The Conard Corporation

Precision Photo Chemical Machining Since 1965

101 Commerce Street
Glastonbury, CT 06033
Phone: 800.443.5218 & 860.659.0591
Fax:: 860.659.8705
Web: ConardCorp.com

Understanding Photo Etching Costs

A Guide Presented by Conard Corporation

Share this guide

Major Cost Elements

Like any other manufacturing process, chemical etching costs are the sum of a number of elements. The most variable cost elements in photo etching are: metal and photoresist, labor, and machine time. The indirect costs consist of etching chemistries including developer, etchant and stripper. Power, water and waste treatment are figured into the overhead cost rate.

Considering alloy and thickness, metal costs vary widely. Common alloys and gauges of copper, steel, or aluminum might run between $5 and $10 per pound. Thinner materials cost more per pound: .001" thick stainless is about $50 per pound. However, .0005" stainless costs more than $100 per pound. Beryllium copper is around $35 per pound. Molybdenum is more than $150 per pound. The cost of photoresist is a constant value per square inch.

Labor Cost Accumulation

The unit of labor in photo etching is the sheet. There are seven manufacturing operations during which labor is accumulated: cutting, cleaning, laminating, printing, developing, photo etching and stripping. Each of these steps requires that the sheet be handled into and out of the operation. The amount of labor required is fairly consistent per sheet, regardless of the size of the sheet. Indirect labor is applied in inspection and packaging.

In most cases, smaller sheets accumulate labor at essentially the same rate as the larger sheets. The application of labor is relatively indifferent to the sheet size. So the sheet size is an important factor in photo etching costs.

Machine time costs accumulate in cleaning, developing, photo etching and stripping. During machine time, multiple sheets are transported by conveyors at speeds determined by the processing requirements. The etching process itself is the slowest, usually running at a few minutes per inch of travel.

We measure capacity at each step in "sheets per hour," which takes into account both the labor and the machine time. Each work step has a through-rate based on sheet size. The through-rate in the etching process is based on sheet size, alloy and metal thickness. Metal alloys etch at known rates per mil (.001") of thickness so the required duration of the exposure to the etching chemistry is predictable.

Design Factor Costs

Dimensional tolerances also affect the sheet size for photo etching as the tolerance variance from the center of the sheet to the edges increases with the distance. So, even a simple part with tight tolerances might have to be produced on a very small sheet. Tight tolerances also affect etching costs because the production yield of parts within tolerance decreases.

At the most generous end of the tolerance spectrum is what we refer to as "decorative." This applies to jewelry, giftware and hobby- type projects where the absolute dimensions are not critical. We etch to a gauge pin dimension and inspect to appearance. This is the most economical sheet we produce. Typically, the decorative sheet is 18 x 24 x .020. In photo etched brass or aluminum, in quantities of 10 or more, these sheets are under $60 each. Parts are shipped tabbed in the sheet.

Tooling Cost

Phototools are another element of photo etching costs. Most tools cost less than $300 for sheets up to 24" x 30". Composite tools containing images of different parts have a one-time set up charge for the additional parts. The phototool is the film master used to transfer the images of the parts onto the resist-coated metal. Phototools are produced from customers' CAD data. They are inexpensive, long-lived and easily regenerated. Tooling charges are one-time, unless the customer

changes physical dimensions of the part. If a phototool becomes damaged while in our use or care, we will replace it at no charge to the customer.

Cost Variables

The two biggest variables affecting the cost of photo etching are metal thickness and sheet size. Metal thickness bears directly on the length of time it takes to etch through a given metal thickness measured in minutes per mil (.001") of thickness. Sheet size drives the amount of labor that accumulates.

The photo etching process has seven essential steps: cutting, cleaning, laminating, printing, developing, etching and stripping. For each of these steps, a sheet of material must be handled. Each time a sheet is handled into and out of a step in the photo etching process, labor is applied. If you were loading and unloading a pizza oven, your hands wouldn't care if it was a small pizza or a large pizza. You can easily see that loading and unloading many small sheets (pizzas) consumes more labor than handling a smaller number of large sheets.

The effect of sheet size on the cost of photo etching is illustrated in the table below:

The "test part" is a 1" x 1" x.010" thick part. It doesn't make any difference whether the part is a simple disk (cheese pizza), a washer (pepperoni pizza), a spring form (pepperoni, sausage and mushrooms), or a screen (the "works"). The photo etching process doesn't care.

Prices shown do not include any material cost.

