Design Brief

Engineering Thin Medical Parts Through Photo Etching

Tech-Etch

www.tech-etch.com

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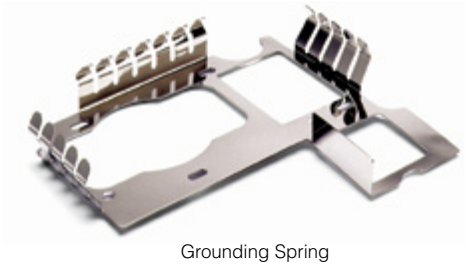
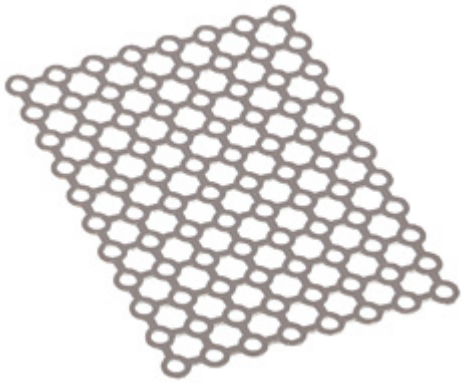


Grounding Spring



.020" Thick Titanium Implant Mesh

Battery Grid

Photo etching, also called chemical milling, photochemical machining and chemical machining, offers many advantages for manufacturing thin metal or polymer film medical parts, including improved accuracy, low-cost tooling, inexpensive prototyping, burr free parts, and speed of production.

Specialty materials such as **tungsten, molybdenum, nitinol, titanium, elgiloy and polyimide** have characteristics that are attractive to the medical industry as components for medical devices such as heart valves, intraocular lenses, pacemaker batteries, surgical tools and catheters. In addition to these specialty materials, photo etching is highly suitable for other metals including beryllium copper, stainless steels, niobium, silver, brass and spring steels.

Photo etching produces filters, fuel cell plates, flat springs, reticles, fluidic circuit plates, haptics, skull plates, and other flat parts for a myriad of medical applications.

Photo Etching Advantages

Photo etching is especially useful in the **prototyping stage** of the design process, when several variations of a new design can be produced and tested at the same time with little additional cost. Even when conventional dies are slated for production runs, chemical milling is often used in the prototype stage due to its economic advantages. For example, the chemical milling cost of tooling for a typical part is only $200 to $300, versus $10,000 to $50,000 for preparation of stamping tools and dies. In addition, revisions and modifications to existing designs can also be accomplished with the same speed and low cost benefits.

Other photo etching design advantages include **stress-free blanking** on ferrous and non-ferrous metal with no chemical or physical alteration to the material. Stamping can alter magnetic and other physical properties, such as hardness, strength and formability in certain materials. Laser machining leaves a heat-affected area at the parts edge. Photo etching easily and economically reproduces intricate part geometries with extremely fine resolutions. Brittle and fragile materials subject to breakage during the stamping process can be photo etched without difficulty. Metal as thin as .0005 in. can be easily etched

The Photo Etching Process

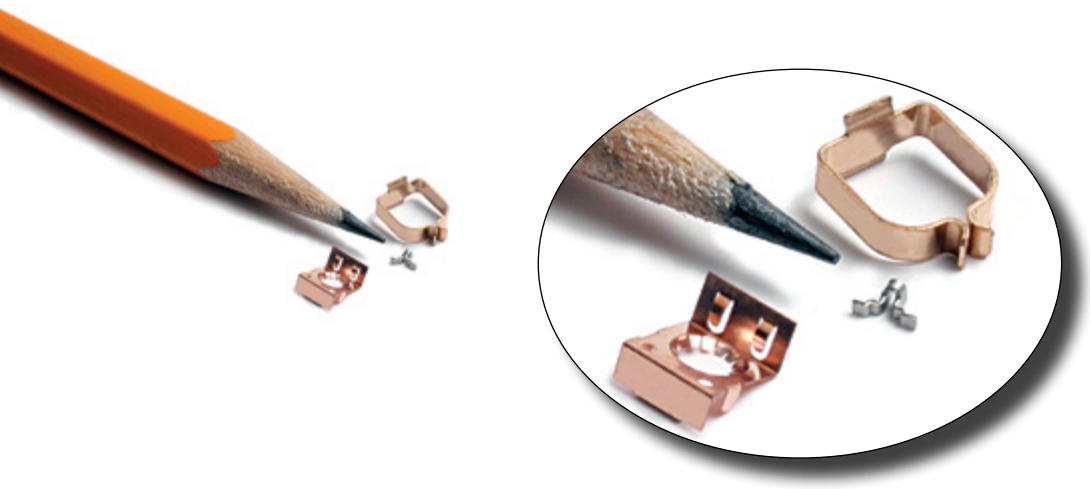
The process starts with flat piece of material and then the unwanted areas of the material are chemically etched away. First a clean, flat piece of material is covered with a photosensitive, etchant-resistant polymer mask.

