

Linetec Continuing Education Program – "Introduction to Coatings: Field Performance and the Application Process"

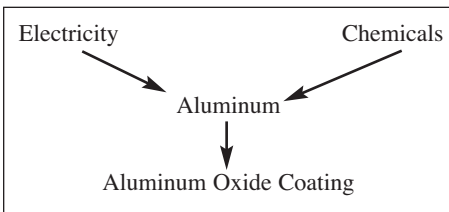
by Tammy Schroeder, Linetec's marketing specialist

Building materials and surfaces are put through some of the most rigorous, day-to-day durability challenges. It helps to know which finishes will be the best choice for maintaining the longest lifespan possible. This certainly applies to exterior architectural aluminum. The finishing technologies and processes involved in this area of design and construction are extremely important.

In the architectural industry, the two types of factory-applied finishes for aluminum are anodize and paint. Both processes can deliver a long-lasting finish on building products. The finish choice of a particular project is based on a combination of personal taste and performance criteria.

What Is Anodizing?

Anodizing is the process of electrochemically controlling, accelerating and enhancing oxidation of an aluminum substrate. The anodizing process produces an oxide film that is uniform, hard and protects the rest of the aluminum substrate from deterioration. The coating produced is extremely durable, and the hardness of the surface is comparable to a sapphire—the second hardest substance on earth. This characteristic makes anodize an excellent choice for use in high-traffic areas where resistance properties are important.



The typical anodizing employed in the architectural industry is called "two-step electrolytic." The actual anodizing and coloring of the aluminum occur in separate steps of the process.

Each step is critical to insure a quality product. The first step is racking the material. Material is clamped or welded to a rack so electrical contact can be made. Contact is critical to ensure mill thickness and tight color match. Weld rack commonly is used for stock length extrusions. The preferred method for cut-to-size and fabricated pieces is clamp racking, and fixture clamping is ideal for large volume identical parts.

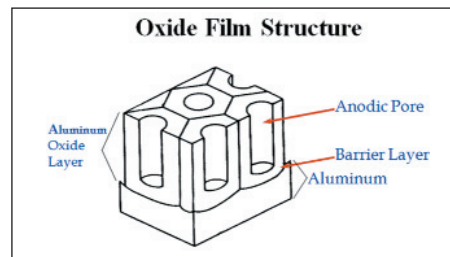
After racking, the anodize process begins with the material being cleaned in a non-etching alkaline chemical cleaner to remove all shop dirt, water, soluble

oils, etc., which may have accumulated on the material.

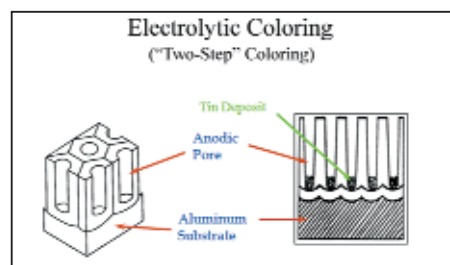
After cleaning, the material is ready for the etch tank. The etch process will produce a matte finish and also minimize minor surface imperfections such as light die lines and minor travel marks.

Next, the material is desmutted and rinsed to remove residuals left from the etch process. This is the final preparation stage prior to anodizing.

The material proceeds to the anodize tank. The anodizing takes place in a tank that contains a solution of sulfuric acid and water. The tank is charged with electrical current, and aluminum oxide is formed on the surface of the aluminum.



After anodizing, the parts can be immersed in an optional coloring tank, to achieve champagne, bronze or black tones, instead of the standard clear or silver finish. In the coloring tank, the anodized aluminum is immersed in a bath containing an inorganic metal, typically tin,



which is deposited in the anodic pores by means of electrolytic current. The amount of time the part is immersed will determine the color achieved. Darker colors are created by extending the immersion time and increasing metal deposition.

The colors seen on architectural products generally range from champagne to dark bronze and black. A recently introduced, propriety system for creating copper-colored anodize 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 given a hot water rinse, closing the top of the anodic pore. This final, important step ensures that the high quality anodized finishes maintain their beauty for many years by protecting the anodic coating and coloring from weathering.



A sophisticated, computerized hoist system guides material through the anodize process

Specifications and Performance

In order to ensure a long-lasting anodize finish on building products, the American Architectural Manufacturers Association's (AAMA) 611-98 specification should be referenced at the

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AAMA Anodizing Specification 611-98

	Class I	Class II
End Use	Exterior	Interior or Exterior with regular maintenance
Film thickness	0.7 mils	0.4 mils
Coating density	Best	Good
Salt-spray resistance	3,000 hours	1,000 hours
Color retention	5 years: Fade + 5 Delta E	5 years: Fade + 5 Delta E

time of the order (see chart). This specification addresses finish mil thickness, color uniformity, and performance of architectural anodize. Finishes that have a high resistance to fading have a low Delta E reading.

