, both liquids and solids. If you are accidently splashed with any of the solutions, wash the area thoroughly with water.

Respirator – Always wear a respirator when working near any of the dry, solid chemicals.

Disposal of electrolytes – All solutions from the etching process may require special care when disposing of them. Do not just pour anything down the drain without reading the directions.

Label chemicals and solutions – Store all chemicals and solutions is plastic bottles with plastic caps, clearly labeled, and in a safe place away from children.

Read the Material Safety Data Sheets (MSDS) – Read the MSDS for all chemicals that you will be working with, and for all the compounds that may be created during the etching process. MSDS are available on the web at www.sciencelab.com, enter the chemical name in the “Search for Products” box on the upper right side of the screen and look for a link to the MSDS.
Equipment

Tank, plastic or glass – I use Better Homes and Gardens square canisters, with lids, from Walmart.

Power supply – Two “D” batteries work well as a very inexpensive power source for electro-etching. I used a battery holder (Radio Shack # 270-386), and two test/jumper leads (Radio Shack # 278-1157), to construct the ones we use in the workshop.

Cathode – I use a piece of 28 gauge copper, with a hook bent in the small end so that it will hang on the edge of the tank.

Other materials we will use in the workshop include:

- Ethyl alcohol
- PnP Blue
- Heat press
- Clear contact paper
- Heavy duty aluminum foil
- Acetone

Electrolytes

Please refer to a later section for directions for preparing the electrolyte solutions.

Sodium chloride – A solution of sodium chloride (plain salt) can be used to etch copper, brass, bronze, aluminum, and nickel silver. The solution is good for several etchings, but it will quickly turn muddy brown. The sodium chloride solution is that it is easy to prepare and etches very aggressively. A disadvantage is that, after etching, the electrolyte contains some metal chloride salts that should not be disposed of by just pouring the used solution down the drain.

Copper sulfate – A copper sulfate solution can be used to etch copper, brass, bronze, and nickel silver. The copper sulfate solution will remain active for years without refreshing. If there are small amounts of precipitate in the bottom of the tank after etching, simply filter the solution through a coffee filter when returning it to the storage bottle, and discard the filter paper.

Copper nitrate – A copper nitrate solution can be used to etch copper, brass, bronze, nickel silver, and silver. The cupric nitrate solution will remain active for years without refreshing. A big advantage is that the copper nitrate solution can be used to etch silver and the silver can be recovered from the solution. Simply filter the solution through a coffee filter when returning it
to the storage bottle, dry the filter paper, and heat the residue with a torch on a charcoal block to melt the silver into a ball.

**Resists**
A resist for electro-etching needs be only an electric insulator that will stay in place on the metal in the electrolyte while the metal is being etched.

**The careful application of the resist is the most critical step in the etching process.**

**PnP Blue** – Press-n-Peel Blue is a Mylar backed material that has several layers of release agents and resist coatings. The negative of the image to be etched is printed, or copied, onto the PnP Blue using a dry toner laser printer, or copier. The image is then transferred onto the metal using a T shirt press, or iron, set at 275 °F to 325° F (wool, polyester, or silk setting) and the Mylar backing lifted off. Acetone will clean the resist off the metal after etching.

**Nail polish** – Nail polish is very useful for touching up flaws in the resists, and for sealing edges. I recommend the use of dark colors, so it is easier to see if the coverage is complete. Nail polish can be removed with nail polish remover or acetone.

**Paint pens** – Paint pens come in several point sizes and are excellent resists. I have had good results with both the DecoColor and CraftsMart brands. The paint may be removed from the metal with nail polish remover, acetone, alcohol, or Goo Gone.

**Clear contact paper** – Clear contact paper is an adhesive-backed sheet of vinyl available at most hardware stores. It stands up well to most common electrolytes; however, there is sometimes a little seepage under the edge when using copper sulfate.

**Sign vinyl** – Sign vinyl is similar to clear contact paper, and might be thought of as a “professional” grade. Coupled with a vinyl cutter connected to a computer (similar to a plotter but with a knife blade instead of a pen) wonderful resist masks can be created.

**Tape** – Electrical tape and packing tape work well for covering the edges and the backs, but be aware of possible leaks at the joints.
Project 1 - Electro-Etched Copper Earrings

In this project the background will be etched into the metal and the design will be left raised above the background. This project makes use of the fact that aluminum will not be electro-etched when using copper sulfate as the electrolyte.

Note: The exposed aluminum contact strip will be quickly etched through if the copper sulfate electrolyte is contaminated with either sodium chloride or cupric nitrate.