A photographically prepared film called a “phototool” is used to shield the material that is to remain after etching. The phototool is produced from a blueprint, sketch or CAD file supplied by the designer. The phototool may contain one or many exact images of the desired part, depending upon the part’s size.

The phototool is contact printed onto the material, transferring the image of the part or parts photographically. It has transparent and opaque areas, with the transparent areas corresponding to the desired final part(s). With the phototool in place above the material, the sheet is then exposed using ultraviolet light. Since the light only goes through the transparent areas of the phototool, it exposes only the desired part(s) on the material. This exposure prepares the transparent area for hardening, which is accomplished with a developing solution.

The result is a piece of material coated with hardened etchant-resistant polymer only where the desired part(s) have been masked by the phototool. The material is then sprayed or immersed with a chemical etchant. The acid dissolves the unprotected area leaving behind the part(s). The amount of material removed depends on the amount of time the material is immersed in the chemical etching solution.

By controlling the time of immersion, depth etch bend lines can be etched onto the part to be used for later hand forming. Additionally, channels, pockets, words and graphics can be etched onto the material. Since there are no additional costs for these steps, the designer saves both time and money. Finally, the parts are rinsed, cleaned, dried and inspected.



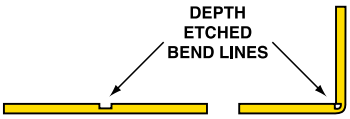
Secondary Processes

After a part is etched, additional processes may be necessary such as plating, forming, heat treating, laminating and assembly. Tech-Etch's in-house plating materials include nickel, gold, electroless nickel, silver, copper, tin, tin-lead, and solderable, plus solder hot oil reflow, electropolishing, surface polishing, and vibratory tumbling. Masking can be used for selective plating. Etched blank can be formed with simple, inexpensive forming dies avoiding the high cost of the blanking dies or progressive tools.

Forming

Tech-Etch manufactures formed parts by combining photoetching, used for blanking, with inexpensive or universal tooling, used for forming. For bends that do not require structural strength and where a sharp internal radius is desired, such as board-level shielding applications, **depth etched bend lines** may be used for hand forming. The lines are produced by etching a groove along the bend line of the part. By eliminating the need for forming tools, the cost is lowered.

Depth Etched Bend Lines



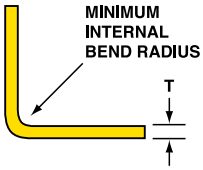
Heat Treatment

Tech-Etch can heat-treat many materials, including Beryllium Copper, to achieve close dimensional control. Heat treatment enhances spring qualities by permitting greater deflection without compression set and without increasing the material's stiffness.

Minimum Bend Radius

Temper selected for a given bend radius depends on material thickness and the position of the bend with respect to grain direction.

Minimum Bend Radius



T = Material Thickness
SB = Sharp Bend

MATERIAL	ALLOY	TEMPER	MINIMUM RADIUS FORMABILITY 90° GRAIN DIRECTION		
			ACROSS	45°	WITH
BeCu	C172	A	SB	SB	SB
BeCu	C172	1/4 H	SB	SB	SB
BeCu	C172	1/2 H	0.5 x T	0.7 x T	1.1 x T
BeCu	C172	H	1.0 x T	2.0 x T	2.2 x T
BRASS	C260	A	SB	SB	SB
BRASS	C260	1/2 H	SB	SB	SB
BRASS	C260	H	0.7 x T	1.3 x T	1.6 x T
BRASS	C260	S	1.0 x T	1.8 x T	3.7 x T
STAINLESS STEEL	301/302	1/4 H	1.0 x T	1.0 x T	1.0 x T
STAINLESS STEEL	301/302	1/2H	1.0 x T	2.0 x T	2.0 x T
STAINLESS STEEL	301/302	H	2.0 x T	4.0 x T	4.0 x T

Consult factory if tighter radius is desired.

