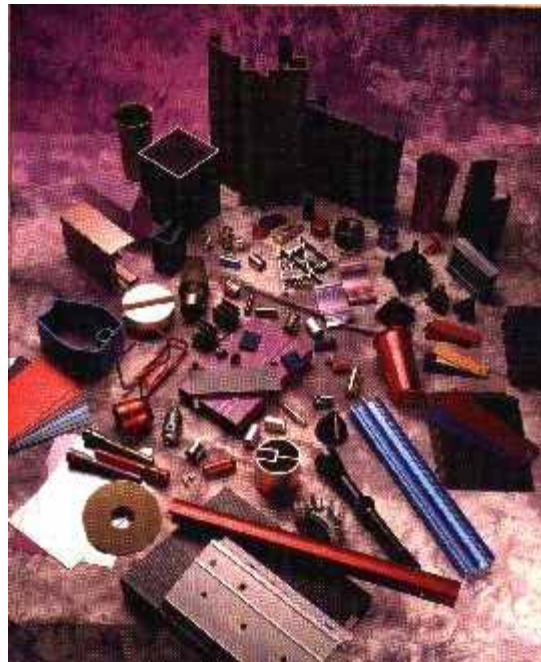


Anodizing... *The Finish of Choice.*

Anodized finishes have made aluminum one of the most respected and widely used materials today in the production of thousands of consumer, commercial and industrial products.

ANODIZED ALUMINUM:

- protects satellites from the harsh environment of space.
- was used in one of the world's tallest buildings --- the Sears Tower in Chicago, Illinois.
- is providing attractive, minimum-maintenance, highly durable exteriors, roofs, curtain walls, ceilings, floors, escalators, lobbies and staircases in skyscrapers and commercial buildings throughout the world.
- has revolutionized the construction of computer hardware, exhibit displays for trade shows, scientific instruments, and a constantly expanding array of home appliances, consumer products, and building materials.
- is environmentally safe, producing few, if any, and harmful effects on land, air or water.



ANODIZIN'S BENEFITS

The unique anodized finish is the only one in the metals industry that satisfies each of the factors that must be considered when selecting a high performance aluminum finish:

Durability. Most anodized products have an extremely long life span and offer significant economic advantages through maintenance and operating savings. Anodizing is a reacted finish that is integrated with the underlying aluminum for total bonding and unmatched adhesion.

Color Stability. Exterior anodic coatings provide good stability to ultraviolet rays, do not chip or peel, and are easily repeatable. Reduces icing using a black anodized finish in cold and harsh winter conditions. The black anodization and black color attracts sunlight and heats significantly to reduce icing of material, while decreasing frictional properties on anodized surface.

Ease of Maintenance. Scars and wear from fabrication, handling, installation, frequent surface dirt cleaning and usage are virtually non-existent. Rinsing or mild soap and water cleaning usually will restore an anodized surface to its original appearance. Mild abrasive cleaners can be used for more difficult deposits.

Aesthetics. Anodizing offers a large increasing number of gloss and color alternatives and minimizes or eliminates color variations. Unlike other finishes, anodizing allows the aluminum to maintain its metallic appearance.

Cost. A lower initial finishing cost combines with lower maintenance costs for greater long-term value.

Health and Safety. Anodizing is a safe process that is not harmful to human health. An anodized finish is chemically stable, will not decompose; is non-toxic; and is heat-resistant to the melting point of aluminum (1,221 degrees F.)

Since the anodizing process is a reinforcement of a naturally occurring oxide process, it is non-hazardous and produces no harmful or dangerous by-products.

ANODIZING AND THE ENVIRONMENTAL ELEMENTS

One of the main uses for anodization is to protect against corrosive elements and high heat frictional applications.

There are many applications where anodizing is proving to be an important protector in the fight against corrosive elements in our environments. Products from satellites, to aluminum siding and window frames are being anodized so as to provide a protective layer against salt air, pollution, oxidization, and pitting. Coastal areas are severally hit by salt corrosion, in which metals such as aluminium become pitted, the salt actually breaks down the external layers of the aluminum product over the years. Using an anodized finish will actually prevent this breakdown and will maintain the look of the product throughout its lifetime.

