Interplex

Chemical Etching

Tech Bulletin

# *Chemical Etching Provides the Solution for Micro-Features and Ultra-Close Tolerances*

## *Etching is a key enabling technology for aerospace, medical and other high-precision applications that require very fine features and tolerances.*

For many of today's most demanding applications, the formation of very fine precision parts with consistent features and very close tolerances has pushed the limits beyond the capabilities of conventional stamping or other metal forming processes.

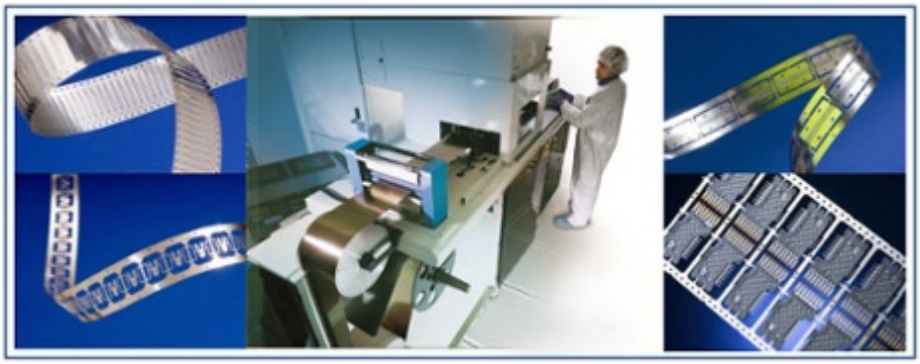
**This Tech Bulletin provides an overview of how chemical etching processes can be used to achieve the very small features, close tolerances and yield consistency that is critical for success in these applications.**

Topics addressed in this Tech Bulletin include:

- Overview of Chemical Etching Processes
- Advantages of Reel-to-Reel Etching
- Process Specifications and Guidelines
- Micro-Groove Applications
- Process Control Requirements
- Keys to Success

**Overview of Chemical Etching Processes**

Chemical etching of metal parts is a photo-chemical metal conversion process that creates highly-repeatable, burr-free components with complex features for intricate metal designs and shapes that would not be achievable with conventional stamping techniques. Reel-to-reel chemical etching produces precision parts on a continuous metal strip made from stainless steel or a wide variety of ferrous and nonferrous materials.



**Advantages of Reel-to-Reel Etching**
Using a tightly controlled reel-to-reel etching process is important to maintain the close tolerances and a high degree of repeatability combined with high-volume production output. Unlike panel etched parts, reel-to-reel etching is inherently automation friendly and allows for smooth integration of secondary processing steps. For example, the etched metal parts can be easily formed, plated or insert molded using various types of automated equipment.

Key advantages of Reel-to-Reel Etching include:

- Continuous reel-to-reel etching has the ability to hold very tight tolerances for small feature sizes with a very high degree of repeatability and consistency.
- The increased repeatability and consistency significantly reduces the total cost of quality, especially in high reliability applications.
- Customers can design burr-free, precision metal components with ultra-fine pitches, intricate shapes and 3-D feature profiles, unavailable using traditional metal stamping processes.
- Chemically etched parts can be produced in a high volume environment which reduces tooling and production costs, while improving time to market.
- Reel-to-reel etched parts can be presented to other automated processes such as forming, plating, insert molding and assembly on a reel, further reducing total manufacturing costs.

The degree of precision and consistency achievable offers a continuous chemically etched metal strip and a mass production advantage alternative to the standard panel or sheet etching process. The excellent control and flexibility makes the reel-to-reel chemical etching approach able to design and deliver parts that meet virtually any specific set of application requirements.

**Process Specifications and Guidelines**
Chemical etching processes are adaptable for a wide range of applications and the guidelines may vary depending on specific design requirements but the following tables provide an overview of the general capabilities and the alloys that can be used.

| General Process Guidelines | |
|---|---|
| • Minimum Feature Size:<br>1.2x Material Thickness<br>• Minimum Thickness: 0.0008" (0.0203 mm)<br>• Tolerance: within +/- 10% of Material Thickness | • Maximum Part Width: 8" (203 mm) wide<br>• Maximum Part Length: 750' (228 meters) long<br>• Maximum Thickness: 0.0200" (0.508 mm) |

| A sampling of the many compatible alloys for chemical etching processes include: | |
|---|---|
| • Alloy 42<br>• Be Cu Alloys<br>• Brass Alloys<br>• Copper & Copper Alloys<br>• Cupro-Nickel<br>• Furukawa Eftec 64T<br>• Invar<br>• Kovar | • Nickel 201<br>• Nickel Alloys<br>• Low Expansion Alloys<br>• Magnetic Permeability Alloys<br>• Monel<br>• Phosphor Bronze<br>• Spring Steel<br>• Stainless Steel, 300 & 400 |

**Micro-Groove Applications**
The continuous reel-to-reel etch process has also been adapted to produce specialized products with "half-etched" micro-grooves for critical high-precision applications in Aerospace, Medical, Industrial and Defense industries.

Primarily applied to austenitic stainless steel alloys, the micro-groove process enables a variety of applications where the part functionality is dependent on precise depth of the etched groove. Examples include one-time-use triggering components that must break at a very specific force point, such as for military ordinance or specialized pressure sensors. In the medical arena, micro-groove etching can be used to implement extremely small and tightly controlled capillary flow applications.

An important etch process requirement for micro grooves is to achieve a very smooth and uniform surface finish in the etched grooves. This is especially important for applications where the capillary flow rate is a critical performance requirement.

In some cases, the material thickness may need to be as small as 2x the groove depth and any variation in the process will either result in excessive scrap or unacceptable levels of field failure.

**Process Control Requirements**
Extensive experience and empirical process improvement has shown that groove depth control is sensitive to several factors including material thickness, groove width, spray pressure, and other process variables.

Real time parametric process controls have demonstrated excellent results and dimensional consistency over virtually miles of precision etched products in continuous strip. One key factor is the use of fully computerized "flat-line" process control system that manages 160 critical physical and chemical process points in real time, to assure uniform and consistent results. These process control parameters are automatically audited by online vision systems.

Incoming material from suppliers must be controlled to very tight tolerances for width, thickness, surface conditions, camber, cross curvature, edge burr and other key parameters. Cleaning lines, lamination, exposure processes and the continuous reel-to-reel etching process all must be tightly controlled and conducted in a certified Class 100 cleanroom environment.

**Keys to Success**
With today's modern reel-to-reel etching and tight process control capabilities, designers are no longer limited by conventional dimensional constraints. To a great degree, today's limitations are largely just a matter of imagination. Designers now have unprecedented latitude and a growing range of options when it comes to specifying ultra-small micro-dimensions and tight process tolerances.

By involving experienced etch process engineers early in the design cycle and exploring these possibilities, product designers can often discover entirely new ways of approaching and overcoming previously unsolvable application challenges.

More information can be found on the web at www.interplex.com/chemical-etching or by contacting Ron Bottino at 508-277-2155 or ron.bottino@us.interplex.com.