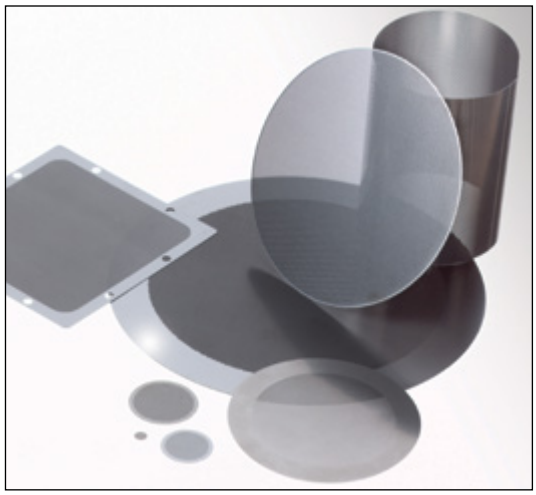
Laminating and Etching Polyimide Film

When a dielectric is required to maintain accurate finger spacing or for insulation, Tech-Etch can laminate materials such as polyimide. **Polyimide** can be die-cut and directly bonded in place or full sheet laminated and then photo etched for extremely accurate positioning. Parts can be formed after lamination of insulation.

Assembly

Tech-Etch's precision spot welding equipment is used to join small parts as well as accurately close cylinders and boxes. Soldering is an alternative. Various adhesives are also applied to join assembled components or for attachment. Staked or welded studs and contacts can also be applied.

Other Photo Etching Medical Applications

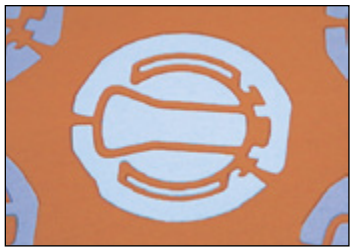


MicroEtch Screens

Fine MicroEtch® Screens

Extremely fine MicroEtch® Screens are manufactured by Tech-Etch using photo etching technology. Unlike stamped screens, etching yields a burr-free product resulting in cleaner more efficient screens with greater material integrity. These superior quality screens feature higher tolerance hole sizes and greater dimensional stability than woven wire mesh, which makes them ideal in applications requiring frequent cleaning or in devices where there is mechanical contact. And unlike woven wire mesh screens, the fixed photoetched openings will not change through use. Photo etching also enables designers to specify a tapered hole, which facilitates liquid filtration and back flow cleaning.

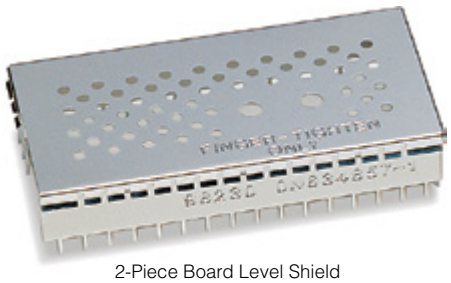
Typical applications of these screens are filters used in the medical market, hydraulic valve screens, fuel filters, laser light filters, extruding screens, as well as particle separation and sizing. They are primarily produced from Stainless Steel, but other materials are available. Tech-Etch, Inc. offers a standard line of screens with holes in a 60° or 90° pattern that are available with a usable perforated area of at least 18" x 21" as shown on the chart below. Other sizes and custom shapes are also available.



