Electrolytic etching of silver

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Introduction -
In using enamel for my (mostly) silver jewelry I strongly prefer email champlevé. Depending on the shape of the jewelry and the desired design, I choose from one of the three following possibilities to realize a champlevé piece:

- overlay
- milling
- etching (electrolytic only)

This article is mainly about electrolytically etching silver. The other two techniques will only be touched upon.

Overlay - In the overlay technique the design is saw-pierced out of a sheet (0.4 - 0.5 mm), and is later on soldered upon a solid base plate. The overlay technique hardly poses any limitations with regard to the shape of the design, but requires a particularly a good technique of cutting and soldering.

Milling - In milling part of the silver is mechanically removed from a rather thick plate (1.2 - 1.3 mm). The same can obviously be achieved with gravers and flat scorpers.
My milling machine only allows me to carve out surfaces bounded by straight lines. No problem for me, because my designs are geometrical most of the time. Hence my choice of design in milling is limited, but on the other hand one obtains perfect steep lines and can vary the depth.

Working with milling machines in general requires continuous attention and concentration in fixing the piece of work on the milling table. This has to be done very accurately to prevent the piece of work from lifting itself off the milling table.

Electrolytic etching - Finally the electrolytic etching of silver, the reverse of silver plating. Why electrolytic etching instead of chemical etching with diluted nitric (40% dilution = fast; 15% dilution = slow)?
In the first place: working with nitric acid requires excellent ventilation with exhaust, like a fume cupboard, and I don't have one. Secondly: I would like to be able to monitor and control the progress of the etching process, and that is a little bit more difficult in the chemical process than in electrolysis.

Go de Kroon en Gert van der Veen published previously in our society's newsletter (EMAIL 1 and 4 of volume 9) about chemical and electrolytic etching of copper, respectively (available in Dutch only). A number of problems were addressed in detail, so there is no need for me to go into that.

Experiment - Lately I performed a number of tests with a view to the following questions:
- which electrolyte
- which resist
- which voltage and current, respectively

And this in view of the requirements of the etched piece, such as:
- rather sharp edges
- equal depth over the entire surface
- little or no undercutting

Which electrolyte? - The following solutions seemed to be potentially useful:
1. The commercially obtainable silver solution, in fact used for silver plating but is it also suitable for the reverse process?
2. Solution of 30 gram NaCN per litre of

water.

3 Solution of $AgNO_3$ – 94 gram and $Cu(NO_3)_2$– 118 gram per litre water.

4 3% diluted HNO_3 ($AgNO_3$ develops in the bath)

I kept the temperature constant at 18 °C. Solution 1 did not work. I did not use solution 2, as I rather don't use cyanide if it can be avoided. Similarly I did not use solution 3, because I only could buy the ingredients by the kilogram. The solutions 1 & 4 were tested at several voltages and with different alloys (fine silver and sterling silver). The 3% HNO_3 solution came out with flying colours. Please note that I use a fine silver plate as cathode.

Which resist? - I tested the following materials:

- Varnish "pour la gravure/charbonnel 331277"
- Varnish (black) "Lefranc/Bourgeois 1650"
- Adhesive plastic sheet
- Scotch Magic Tape, 810.

In practice the tape turned out to be the resist of choice, adopting the following procedure:

The design is marked on the silver with a scriber or sharp point.

- After scouring thoroughly (trichloroethylene) the tape is fixed (electrode wire may be useful) onto the front and back side and solidly pressed.
- The tape edges are cut off
- Using a delicate surgical scalpel the design is cut out of the tape.

The edges are pressed firmly and any remains of glue are removed from the silver with trichloroethylene.

- Subsequently all edges and the places where the electrode wires are fixed are sealed with galvanic lacquer (a resist). I prefer this varnish to bee wax.
- If this is feasible I don't use electrode wire but keep an extra long piece of silver on the object, which is sawed off at a later stage. A small hole is pierced

into this silver 'handle' so as to attach the electrode wire. Leakage is no longer a problem because the extra piece of silver sticks out of the bath.

Which voltage (current)? - I will be brief about the amperage (strength of the current): this is taken care off automatically, determined by the voltage, the earthing of the bath, and the size of the object.
If the facility is available, the output current of the rectifier should be set to maximum. The rectifier, Voltcraft/Digi 40, can deliver up to 5 A. During etching the actual current is approximately 5-25 mA.
The voltage does need adjusting accurately. Keep in mind: the more haste the less speed.
While using 0.8 - 1.0 V initially, I now tend to apply a lower current, namely 0.1 - 0.2 V. The time of etching is then about 5-6 hours. With this lower current the edges are eaten into less, but the problem of undercutting still remains. The extent to which the latter occurs is closely related to the depth of etching. Up to a depth of 0.2 mm undercutting is minimal. For niello this depth is more than adequate, but with enamel I prefer a depth of 0.3 - 0.5 mm, but then the undercutting increases almost quadratically.
Of course it is possible to touch up the undercut edge with a mill or/and scraper. It is good foresight to keep this in mind at the designing stage. It is also possible to leave the undercut edge as it is, but bear in mind that the enamel under the edge and the material above it have different expansion characteristics, so that the chance of all kinds of cracks developing becomes bigger and bigger. I know all about it.

After about 75 min. the etching process is interrupted, the object cleaned thoroughly under running water and carefully dried. The edges of the design are fixed again on

top of the tape using galvanic lacquer, in such a way that a small edge of lacquer is attached onto the silver, thus covering the edge. After that the lacquer covering the upper part of the edge is carefully scratched away. The lacquer on the inside remains intact and protects against undercutting. This procedure is repeated 2 or 3 times, about every 60-90 min, depending on the speed of etching.