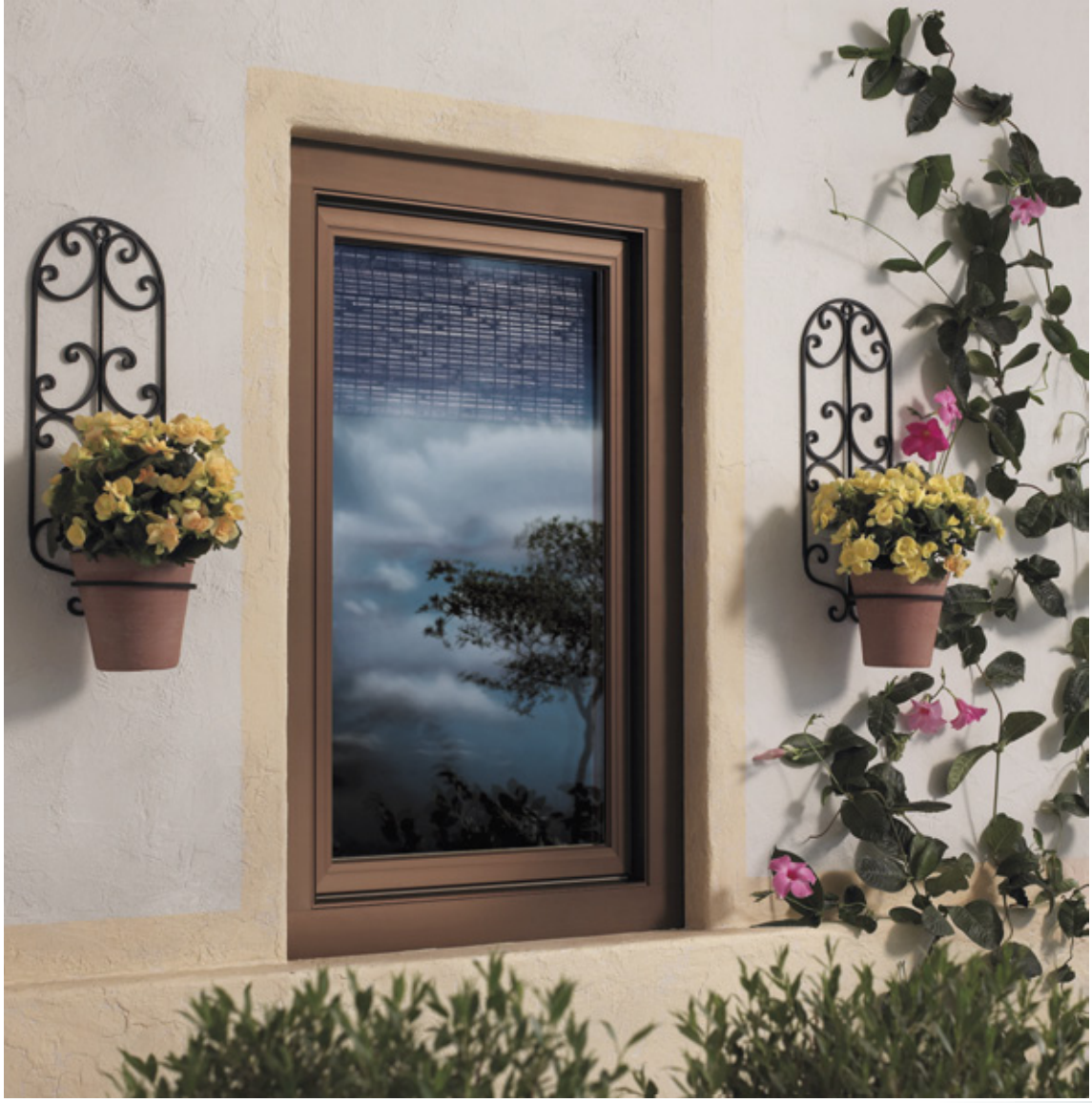


Anodize analyzed

By Tammy Schroeder, Linetec

A versatile and durable technology, the process known as anodizing can boast of numerous applications, including architectural, recreational, commercial, and automotive. In building construction applications, anodized aluminum can be found throughout a structure's framing, in windows, doors, skylights, curtain walls, and entrances. Aluminum anodize also can be found on panel systems, roof coping, flat sheet, and brake metal, as well as ornamental work.