Polyimide Haptic

Polyimide Haptics for Intraocular Lenses

Tech-Etch has etched precision Haptics for Intraocular Lenses used in cataract surgery and other corrective implants since 1978. Polyimide has material characteristics that make it attractive for this medical procedure, in addition to providing the advantages of a 3-piece IOL. It is optimal for foldable IOL silicone or acrylic lenses. Polyimide offers flexibility comparable to polypropylene and PMMA haptics, with greater tensile strength, and superior shape memory. Since polyimide is safe for implant, additional medical applications can be derived from its shape retention spring properties.

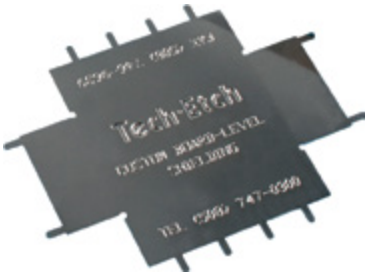


2-Piece Board Level Shield

Board Level EMI/RFI Shielding for Medical Electronic Devices

Board Level Shielding is designed to either keep in or keep out electromagnetic interference at the circuit board level. It isolates components and minimizes crosstalk without affecting system speed, since the shielding material reflects and absorbs incident radiation. Using photo etching, prototypes for medical devices are available in five days. The process allows the fabrication of shields with complex shapes and features that are impossible to duplicate by other methods without expensive tooling.

Whether one piece or multi-compartmental, Board Level Shielding is typically milled from .007" to .020" brass, nickel silver, copper or cold rolled steel. The most common finish is tin plate. It can also be manufactured from Beryllium Copper (BeCu), if spring qualities are desired.



1-Piece Board Level Shield

Custom Board Level Shield

Even when conventional dies are slated for production runs, photo etching is often used in the prototype stage due to its economic advantages.

In addition to custom shields, Tech-Etch offers a standard two-piece board level shield design with unique spring finger style attachment between fence and cover. These low-cost shields use a combination of etching and dedicated hard tooling. A series of standard hard forming tools create the unique spring finger design, and this cost is not passed on to the customer. The flexibility for inexpensive customization lies in the development of chemical etching masks. The customer's specific design is used for the fence and cover dimensions, while standard tooling forms the spring fingers for the proper alignment and fit.

Photo etched board level shielding offers true flexibility of design. Mounting pin styles are available in any configuration. Pin locations can be set to a customer's specified position or to a defined pitch. Through holes and slots can be added for heat dissipation for no additional cost. And since board level shielding covers typically have many ventilation holes, this process can be done in one step, as compared to a laser having to make each hole individually.

Etchable Medical Materials

Tech-Etch uses specially designed etching machines and proprietary chemistry and processes to etch these medical materials.

TUNGSTEN and MOLYBDENUM are difficult to etch refractory materials used for high-temperature, corrosion resistant applications. Because tungsten is extremely dense, 71% heavier than lead, it is used in medical applications including grids used to collimate and attenuate stray x-rays in CT scanners, as well as ID tags used in implanted medical devices.

TITANIUM is strong, light weight and highly resistant to corrosion. Its strength is comparable to 304 stainless steel and it is used for human implants. It is often used for dental implants, cranial closure implants, reconstructive meshes, and anode-cathode battery grids used in implantable devices.

ELGILOY is typically used when requirements call for a material that is highly corrosion resistant with high fatigue strength. It is used for implants and is highly desirable for closures and vascular stiffeners.

POLYIMIDE FILM exhibits good physical, chemical and electrical properties over a wide temperature range. Its electrical and chemical resistance properties are excellent even at unusually high temperatures.

NIOBIUM or Columbium is a light-weight refractive material with excellent high temperature corrosion resistance. It is ductile, easily formed, and has excellent welding characteristics.

NITINOL is a shape memory alloy. Its unique characteristics allow it to return to a predetermined shape after undergoing deformation. Nitinol has excellent biocompatibility, good spring characteristics and high corrosion resistance.