Size estimate: 1 inch drop

Materials required:

- 2 – Copper circles, 1 inch in diameter
- 2 – Titanium ear wires
- Heavy duty aluminum foil
- Clear contact paper

Tools required:

- Ethyl alcohol
- Acetone
- T-shirt press
- Basic electro-etching setup
- Copper sulfate electrolyte
- Liver of sulfur
- Tumbler and stainless steel shot for burnishing

1. Prepare the copper circles by smoothing the edges with fine sandpaper, scrubbing them well, and wiping them with alcohol.
2. Apply the PnP Blue resist using a T-shirt press. A regular iron may also be used, and that technique will be discussed in the workshop.

3. Place the circles face down on a work surface and place a strip of aluminum foil on the back, so that it just touches both of the circles. Use a small piece of clear contact paper to hold it all together and protect the back of the circles from accidental etching.

4. Hang the package on the edge of the tank by the strip of aluminum foil, and clamp it in place with the red alligator clip from the battery pack. Hang a copper strip on the other side of the tank and clamp it in place with the black alligator clip from the battery pack. Fill the tank with the copper sulfate electrolyte so that it completely covers the circles, but do not allow it to touch either of the alligator clips.

5. Inspect the etching after about an hour. If a deeper etch is desired, just hang the package back into the tank and let the etching continue. You may inspect it as often as you want.

6. When the desired etch has been reached remove the contact paper and the aluminum strip from the back of the circles. If you plan to patina the earrings, I recommend using liver of sulfur to patina them before removing the resist.

7. Remove the resist using acetone. Clean with soap, rinse with water, and dry.

8. Punch a small hole in each circle for attaching the ear wires. Be careful you don’t punch the hole too close to the edge.
9. Place each circle face down in a dapping block, cover it with the suitable size punch, and strike it with a hammer to give the circle a dish shape.

10. Attach the ear wires.

11. Burnish in a tumbler for 5-10 minutes.
Project 2 - Electro-Etched Copper Earrings

In this project the design will be etched into the metal and the background will left raised above the design.

**Size estimate:** 1 inch drop

**Materials required:**

- 2 – Copper circles, 1 inch in diameter
- 2 – Titanium ear wires
- Heavy duty aluminum foil
- Clear contact paper

**Tools required:**

- Ethyl alcohol
- Acetone
- T-shirt press
- 7/8” paper circle punch
- Basic electro-etching setup
- Sodium chloride electrolyte
- Tumbler and stainless steel shot for burnishing

1. Prepare the copper circles by smoothing the edges with fine sandpaper, scrubbing them well, and wiping them with alcohol.
2. Apply the PnP Blue resist using a T-shirt press. A regular iron may also be used, and will be discussed in the workshop.

3. Using a 7/8 inch circle paper punch, punch two holes in a 2½ by 3 inch piece of clear contact paper. Punch the holes along the 3 inch side with the edge of the holes a half inch in from the edges of the contact paper.

4. Peel off the backing of the contact paper and apply it to the front of the copper circles, centering the holes on the circles. Be careful that none of the design is covered by the contact paper. Be sure to align the design in both circles because etching in copper will leave striations and you want the earrings to match.

5. Turn the package over so the circles are face down. Place a strip of heavy duty aluminum foil on the back, so that it touches both of the circles and extends a couple of inches above the top edge of the contact paper.

6. Remove the backing from a second piece of contact paper and cover the back, sealing everything inside except for the areas to be etched on the front. Turn the package over and carefully examine the exposed PnP resist. If there are any flaws or weak spots, touch them up with nail polish and let it dry before continuing.

7. Hang the package on the edge of the tank by the strip of aluminum foil and clamp it in place with the red alligator clip from the battery pack. Hang a copper strip on the other side of the tank and clamp it in place with the black alligator clip from the battery pack. Add enough sodium chloride electrolyte so that it completely covers the circles, but do not allow it to touch the aluminum foil strip or either of the alligator clips.
8. Inspect the etching after about half an hour. If a deeper etch is desired, just hang the package back into the tank and let the etching continue. It may inspect it as often needed.

9. When the desired etch has been reached, remove one of the batteries from the battery holder, remove the package from the electrolyte, and rinse.

10. If the etched area is to have a patina, I recommend doing it before removing the resist.

11. Remove the resist using acetone. Clean with soap, rinse with water, and dry.

12. Punch a small hole in each circle for attaching the ear wires. Be careful you don’t punch the hole too close to the edge. Place each circle face down in a dapping block, cover it with the suitable size punch, and strike it with a hammer to give the circle a dish shape.

13. Attach the ear wires, and burnish in a tumbler for 5-10 minutes.
Scaling Up

Tank

It is very easy to scale the process up to etch larger sized pieces. The size of the tank can be increased to whatever size is needed. Keep in mind that 2 to 4 inches is probably the best separation between the cathode and the anode, so even a larger tank does not have to be very deep, front to back.

Power Supply

For jewelry sized electro-etching increasing the power supply to 5-6 volts at 1-2 amps is probably sufficient. The next step from the current 2 “D” cell battery pack might be to a 6 volt lantern battery.