Sheet Size	**12 x 12**	**12 x 18**	**12 x 24**	**18 x 24**
Min Tolerance	+/-.002	+/-.0025	+/-.003	+/-.004
500	.59	.43	.41	.38
1000	.56	.39	.36	.31
2500	.52	.38	.29	.25
5000	.45	.33	.29	.23
10000	.42	.31	.27	.22
25000	.40	.30	.26	.21
50000	.39	.29	.26	.20
Sheets/ 1k Parts	15	9	7	5

Cost Effects of Dimensional Tolerances

The minimum tolerances shown apply to .010 thick material at the sheet sizes indicated. So, the evidence is clear. The larger sheet sizes are definitely more cost effective in photo etching. Over the course of 50000 pieces, the accumulated labor for the 12 x 12 sheets will be more than double compared to the 18 x 24 sheets.

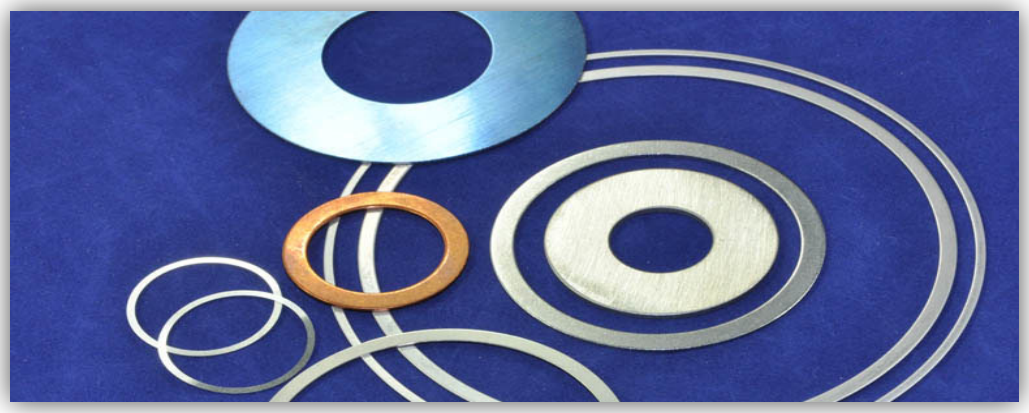
Remember, too, that allowance must be made for the dimensional tolerances the larger sheets require.

Dimensional tolerances are often the determining factor in planning the sheet size for chemical etching. Most engineering drawings have a standard tolerance of +/-.005" for three-place decimals. If you are designing for photo etching, that dimensional tolerance band is adequate for materials up to .030" thick. The *location* tolerance in photo etching is +/-.001" to drawing nominal. Locations are established in your CAD file which is exactly the data from which the photo tool is made. If your data is right, the phototool will be right.

Designing for Economy

Metal thickness and dimensional tolerances play a major role in planning the sheet size for etching. Sheet size is a significant determinant of the cost of photo chemical etching. Our experience suggests that it is often the case that a designer will be overly generous with the material thickness and stingy with tolerances. And, when you have an actual conversation about the part and its application, you discover that neither needs to be that way.

To design for economy in photo etching, watch for these money-wasting flaws: too much metal, too tight tolerance, feature sizes that are too small for the thickness, inaccurate specifications and unavailable material selections.



The Conard Corporation

Precision Photo Chemical Machining Since 1965

About Conard Corporation

Conard was founded in 1965 in Glastonbury, CT and has continuously specialized in Photo Chemical Machining (PCM) or chemical etching. The founder, Richard C. Huttinger, was a metallurgist and engineer who had previously worked for both Boeing and Pratt & Whitney. Huttinger developed a process to chemically mill the surface of forged aluminum propeller hubs for Pratt & Whitney. This process was more efficient and cost effective than conventional milling in the days before CNC machining was widely available.

Conard's early expertise in etching aluminum came to the attention of a major aerospace avionics company. Military and commercial avionics systems needed flat aluminum heatsinks to cool printed circuit boards. The heatsinks required detailed cutouts around each component. Photo etching was a cost-saving ideal solution, and flat heatsinks remain a significant part of our business today.

Conard is a Green Circle Award recipient from the Connecticut Department of Environmental Protection for consistently meeting and exceeding our environmental requirements. Conard has achieved registration under the AS9100/ISO9001 standards, in order to assure both existing and new customers that we are qualified to meet your requirements.

Conard has assisted hundreds of companies in developing applications for photo etching. We provide engineering and design support; rapid turn around of prototypes; and engage in special development projects to help customers solve complex problem.