Photoetching Dimensions and Tolerances

Figure 1
Typical Etched Edge

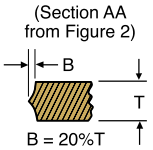
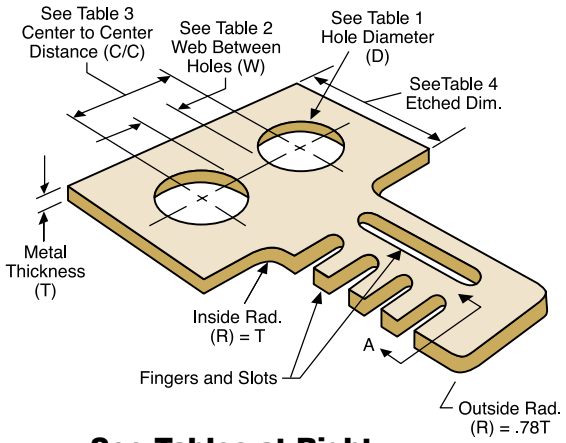


Figure 2
Typical Etched Dimensions



See Tables at Right.

Fingers and Slots

The minimum feature for a web or finger (ref. Fig. 2) is equal to material thickness. The minimum feature for holes or slots is equal to 1.1 times material thickness, .003" min. (e.g. min. feature on .002" thk. material is .003", min. feature on .003" thk. material is .0033".)

Relationship of Hole Diameter to Metal Thickness

Generally, the diameter of a hole cannot be less than the metal thickness. This relationship, however, varies as the metal thickness changes. A more exact relationship is illustrated in Table 1.

Table 1. HOLES OR SLOTS

Metal Thickness (T)	Diameter or Width
.001"-.005"	1.1 Times Metal Thickness (.003" Min.)
.005" or Over	Min. of 1.1 Times Metal Thickness

Table 2. WEB OR FINGER

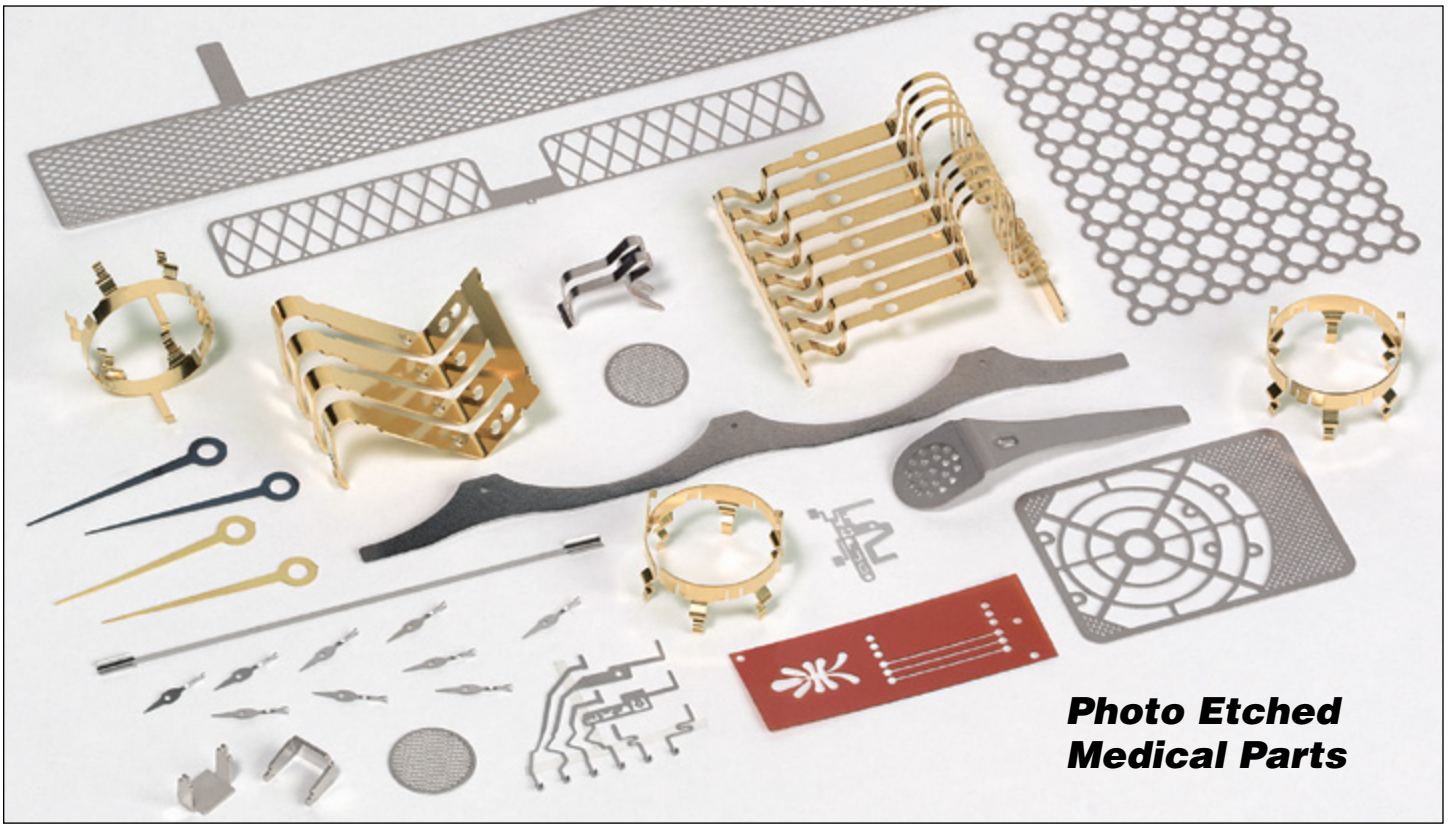
Spaces Between Holes (W)	At Least Metal Thickness