Class I anodize is used on the exterior of architectural projects. It has a higher mil thickness than Class II anodize; it is more resistant to salt spray and the sea coast; and it is more durable in high traffic areas.

The strengths and limitations of anodize can be summarized as follows:

Strengths of Anodize

- Durability, abrasion resistance
- Metallic appearance
- Color stability

Limitations of Anodize

- Limited color choices
- Difficult touch up
- Coastal corrosion
- Color will vary depending on aluminum alloy and trace elements in the aluminum

What is Painting?

Painting is the application of a protective, decorative organic coating to the surface of a substrate. The range of color choices and specialty-type paints is seemingly boundless, and includes finishes with effects provided by metallic and mica content. Color and decorative aspects of the coating generally are based on personal preference. The end-use of the architectural element, on the other hand, determines the level of protection required from a paint or coating. Paints vary in performance characteristics, including hardness, salt-spray resistance, and UV protection.

The Application Process

As with anodize, the first stage in the paint application process is racking the material. Racking is a critical step in the process to ensure the automated spray bells and the painters can achieve good coverage in all exposed areas.

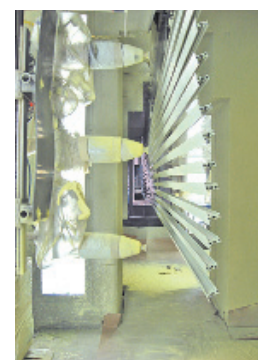
The second stage in the painting process is the pretreatment, critical for corrosion and adhesion. Paint systems are applied to clean metal that has been properly pretreated. Pretreatment consists of three basic stages:

1. Cleaning – alkaline or acid base cleaner, which removes water soluble oils, dirt, and other, minor grime;
2. Conversion Coating – added to the aluminum surface to increase the corrosion resistance, adherence and durability of any applied paint film;
3. Rinse – a high-power, clean water rinse and the final stage of pretreatment. Without a proper pretreatment, delamination likely will occur within the first year of installation of the finished element. Different pretreatments are available, but chrome-type pretreatments are widely recognized as being capable of ensuring a long-lasting coating on aluminum.

The next stage in the process is the actual paint application using:

- hand spray, where a person in a booth paints the material;
- automatic spray equipment, which provides the best flexibility, efficiency, and consistent quality; or
- a combination of automatic equipment and hand sprayers.

As part of the automatic spray equipment, rotary atomization bells, or "robots," serve as the primary paint applicators in many production settings. As the parts move through the paint line, electric "eyes" direct the robots to adjust height and

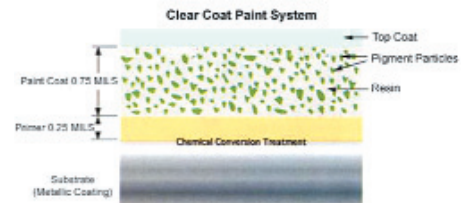


distance to target the paint spray on each piece. The bells spin at 10,000 rpm, atomizing the paint into small droplets, which are electrostatically attracted to the parts. This

maximizes the amount of paint reaching the part and minimizes wasted paint.

Hand spray application of paint is applied by highly trained painters to areas that automatic equipment does not adequately cover. Most finishers will use both application types to provide the flexibility needed to paint a wide range of material shapes and sizes.

Many high-performance coatings are multi-coat systems that require a primer, color coat, and optional clear coat, depending on the color and paint type.



The last step in the application process is curing of the paint. Without heat proper cure, the paint will not perform in the field and may exhibit color or gloss problems.

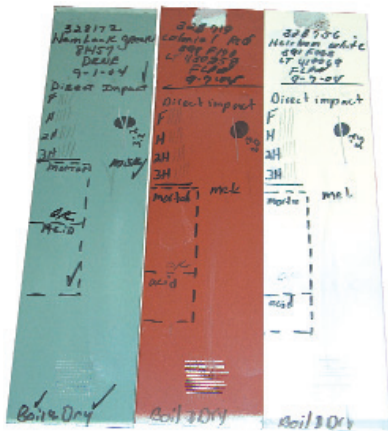
Paint Quality Control

After the paint has cured, finishers will check the quality of the coated surfaces; including mil thickness, color, and gloss.