Satellites and communication equipment have come to rely on anodized finishes to not only protect the products material from breakdown, but also to meet and maintain their level of performance over the course of their lifetime.

The oil and gas industry has come to rely on aluminums capability of anodized finish, to provide a high wear layer for their industrial strength ball bearing applications. The anodized finish is able to provide a very strong wear layer, that protects high speed moving parts, against the usual material breakdown points.

The Canadian Military and Canadian Utilities have also seen new uses for anodized products. With the harsh Canadian winters and severe snow and ice loadings, outside buildings and structures are being black anodized so as to increase the speed of de-icing and depending on the location, results have been seen from 10-35% quicker de-icing times than usual un-anodized applications. They have also remarked that their products and structures are able to survive longer without showing signs of degradation and failure, that were seen previously with other materials and finishes.

ANODIZING AND THE ENVIRONMENT

Anodizing's environmental friendliness and relative safety are among its best properties, in the age of increasing concern for human protection and quality of our land, water and air.

Anodizing uses simple water-based chemicals that can be treated easily and that release no harmful by-products. The liquid by-products are recycled and returned to the process. Solid by-products can be isolated and diverted for use in the manufacture of alum, baking powder, cosmetics, newsprint, fertilizer and water purification systems. The U.S. Environmental Protection Agency, which heavily regulates the production and use of solvent-based paints and flouropolymer finishes containing volatile organic compounds (VOCs), regards anodizing as an environmentally friendly process.

Anodizing does create a by-product composed primarily of aluminum hydroxide, some aluminum sulfate and water. It is harmless because it contains no significant amounts of heavy metals. In some cases, municipal sewerage treatment plants benefit from these by-products by using them as filters in the secondary treatment of sewage.

ANODIZING, WHAT IS IT?

Anodizing successfully combines science with nature to create one of the world's best metal finishes.

It is an electrochemical process that thickens and toughens the naturally occurring protective oxide. The resulting finish, depending on the process, is the second hardest substance known to man, second only to the diamond. The anodic coating is part of the metal, but has a porous structure which allows secondary infusions, (i.e. organic and inorganic coloring, lubricity aids, etc.)

ANODIZING DEFINITIONS AND METHODS

While the chemical anodizing process remains the same for all applications, the mechanical methods vary according to the two physical types and shapes of metals used:



- **Batch Anodizing** - Involves racking parts and immersing them in a series of treatment tanks. Extrusions, sheets or bent metal parts, castings, cookware, cosmetic cases, flashlight bodies, and machined aluminum parts are just a few of the items that are batch anodized.
- **Continuous Coil Anodizing** - Involves continuous unwinding of pre-rolled coils through a series of anodizing, etching and cleaning tanks, and then rewinding for

shipment and fabrication. This method is used for high volume sheet,

foil and less severely formed products such as lighting fixtures, reflectors, louvers, spacer bars for insulated glass, and continuous roofing systems.

Appearance options and quality are improved through the use of dyes and special pretreatment procedures. This makes the aluminum look like pewter, stainless steel, copper, brushed bronze or polished brass and can also be colored with brilliant blues, greens, reds, and many varieties of metallic gold and silver.

The unique dielectric properties of an anodized finish offer many opportunities for electrical applications.

The surface of the aluminum itself is toughened and hardened to a degree unmatched by any other process or material. The coating is 30 percent thicker than the metal it replaces, since the volume of oxide produced is greater than that of the metal replaced.

The resulting anodic coating is porous, allowing relatively easy coloring and sealing.

Hard Anodizing is a term used to describe the production of anodic coatings with film hardness or abrasion as their primary characteristic. They are usually thick by normal anodizing standards (greater than 25 microns) and they are produced using special anodizing conditions (very low temperature, high current density, special electrolytes). They find application in the engineering industry for components which require a very wear resistant surface such as piston, cylinders and hydraulic gear. They are often left unsealed, but may be impregnated with materials such as waxes or silicone fluids to give particular surface properties.