Anodized aluminum offers three, inherently desirable characteristics:

- protective chemical resistance to the environment, inside or out;
- transparency, which does not call attention to itself, but highlights the base metal; and
- application of various colors directly into the pores of the aluminum surface.

What is anodizing?

Anodizing successfully combines science with nature to create a high-performance metal finish. It is the process of electrochemically controlling, accelerating, and enhancing oxidation of the aluminum part, creating a durable, scratch-resistant coating on the aluminum.

The anodize process typically begins with the cleaning of the aluminum in a non-etching alkaline chemical. This removes all shop dirt, water, soluble oils, etc., which may have accumulated on the material during handling and/or manufacturing. After cleaning, the

material is ready for caustic etching.

The caustic-etch process will produce a matte finish, and also minimizes minor surface imperfections such as light die lines and minor travel marks. Caustic etching will not eliminate all surface imperfections. A good rule to follow is that if the imperfection can be felt with a fingernail prior to anodizing, it likely will not be removed by caustic etching.

The material is then "desmutted" and rinsed to remove residuals left from the caustic etch. This is the final preparation stage prior to anodizing.

The sulfuric acid (Type II) anodizing process produces a protective and decorative oxide finish on aluminum. The aluminum oxide layer is made thicker by passing a DC current through a sulfuric-acid solution, with the aluminum part serving as the anode—the negative electrode. The current releases hydrogen at the cathode—the positive electrode—and oxygen at the surface of the aluminum anode, creating a buildup of aluminum oxide.

If the material requires coloring, it is moved to an electrolytic two-step coloring tank. Tin metal is electrochemically introduced into the anodic pores to produce bronze tones ranging from light champagne to black. A proprietary system for creating copper-colored anodize has been introduced that involves using actual copper to color the aluminum while isolating the copper in the coating. This unique process gives the look of rich, real copper, and is reported to resist stains from salt runoff, galvanic corrosion, and the formation of patina.

After anodizing and coloring, the material is sealed in a mid-temperature hydrothermal seal and then given a final hot-water rinse. This final, important step ensures that the high-quality, anodized finish maintains its beauty for many years.

Anodizing per the American Architectural Manufacturers Association (AAMA) 611 specification is most common, although other specifications may be followed per job requirements. AAMA developed specifications to provide performance criteria and to aid in the selection of an anodized coating for a particular application. AAMA 611-98 is the Voluntary Specification for Anodized Architectural Aluminum.

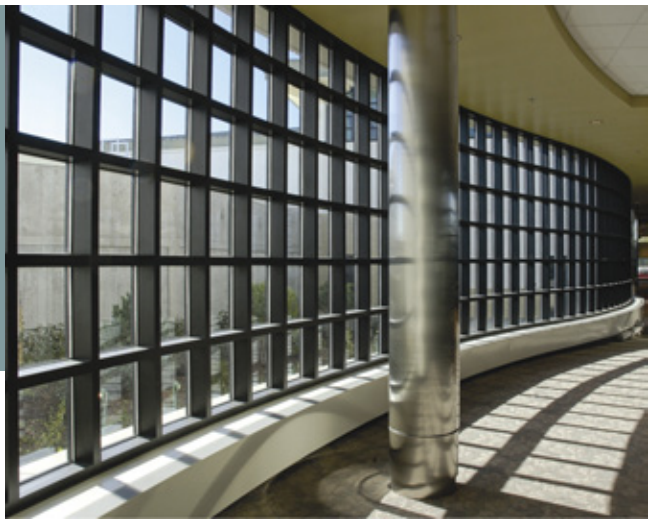
Class I and Class II anodic coatings are designations created by the Aluminum Association for the purpose of codifying the AAMA 611 specification. A Class I coating has a mil thickness of 0.7 (18 microns) or greater. It is a high-performance anodic finish used primarily for exterior building products and other products that must withstand continuous outdoor exposure.