In my studio I use a twin PC power supply that I constructed from Radio shack parts that allows me to etch in two tanks at the same time.

For larger pieces I use an auto battery charger.
Preparing the Electrolyte Solutions

Sodium chloride (NaCl)

Prepare a saturated solution of distilled water with canning and pickling salt, or kosher salt. Read the label on the package of salt to make sure there is nothing added, like the anti-caking agent in table salt, or iodine. The solution will take between 3/4 and 1 cup of salt per quart of distilled water. Prepare the solution the day before and let it sit overnight. There should be a thin layer of un-dissolved salt in the bottom of the storage bottle.

Disposing of the used sodium chloride electrolyte
The used electrolyte contains copper chloride, and cannot legally be poured down the drain if it contains more than 5 parts per million (ppm) of copper chloride. Wear rubber gloves and eye protection when handling the used electrolyte. Please contact your local Hazardous Waste Disposal for proper disposal information.

Copper sulfate (CuSO4)

Caution – Please wear rubber gloves and eye protection while preparing and using the copper sulfate solution.

Prepare a saturated solution of distilled water with Copper Sulfate Pentahydrate, or Root Killer from a local hardware store. Read the label on the package to make sure there is nothing added, like an anti-fungal agent. The solution will take about 7 ounces of copper sulfate per quart of distilled water. Prepare the solution the day before and let it sit overnight.

Disposing of the used copper sulfate electrolyte
The directions on the container of Root Killer say to pour the entire contents of the container down the toilet, to kill the roots in the sewer pipes. We are only using about a fifth of the container per quart of solution, so, if there is less than 5 quarts of solution and it has only been used to etch copper, I feel comfortable disposing of the used solution by pouring it down the drain. Please contact your local Hazardous Waste Disposal if you have any concerns.
Cupric nitrate (Cu(NO₃)₂)

Caution – Please wear rubber gloves, dust mask, and eye protection while preparing the cupric nitrate solution.

Prepare the electrolyte by dissolving about 7 ounces of cupric nitrate per quart of distilled water. Prepare the solution the day before and let it sit overnight.

Cupric nitrate may be purchased from The Science Company at www.sciencecompany.com.

Disposing of the used cupric nitrate electrolyte
Please contact your local Hazardous Waste Disposal for proper disposal information.
Working with PnP Blue and Toner Transfer Paper

It is important that the PnP Blue or Toner Transfer Paper be securely applied to the metal, otherwise the resist may fail. I use the following technique with good results.

![Diagram of the application process]

Starting at the bottom of the stack:

- **A high temperature silicon pad** – This is either the pad on the base of a T-shirt press, or if an iron, or other heat source, is being used, a 6x6 inch standalone silicon pad. The silicon pad helps to make sure that the PnP Blue will be pressed against the metal with equal pressure, even if the metal is not perfectly flat.
- **A sheet of clean paper** – The paper protects the silicon pad from any excess resist. Make sure the paper does not have any printing on it, or the ink may transfer to the work at these temperatures.
- **The piece of PnP Blue, or Toner Transfer Paper** – The side with the pattern to be transferred is facing up
- **The metal** – The side of the metal to receive the pattern is facing down.
- **A sheet of clean paper** – The paper protects the heat source from any excess resist.
- **The heat source** – Both PnP Blue and Toner Transfer Paper work well at about 300 °F. This is usually the wool, polyester, or silk setting on an iron. When using an iron, avoid having the steam holes over the metal as this will leave a cooler spot in the metal and the resist may not transfer properly.

I have found that 2 to 2½ minutes of evenly applied pressure works well.
Suppliers
These are some of the suppliers that I used for materials in the workshop.

Metals:
- Copper – Metalliferous at www.metalliferous.com

Equipment:
- Battery holders (270-386), and Test/Jumper Leads (278-1157) – local Radio Shack stores
- Tanks – Walmart, the Better Homes and Gardens square canisters with flip-tite lids

Resists:
- Clear contact paper – local Hardware Store
- Paint pens – Michaels, or local Craft Stores and Art Supply Stores
- Press-n-Peel (PnP) Blue – Electronix Express at www.elexp.com

Chemicals:
- Acetone – local Hardware Store
- Copper Sulfate – Root Killer at a local Hardware Store
- Cupric Nitrate – The Science Company at www.sciencecompany.com

Patinas:
- Patina Gel - Liver of Sulfur in Gel Form at www.cooltools.us
- Perma Blue – liquid gun blue from a local gun store
References

http://www.pcbfx.com/main_site/pages/start_here/overview.html - PCB Fab-In-A-Box - Toner Transfer Paper and Green TRF Foil

http://mordent.com/etch-howto/ - Mordent Design - general


http://www.greenart.info/galvetch/contfram.htm - Green prints - general electro-etching