BATCH AND COIL ANODIZING

Batch and coil anodizing are accomplished in five carefully controlled, calibrated, quality-tested stages:

1. Cleaning. Alkaline and/or acid cleaners remove grease, and surface dirt.

2. Pre-Treatment.

- Etching. An appealing matte surface finish is created with hot solutions of sodium hydroxide to remove minor surface imperfections. A thin layer of aluminum is removed to create a matte or dull finish.
- Brightening. A near mirror finish is created with a concentrated mixture of phosphoric and nitric acids which chemically smooths the aluminum's surface.

3. Anodizing. The anodic film is built and combined with the metal by passing an electrical current through an acid electrolyte bath in which the aluminum is immersed. The coating thickness and surface characteristics are tightly controlled to meet end product specifications.

4. Coloring. Coloring is achieved in one of four ways:



- Electrolytic Coloring (The two-step method) - After anodizing, the metal is immersed in a bath containing an inorganic metal salt. Current is applied which deposits the metal salt in the base of the pores. The resulting color is



black shades while more abrasive resistant than conventional anodizing. It is the most expensive process since it requires significantly more electrical power.

- Organic Dyeing - The organic dyeing process produces a wide variety of colors. These dyes offer vibrant colors with intensities that cannot be matched by any other paint system in the market. They can also provide excellent weather-fastness and light-fastness. Many structures built with these finishes have lasted more than 20 years. The color range can be broadened by over-dyeing the electrolytic colors with the organic dyes for a wider variety of colors and shades. This method is relatively inexpensive and involves the least amount of initial capital of any other coloring process.
- Interference Coloring - An additional coloring procedure, recently in production, involves modification of the pore structure produced in sulfuric acid. Pore enlargement occurs at the base of the pore. Metal deposition at this location produces light-fast colors ranging from blue, green and yellow to red. The colors are caused by optical-interference effects, rather than by light scattering as with the basic electrolytic coloring process. Further development will produce a greater variety of colors.

Here is detailed information comparing two of the most common coloring processes used: (note - these two types of processes will not produce identical colors; both can be overdyed. Source: Aluminum Anodizers Council Technical Bulletin #1-94, issued January, 1994.) See below.

5. Sealing. This process closes the pores in the anodic film, giving a surface resistant to staining, abrasion, crazing and color degradation.

Quality control. Throughout the entire anodizing process, AAC members monitor the process and quality of the product. The application of

electrical power and color is pre-programmed and verified on all batches and coils.

This quality control ensures uniformity to end product specifications for film thickness, density, abrasion resistance, corrosion resistance, color uniformity, fade resistance, reflectivity, image clarity, insulative properties, adhesion and sealing.

In many cases, AAC members use Statistical Process Control (SPC) methods to meet rigorous quality assurance standards.

Comparison of A32/A42 and A34/A44 Colored Aluminum Anodic Finishes

	A32 & A42	A34 & A44
Generic Names	Integral One Step Architectural Hardcoat	Electrolytic Coloring Two Step
Representative Trade Names	Duranodic Kalcolor Permanodic	Anolok Sandocolor Colormax
Colors	Champagnes, Bronzes, Blacks, Grays	Champagnes, Bronzes, Blacks, Pinks, Burgundies
Exterior Durability	Excellent	Excellent
Color Match	Good	Excellent
Color Reproducibility	Good	Excellent
Alloy Sensitivity	High	Low
Cost to Produce	Moderate	Low
Energy Required to Produce	High	Low
Availability-Batch Processing	Limited	High

Availability-Coil Processing

Unavailable

High

ANODIZED ALUMINUM APPLICATIONS

Anodized products and components are used in thousands of commercial, industrial and consumer applications, including:

- Structures and architectural categories of all types
- Appliances
- Commercial and residential building products
- Food preparation equipment
- Furniture
- Sporting goods and boats
- Motor vehicle components