A Class II coating has a minimum mil thickness of 0.4 (10 microns). A Class II coating is a commercial anodic finish recommended for interior applications or light exterior applications receiving regularly scheduled cleaning and maintenance, such as storefronts.

For the best finishing performance, an architectural Class I anodize coating is strongly recommended (see table, p. 22). The thicker coating is less vulnerable to weathering and more resistant to corrosion and scratches.

With documented testing, some finishers offer warranties of five years on Class I Anodize. In some cases, with prior approval and a minimal upcharge, finishers may offer an extended warranty of up to 10 years. The anodizing warranty for Class I, (0.7 mil) clear, bronze, and black

Time-tested technology delivers protection, color, and aesthetic appeal to aluminum building elements



The anodizing process enhances the protective and aesthetic characteristics of aluminum with a transparent color effect that accentuates the look of the base metal. Facing page: Copper anodize window unit; photo courtesy of Marvin Window and Door. Left: Commercial-building application of bronze anodize; photo courtesy of Tubelite Inc.

Table: Weathering Performance

	Class I	Class II
Color & Gloss Retention	Excellent	N/A
Chalk Resistance	Excellent	N/A
Color Options	Few	Few
Gloss Options	40 – 80	40 – 80
Hardness	Excellent	Very Good
Salt Spray Resistance	Fair	Very Poor
Chemical Resistance	Good	Fair
Effect of Poor Substrate Quality	Significant	Significant
Warranty	5 years	None
Initial Cost	Low	Very Low

finishes generally warrant that the finish will not chip, crack, peel (adhesion), chalk, or experience color change and fading.

Class I and Class II coatings should not be confused with Type I, Type II, and Type III anodic coatings as described in the authoritative anodizing standard, MIL-A-8625. Type I anodize refers to chromic acid anodizing. Type II is normal, "clear" sulfuric-acid anodizing. Type III is "hard coat" using sulfuric-acid or mixed-chemistry electrolytes.

Why use anodizing?

An anodized finish satisfies each of the following factors that must be considered when selecting a high-performance aluminum finish.

Durability. Anodize offers hardness and scratch resistance that surpasses paint. (The hardness of anodize is compared to that of a sapphire, the second-hardest substance next to the diamond.) The aluminum oxide created in the process becomes an integral part of the substrate and is much harder than the aluminum it replaces, producing a high level of wear and abrasion resistance. Because the anodic coating is an integral part of the substrate, it will not chip, peel, or flake over time.

Color stability. Exterior anodic coatings provide a high level of resistance to ultraviolet light do not chip or peel, and are easily reproducible.

Maintenance simplicity. Scars and wear from fabrication, handling, installation, frequent surface-dirt cleaning, and usage in service are virtually nonexistent. Rinsing with water, 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. Anodized surfaces, unlike stainless steel, will not show fingerprints.

Anodizing offers an array of gloss and color alternatives, minimizes or eliminates color variations, and allows the aluminum to maintain its metallic appearance. Photo courtesy of Marvin Window and Door.

Metallic appearance. Anodizing offers an increasing number of gloss and color alternatives and minimizes or eliminates color variations. Anodizing allows the aluminum to maintain its metallic appearance.

Lower cost, greater longevity. 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, 1221 F. Since the anodizing process replicates the naturally occurring oxide process, it is non-hazardous and produces no harmful or dangerous by-products.

