

Design Guidelines for the Photochemical Machining of Titanium



When designing or specifying for photo-etched or chemically machined titanium parts, there are a few guideline adjustments required. These modifications become more dramatic as the part thickness requirement increases. PEI offers this Design Guideline addendum as a general instruction to help our customers produce prints which take the titanium etching process modifications into consideration. If your specifications do not agree with any part of this guide, contact your PEI sales engineer for advice. Because of the nature of the etching process and the inherent undercutting at the edges of the resist pattern on the surface, all dimensions, tolerances and configurations are a function of the thickness of the stock being etched, and to a lesser extent, the process variables. This data that follows does not define the ultimate capabilities of chemical machining but is intended to be a helpful resource.

Dimensions & Tolerances

For dimensions such as slots, corners, etc., there are a few guidelines for designers which express practical limitations when the dimensions under consideration approach the thickness of the metal. The most common rules are as follows:

Relationship of Hole Diameter & Features to Metal Thickness

Generally, the diameter of a hole (D) cannot be less than twice the metal thickness (T). This relationship however, varies as the metal thickness changes. A more exact relationship is illustrated below.

Metal Thickness (T)	Smallest Hole Diameter (D)
0.001" - 0.006"	0.008" Ø
0.007" - 0.012"	≈ 1.2 x T
0.013" - 0.020"	≈ 1.4 x T
0.021" - 0.040"	≈ 1.6 x T
0.041" or over	≈ 1.8 x T

Features such as length and width follow similar rules as holes. Tighter tolerances can be achieved with advanced consultation. Call the PEI Sales Department for more information.

Relationship of Feature Spacing to Metal Thickness

The distance (or land) between holes or other openings is only problematic in the chemical machining of titanium when narrow. The minimum "land" for titanium should be 2 x T or greater. This is especially critical with thicker stock.

Relationship of Inside Corner Radius to Metal Thickness

The smallest inside corner radius is approximately equal to the thickness of the metal (i.e., for metal 0.002" thick, the sharpest corner radius would be 0.002"). This rule must be relaxed with thicker stock, as the inside radii decrease somewhat.

Relationship of Outside Corner Radius to Metal Thickness

Outside corners tend to etch more sharply than inside corners. Therefore, radii less than the metal thickness can be obtained. As a general rule, outside radii are considered to be at least 75% of the metal thickness (T). At PEI however, artwork can be created that will produce outside corner radii approaching zero, if required.

Relationship of Bevel to Metal Thickness

This is where titanium differs most from other metals. Etching solution or etchant attacks metal laterally as well as vertically. Assuming that the material is being etched equally from two sides, a bevel or “feather” is produced at all the edges. When etching titanium, the width of the feather increases with the thickness of the metal.

0.030” thick titanium leaves \approx 0.010” feather

0.020” thick titanium leaves \approx 0.007” feather

0.010” thick titanium leaves \approx 0.005” feather, etc.

The photo shows a 0.010” feather on a 0.030” thick titanium part.