Table 3. CENTER TO CENTER TOLERANCES

C/C Dimensions (inches)	Tolerance Attainable
1.0" or Less	±.0005"
1.0" - 3.0"	±.0010"
3.0" - 6.0"	±.0020"
6.0" - 10.0"	±.0030"

Table 4. ETCHED DIMENSION TOLERANCES

	Thickness (T) (inches)					
	.001"	.002"	.005"	.010"	.015"	.020"	.040"
Empirical		±.0010"	±.0010"	±.0015"	±.0020"	±.0030"	±.0050"



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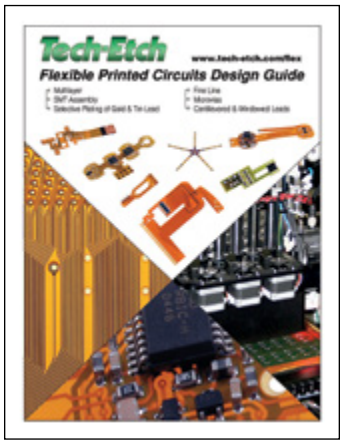
Precision Engineered Parts

Photoetching, forming, laminating and laser machining capabilities are described.

Flexible Printed Circuits

Design Guide highlights advanced manufacturing techniques.



EMI/RFI Shielding Products

Our 52-page catalog describes all standard EMI/RFI shielding products.

TECH-ETCH - A TOTAL CAPABILITY

Manufacturing Facilities

Tech-Etch corporate headquarters is located in Plymouth, Massachusetts, just 40 minutes south of Boston. Using the latest etching, metal fabrication and metal finishing equipment, Tech-Etch specializes in photoetching, forming and laminating engineered components and flexible circuits. The Laser Machining Center provides the additional capability to cut thicker materials to precise specifications. In all, Tech-Etch has over 150,000 square feet of manufacturing and office space. Tech-Etch conforms to all local and EPA regulations, and waste treatment facilities set the standard for the industry.

Wide Range of Services

Tech-Etch performs a wide variety of services, and this single-source capability enables it to assume total responsibility for the quality and delivery of our precision products. In-plant services include photoetching and chemical milling, artwork generation and phototooling, stamping from coil stock and forming from etched blanks, tool and die making, production heat treating, flexible circuit design and production, welding and soldering, metal finishing, plating, and laser cutting. Secondary operations such as soldering joints to seal seams, spot welding, and the application of pressure sensitive tapes and insulation materials are also available.

ISO 9001:2015 Certification

Tech-Etch operates a Quality Management System that is registered to ISO 9001:2015 and AS9100D, the internationally recognized standards of quality. These standards set guidelines that a company follows to provide confidence to its customers that it is able to supply products that consistently meet requirements. AS9100D is based on the core requirements of ISO 9000, but includes additional requirements necessary to meet the needs of the aerospace industry.

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