A natural, green alternative. Anodize is a waterborne process and uses no volatile organic compounds (VOCs). Anodizing enhances aluminum and its environmental virtues by using the base metal—the aluminum alloy—to create a thin, extremely strong, and corrosion-resistant finish, thus preserving and extending the life of the aluminum product. Anodized aluminum is 100% recyclable; no intermediate processing is needed for anodized metal to re-enter the recycle chain.

Challenges, limitations to consider with anodize

A few challenges associated with an anodize finish include the following.

Limited palette. Architectural anodize finishes are limited to certain colors, including clear/silver, black, champagne, and traditional bronze tones.

Color variation. The color obtained in the anodize process is dependent on many factors such as alloy, temper, shape, etc. Therefore, it is impossible to produce a perfect color match.

Difficult touch-up. Anodize finishes are factory applied; any field repair touch-up must be done with a paint. A paint finish will never precisely match an anodize finish.

Low hide. Anodize is an integral part of the aluminum, therefore heavy die lines, dents, and dings on the aluminum part will show through the finish.

For best results…

Anodized finishes provide outstanding surface properties, including a high degree of resistance to abrasion, erosion, and ultraviolet-light degradation. These finishes are highly durable, deliver an exceptionally long life expectancy, and require only minimum maintenance. Some basic guidelines to consider when preparing metal for an anodize finish are the following.

Be consistent. The easiest way to ensure consistency in aluminum parts is to work with one metal source/extruder per project.

Don't mix the metal. Mixed aluminum alloys or even tempers will not produce uniform results. For best results, 6063 alloys are recommended for extrusions and 5005 are recommended for sheet stock.

Bend and form before finishing. Anodic films are very hard. As a result, most post-production bending will lead to "crazing" of the film, which will give the appearance of a spider web. Crazing produces a series of small cracks in the finish.

Store properly. The aluminum should be stored in a dry and controlled environment. Moisture should not be allowed to build up between the pieces, as this will cause severe corrosion, known as white rust, which will not be removed in the finishing process. This is important not just to the fabricator; the finisher should also ensure proper climate control where aluminum is stored.

Avoid adhesives. Tape or adhesive on the aluminum may leave a residue that may not be removed in the anodize process.

Agree on specifications and expectations. In the architectural industry, the most widely recognized specification is AAMA 611-98. If specific parameters are required, it is important to furnish the finisher with the desired requirements to ensure the job is completed to the customer's expectation.

In building construction applications, anodized aluminum can be found throughout a structure's framing, in windows, doors, skylights, curtain walls, and entrances. Photo courtesy of Tubelite Inc.

Watch for welds. Welded parts will show a different color on the weld than on the remainder of the part. The heat developed from the welding process can disturb the metallurgy on nearby metal and cause a localized discoloration after anodizing. The fabricator should ensure that the proper 5356 alloy welding wire and the lowest heat possible are used.

Prevent solution entrapment. Proper drainage holes are essential for drainage of solution, allowing entrapped gas to escape from the parts. Even the tightest of welded joints will cause anodize chemicals to seep out.

Talk about racking. The finisher needs to know where parts can be racked. There are a variety of ways for anodizers to rack parts, from welding material to spline bars, to a screw down-bolt system. In any case, contact marks are visible on the aluminum. It is important to define what is acceptable and what is unacceptable with regard to exposed surfaces and rack marks.

Handle with care. Good shipping practices are essential to a quality job. Prior to shipment to the finisher, the fabricator should package metal carefully to ensure the metal arrives dry and free of scratches and dents.

Quality in, quality out. Metal free from defects will produce a higher-quality finish. The fabricator should avoid sending the finisher metal with scratches, dings, heavy die lines, die pick-up, etc. These quality defects in the metal will show through the anodize process.

Installation issues

To ensure a long-lasting anodize finish, the following issues should be considered during installation:

Dissimilar materials. Architectural designs often incorporate many different materials, making the potential for contact between dissimilar materials an important consideration. If questions occur regarding compatibility, the manufacturer of the aluminum products should be contacted.

