

Aluminum Anodizing by AACOA, Inc.



Aluminum Anodizing

What is Anodizing?

It is an electrochemical oxidation of the aluminum surface to produce a stable film of aluminum oxide (Al_2O_3).

- Aluminum is “rusted”
 - artificially and uniformly
- Electricity and Chemicals required
 - electrical current passes through aluminum immersed in an acid solution

Anodic Coating Properties

- Abrasion Resistance

- only diamond is harder

- Corrosion Resistance

- withstands salt spray and CASS testing

- Thermal Resistance

- aluminum substrate will melt before the coating

- Electrical Resistance

- 800 V required to pass a current through 1 mil of coating

- Porous



allows for the coloring and sealing of the coating

Aluminum Anodizing

Common Process Steps

1. Racking
2. Cleaning
3. Etching
4. Desmutting
5. Anodizing
6. Coloring
7. Sealing
8. Unracking
9. Packing
10. Lab Testing

Racking

- Provides a secure connection for transportation of the parts through the various chemical solutions
- Provides a secure connection for the flow of electricity through each individual part
- Allows for uniformity and consistency of current flow from part to part

Clean, Etch, and Desmut

Cleaning - heated, nonetching alkaline cleaner (10 min)

- removal of most shop residues and fabrication oils
- no removal of adhesives, greases, or buffing compounds

Etching - heated sodium hydroxide (0-20 min)

- roughens the surface to provide a matte finish
- limited success at obscuring scratches, die lines, and bearing marks
- removal of aluminum 0-2.5 mil (0-65 microns) per side

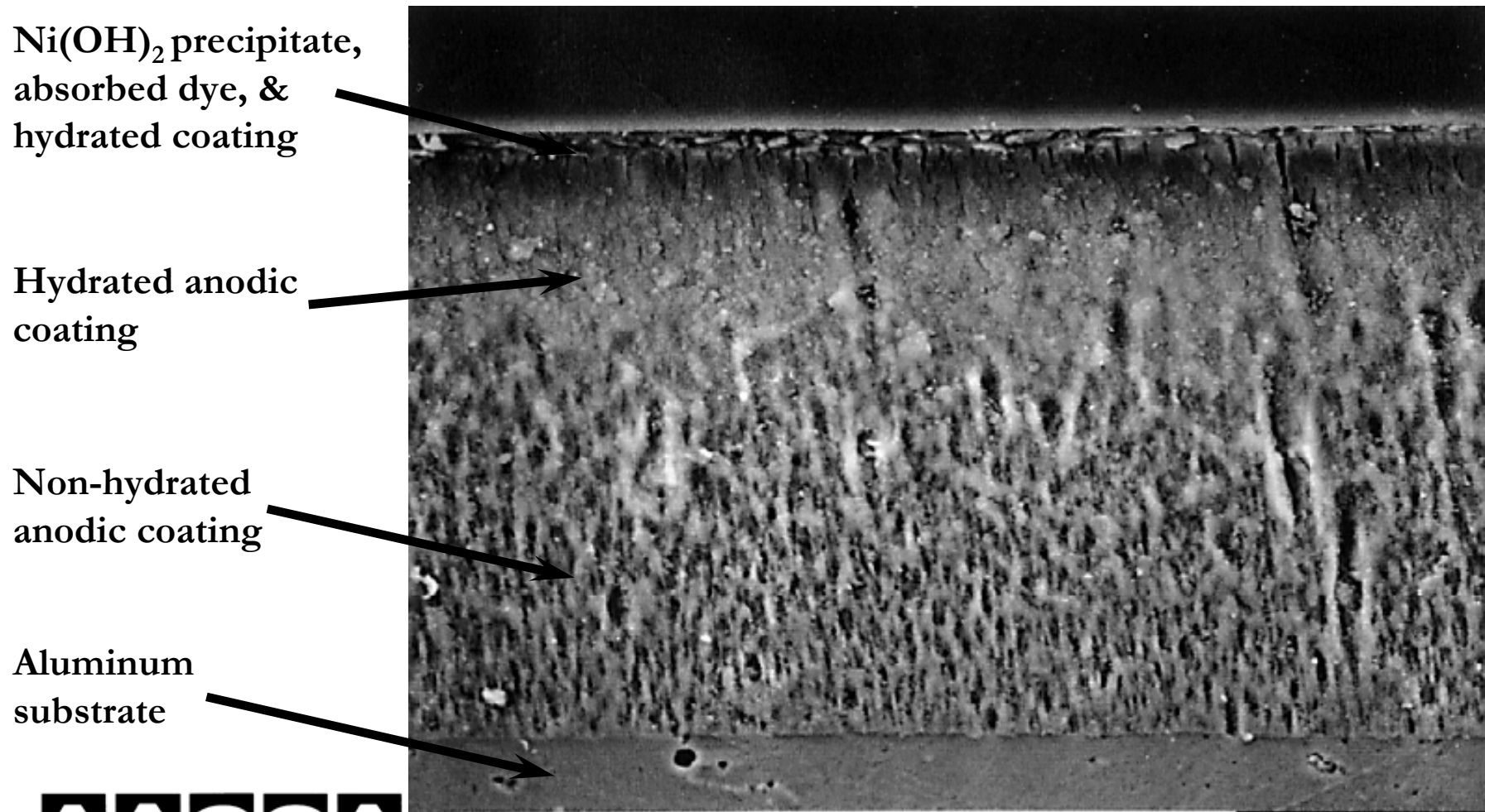
Desmutting - ambient acid bath (1-5 min)