Here are a few examples of products entirely and /or partially made up of anodized aluminum:

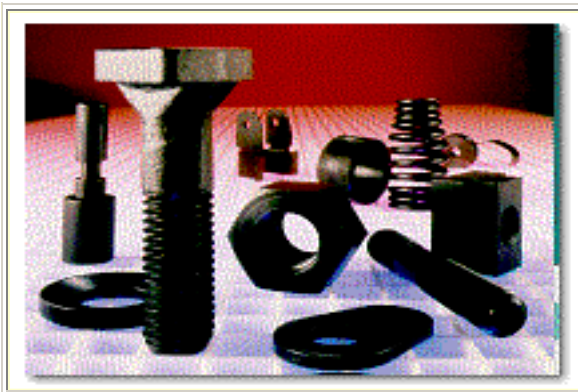
- Building exteriors, such as storefronts, curtain walls and roofing systems.
- Appliances such as refrigerators, dryers, coffee brewers, ranges, televisions, microwave equipment.
- Vents, awnings, dust covers, light fixtures, storm doors, window frames, mailboxes, bathroom accessories, patio covers, and wall switch plates for buildings.



- Display cases, pans, coolers, and grills for the food industry.
- Tables, beds, files and storage chests for homes and offices.

- Golf carts, boats, and camping/fishing equipment for the leisure industry.
- Hundreds of components for motor vehicles of all kinds such as trim parts, wheel covers, control panels, and name plates.
- Exterior panels for aerospace vehicles, clocks and electronic products, fire extinguishers, photo equipment, solar panels, telephones, picture frames, and bathroom accessories.
- Interior decoration and trim.

This is just a small sample list of products made up of anodized aluminum, designers could take advantage of anodizing for thousands of other products.



Anodized Fasteners



Type II Class 2 Colors



Anodized Fitting Assemblies

Anodize Type II (Sulfuric)

[MIL-A-8625F]

Anodizing is a conversion of the aluminum surface to practically pure aluminum oxide: the anodic coating. Type II is of particular interest to the designer wishing to extol both the virtues of form and function.

This anodic coating is significantly more abrasion and corrosion resistant than the untreated metal. The coating thickness is a combination of both penetration and build-up, in approximately a 50-50 ratio. This coating may be subsequently dyed in a variety of colors, imparting a very decorative finish both in a satin and a polished surface result.

AMS 2472C listed as similar to this spec, Type II, Class 2 (informational only.) AMS 2471C listed as similar to this spec, Type II, Class 1 (informational only.) Coatings can be colored with a large variety of dyes and pigments. Conventional Types I, IB and II are intended to improve surface corrosion protection under severe service conditions or as a base for paint systems.

Type I and IB coatings should be used on fatigue critical components (due to thinness of coating). Type IC and IIB coating provide non-chromate alternatives to Type I and IB where corrosion, resistance, paint adhesion and fatigue resistance is required. Specify class of anodic coating and any special sealing requirements.

APPROVALS

Lockheed

Honeywell

- Commercial Flight Systems Group
 - Air Transport Systems Division
 - Business & Commuter Aviation Systems Division
 - Central Technical Operations
 - Honeywell Electro Components
-

Kearfott Guidance & Navigation Corporation

GEC - Marconi Electronics Systems Corporation

Grumman Aerospace Corporation

General Dynamics Corporation

Eaton Corporation

- AIL Division
-

Fairchild Republic Corporation

- Camloc Products
-

Textron Lycoming

- Textron Defense Systems
-

Parker Hannifin Corporation

- Gull Electronics Systems Division

Simmonds Precision

-Motion Controls Division

Allied Signal Aerospace

-Bendix Brake & Strut Division
-Red Bank Division
-Energy Controls Division
-Eclipse - Pioneer Division
-Bendix Engine Controls Division

Sperry Corporation

-Aerospace Group
-Marine Group
-Flight Systems Division

*Note: these are major corporations approvals.
For info regarding other approvals please contact us.*

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