Masonry work. The major source of damage to in-place aluminum components usually comes from the splashing, splattering, or run-down from adjacent or overhead masonry work. Acids used for cleaning operations also pose a serious problem. Any mortar, plaster, concrete, fireproofing, sprays, paints, or other wet preparations that inadvertently splash on the aluminum must be immediately wiped clean before they dry, and the affected area washed liberally with water. Dried splatterings should be removed with wooden or plastic scrapers (not metal), which will not scratch the surface.

Chemical attack. Chemical attack occurs when acid or alkaline materials come in contact with aluminum finishes, especially an anodized finish. The most common occurrence is encountered when mortar or muriatic acid is allowed to dwell, even for a short time, on a window or aluminum building component. Once the finish is visually affected, irreversible damage has occurred and the discolored item may need to be replaced.

Contact with strong cleaners. If strong cleaners are used to clean brickwork and masonry, they should be confined to the area being cleaned. Cleaners strong enough to dissolve mortar spots on brick will surely damage any aluminum finish and possibly the underlying metal. Accidental contact from these solutions should be flushed from the aluminum surface immediately with clean water.

Welding fluxes. Welding fluxes can cause damage to aluminum during installation, and should be immediately flushed from the surface with water if accidental contact is made. Care also should be taken to ensure that heat generated during welding does not affect the finish. Applying high temperature to anodize and painted coatings can permanently damage or discolor the finish.

Tar roofing. When tar roofing is applied, the roofing should be graveled on the same day to minimize staining from run-down. Failure to avoid contact with the aluminum will result in staining that is extremely difficult to remove.

Care of anodized aluminum following installation

It is crucial that aluminum work be carefully protected after the installation is complete and prior to the building's final acceptance. This protection is usually the general contractor's responsibility. Most damage to aluminum work will occur during this time.

Installed aluminum work is considered a "finished product," while the other building components are generally in a rough or unfinished state. Aluminum materials, therefore, must be well protected and shielded, since it is often impossible to satisfactorily repair damaged materials in the field. Even if possible, rework is costly and can lack the quality of the original work. Likewise, replacement is time consuming and expensive.

Cleaning procedures for aluminum should be initiated as soon as practical after completion of installation to remove construction soiling and accumulated environmental soiling and discolorations.

For light soils, the simplest procedure is to flush the surface with water using moderate pressure. If soil is still present after air-drying the surface, scrubbing with a brush or sponge and concurrent spraying with water should be tried. If soils still adhere, then a mild detergent cleaner should be used with brushing or sponging. Washing should be done with uniform pressure, first horizontally then vertically. After the washing, the surfaces must be thoroughly rinsed by spraying with clean water.

Certain precautions must be taken when cleaning anodized aluminum surfaces. Aluminum finishes must first be identified to select the appropriate cleaning method. Aggressive alkaline or acid cleaners must never be used. Cleaning hot, sun-heated surfaces should be avoided, since possible chemical reactions will be highly accelerated and cleaning non-uniformity could occur. Strong organic solvents, while not affecting anodized aluminum, may extract stain-producing chemicals from sealants and may affect the function of the sealants. Strong cleaners should not be used on window glass and other components where it is possible for the cleaner to come in contact with the aluminum. Excessive abrasive rubbing should not be used because it could damage the finish.

For added protection, wipe-on surface protectants are available and are estimated to provide protection for 12 to 24 months in the harshest environments. The benefits of such an application are two-fold: first, it protects the finish; and second, it makes subsequent maintenance easier. Subsequent maintenance may be reduced to simply flushing the surface with water, permitting it to dry, and wiping on a surface protectant every few years. In applying these protectants, it is important that the manufacturer's recommendations be carefully followed.

Working with an experienced finisher, the resulting beauty, versatility, and ease of maintenance of anodizing make it a highly recommended choice for architectural building applications where durable aluminum building components are sought.

JAC