AACOA removes etch smut resulting from alloying constituents
Aluminum Anodizing

Anodizing

- Immersion in chilled 10% (v/v) sulfuric acid bath
- DC current applied at densities of 8-20 amps/ft²
 - Time varies based on coating thickness (10-60 minutes)
- Barrier layer formed first to a 0.0005 mil thickness
- Coating builds to a 1.0 mil (25.4 μm) max. thickness
- Pores develop as the acid solution dissolves the coating
 - 250 - 500 billion pores per square inch
- Part dimensions increase as the coating is 40% penetration and 60% build-up from the pre-anodized

Cross Sectional View of a Dyed and Sealed Anodic Film



Aluminum Anodizing

Types of Anodic Finish

- Clear
- Hardcoat
- Absorptive dye
 - Uptake of organic or inorganic molecules
- Electrolytic Two-step
 - Tin Deposition
 - Cobalt Deposition
- Other
 - Integral Color



– Overdye

Aluminum Anodizing

Clear Anodic Finish

- Translucent film allows the aluminum substrate surface to be visible
- Coating thickness varies based upon specification

Alum. Assoc.

Specification

A21

A211

A212

A31

A41

Coating Thickness

<0.1 mil or <3 microns

0.1 mil or 3 microns

0.2 mil or 5 microns

0.4 mil or 10 microns

0.7 mil or 18 microns

ALCOA

Specification

Flash

201

202

204

215

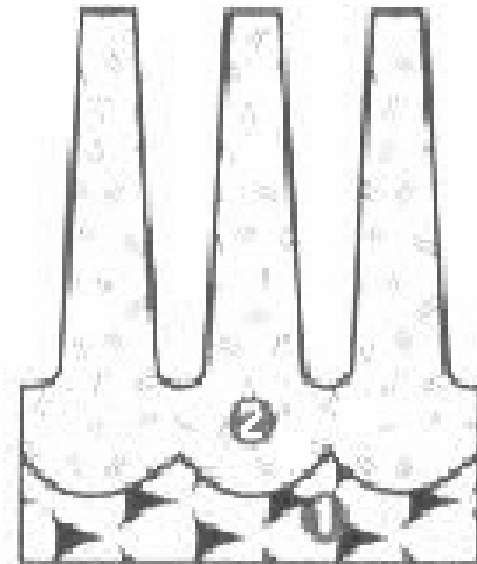


Aluminum Anodizing

Hardcoat Anodic Finish

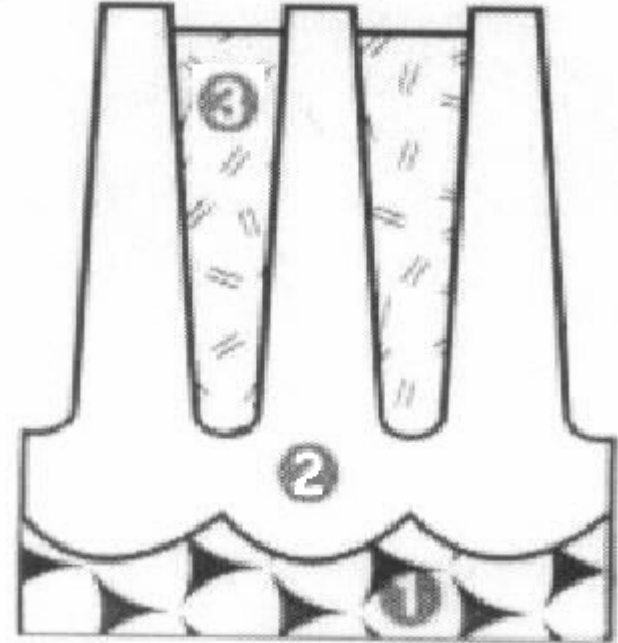
- Low temperature anodizing
 - Coating (aluminum oxide) density greatly increased over standard anodizing
 - High wear or abrasive applications
-

