

Anodizing Tolerances

Purpose:

This datasheet explains dimensional changes associated with aluminum anodizing, including oxide growth and metal removal during etching, to help customers account for tolerance impacts during design and machining.

1. Oxide Growth During Anodizing

Aluminum anodizing is a conversion coating process. Unlike paint or plating, anodizing converts the surface of the aluminum into aluminum oxide.

Oxide Growth Characteristics

The anodic oxide layer grows:

- ~50% inward (into the base metal)
- ~50% outward (above the original surface)

This means anodizing both consumes base metal and adds thickness to the part.

Dimensional Impact

For a coating thickness of 0.001" (1 mil):

- ~0.0005" penetrates the base metal
- ~0.0005" builds outward

Critical dimensions such as:

- Hole diameters
- Mating parts
- Threaded features

may be affected and should be designed accordingly.

Typical Anodize Thickness Ranges

Type II 0.0001" - 0.0009"

2. Etching (Chemical Metal Removal)

Prior to anodizing, aluminum parts typically undergo a caustic etch to:

- Remove surface contamination
- Eliminate minor scratches or extrusion lines
- Create a uniform matte appearance

Etch Characteristics

- Etching removes base metal uniformly
- Metal removal depends on:
 - Alloy type
 - Etch chemistry
 - Time
 - Temperature

Typical Metal Removal

- Light etch: 0.0001" – 0.0005" per surface
- Standard etch: 0.0005" – 0.0010" per surface
- Heavy etch: 0.0009"-0.0019 or more per surface

Note: Etching reduces dimensions before anodizing occurs and is not recovered by oxide growth.

3. Combined Dimensional Effect (Etch + Anodize)

When etching and anodizing are combined, total dimensional change is the result of:

1. Metal removal during etch
2. Outward oxide buildup

Example (Type II Anodize, Standard Etch)

- Etch removal: 0.0008" per surface
- Anodize thickness: 0.0007"

Net effect per surface:

- 0.0008" removed (etch)
- 0.00035" added (outward oxide)

Net result:

≈ 0.00045" net dimensional reduction per surface

4. Tolerance & Design Recommendations

Allow additional clearance for:

- Tight-tolerance holes
- Sliding or mating parts

Specify:

- Anodize type and thickness
- Cosmetic vs functional requirements
- Whether etching should be minimized or eliminated

5. Important Notes

- Dimensional changes vary by alloy (e.g., 6061 vs 7075 vs cast alloys)
- This datasheet provides typical values, not guaranteed limits