- 1) Aluminum substrate
- 2) Anodic Coating



Dyed Anodic Finish

- Absorption of either organic or inorganic molecules into the pores of the coating (2-30 min)
- Limitless range of colors
- Typically less fade resistance than other colored anodic finishes

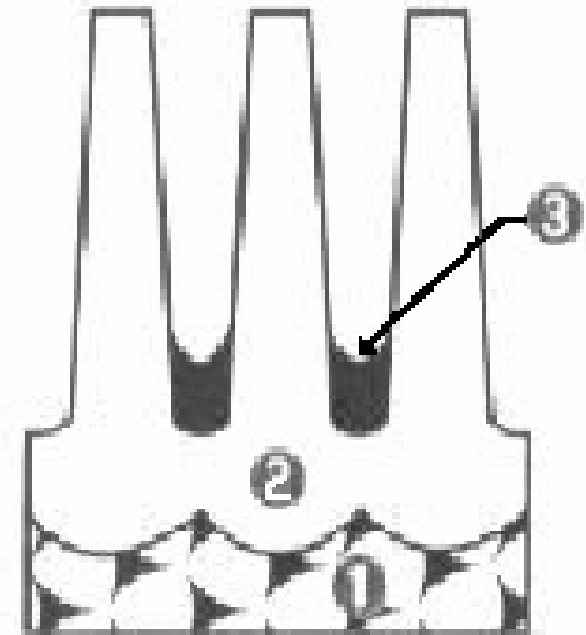


- 1) Aluminum substrate
- 2) Anodic Coating
- 3) Organic/Inorganic Dyestuffs

Aluminum Anodizing

Electrolytic (2-Step) Color

- Step 1: Clear Anodize
- Step 2: Electrolytic Color
 - AC plating of metal in the base of the coating pores
 - Bronze colors ranging from Champagne to Black (2-25 min)



- 1) Aluminum substrate
- 2) Anodic Coating
- 3) Metal Deposit—either Tin or Cobalt

AIA COIA

Aluminum Anodizing

Sealing

- **Unsealed - Excellent base for paint and adhesives**
- **Hydrothermal Seal - 200-205 F (15-60 min)**
 - Temperature drives coating hydration causing coating expansion to squeeze shut the pores at the surface
- **Mid-Temperature Seal with Metal Salts - 180 F (15 min)**
 - Deposition of metal salts in pores and some sealing by hydration
- **Room Temperature Seal - 90 F (15 min)**
 - Creation of a “super molecule” at the surface consisting of coating, metal salts, and fluoride



Prone to causing green tints or a fuzzy surface

Aluminum Anodizing

Unracking and Packing

- **Unracking - First Inspection Point**
 - Appearance
 - Coating Thickness
 - Seal Quality
- **Packing - Second Inspection Point and Packaging**
 - Type
 - Size

Laboratory Testing

- Coating Thickness - ASTM B244 - Eddy Current
- Coating Weight - ASTM B137 - Acid Dissolution
- Seal Quality
 - ASTM B136 - Modified Dye Stain
 - ASTM B680 - Acid Dissolution
- Abrasion Resistance - FED-STD-141 Method 6192.1
- Gloss - ASTM D523
- Corrosion Resistance
 - ASTM B117 - Salt Spray



ASTM B368 - CASS Aluminum Anodizing

Advantages of Anodizing

- Highly durable
- Inexpensive to produce and maintain
- Won't chip, flake, peel or chalk
- Maintains metallic appearance of aluminum
- Environmentally friendly
 - No VOC's
 - No heavy metals
 - Byproducts aid municipal wastewater treatment facilities to separate solids and neutralize pH



Maintenance

Anodizing: The Renewable Finish

- Accumulated dirt and stains can be removed with a mild detergent applied with an abrasive cleaning technique
- AAMA 609.1 Voluntary Guide for Cleaning and Maintenance of Architectural Anodized Aluminum

Metallurgical Factors

- Alloy and temper selections
- Mixed alloys - various products
 - Extrusion, sheet, forming, casting
- Extrusion defects
 - Hot spots, corrosion, die lines, bearing marks

Specifying Anodizing

- **Aluminum Association Designation System for Aluminum Finishes**

- Example: **AAM12C22A31**

- where **AA** = Aluminum Association

- where **M** = Mechanical finish

- where **C** = Chemical pretreatment

- where **A** = Anodic coating process



AACOA, Inc.

www.aacoa.com

Anodizing Facility

2551 C.R. 10 W.

Elkhart, IN 46514

Phone: 574.262.4685

Fax: 574.262.3439

Extrusion Facility

2005 Mayflower Road

Niles, MI 49120

Phone: 269.697.6063

Fax: 269.697.6061



Aluminum Anodizing