Test panels can be run with project material. The AAMA specification tests are then conducted on these sample panels to ensure a quality product. The test results should be kept on file for future reference. Some of the tests done are:

- Impact resistance
- Adhesion
- Mortar resistance
- Acid resistance
- Mil thickness
- Pencil hardness



Environmental Considerations

Architects and specifiers who regard environmental considerations as a top priority in their material-selection process will want to know how the finish applicator controls volatile organic compound (VOC) emissions. Ideally, a 100% enclosed capture area should be used to contain emissions generated during application and cure, with VOCs routed to and destroyed by a thermal oxidizer (as shown). The thermal oxidizer burns the solvents, turning them into carbon dioxide and water vapor before emitting them into the atmosphere. The handling of chrome waste related to pretreatment by a wastewater-recovery



system is also important. Hazardous waste disposal procedures must be followed for any residual waste material produced by the recovery system.

Composition

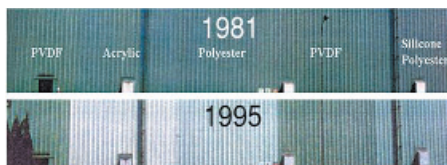
The resin system incorporated into the paint is the determining factor in the specific characteristics and performance properties. In the architectural industry, two primary resin systems are involved in prefinishing of metals: fluoropolymer-based or "baked enamel" type, usually composed of acrylic or polyester resins.

A fluoropolymer system is used on exterior elements where UV protection, fade resistance, and protection against environmental conditions are important. This type of coating is frequently seen on metal curtainwall systems, windows, skylights, panel systems, storefronts, and doors. A baked enamel (acrylic/polyester) system is used more commonly on interior elements. These paints offer excellent hardness and abrasion resistance, but do not provide the same level of UV protection as fluoropolymer coatings.

Weatherability

Resistance to chalk and fade are two, key weatherability characteristics of paints used in exterior settings. Fade results when substances in the environment attack the pigment portion of the paint and cause color change.

The following photo illustrates the difference in fade resistance exhibited by paints based on fluoropolymer Kynar 500®/Hylar 5000® finishes, also known as polyvinylidene fluoride (PVDF) resins, and those based on polyester and silicone-polyester resins.



Paints also exhibit varying degrees of resistance to chalking, which is caused by the degradation of the resin system at the surface, due predominantly to UV

exposure. As the resin system breaks down, resin particles, along with embedded pigment particles, lose adhesion and take on a whitish appearance. Chalking is measured on a numerical scale—the higher the number, the better the chalk resistance.

Specifications and Performance

Architects should determine which performance specification is required, along with the paint color. In order to ensure the paint performance expected for a given application, one of three AAMA specifications should be referenced: AAMA 2603, 2604, and 2605. These three specifications apply to progressively stronger performance levels as indicated by South Florida outdoor exposure and laboratory accelerated testing results. The relevant performance properties and specified results:

- AAMA 2603 is typically an interior specification. Baked enamel (acrylic/polyester) paints should meet AAMA 2603. The baked enamel coatings are harder than the fluoropolymer PVDF coatings and often are used for interior application where color retention is not required. These paints are less expensive than PVDF paints, but once again, have poor resistance to color fading and chalking.
- AAMA 2604 is an "intermediate" specification. A paint meeting this specification would be a 50% fluoropolymer. An application for this paint would be storefront, doors, or other high-traffic areas. This finish will provide you with good color and gloss retention. It also will provide good hardness and abrasion resistance.
- AAMA 2605 is the high-end exterior specification. A paint meeting this specification would be a 70% fluoropolymer. These finishes exhibit outstanding resistance to humidity, color change, chalk, gloss loss, and chemicals. An application for this finish is monumental architectural projects.



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AAMA Specifications for Paint

Specification	2603	2604	2605
South Florida Weathering:			
Color retention	1 year: "slight" fade	5 yrs: Fade = 5 Delta E	10 yrs: Fade = 5 Delta E
Chalk resistance	1 year: "slight" chalk	5 yrs: Chalk = 8	10 yrs: Chalk = 8
Gloss retention	No specification	5 yrs: 30% retention	10 yrs: 50% retention
Erosion resistance	No specification	5 yrs: 10% loss	10 yrs: 10% loss
Dry Film Thickness	0.8 mils minimum	1.2 mils minimum	1.2 mils minimum
Pretreatment System	Chrome or Chrome-Free	Chrome or Chrome-Free	Chrome or Chrome-Free
Accelerated Testing:			
Salt spray	1,500 hours	3,000 hours	4,000 hours
Humidity	1,500 hours	3,000 hours	4,000 hours

process as liquid paint, with the exception of using dry powder rather than wet paint. The dry powder then melts and adheres to the metal in the cure oven. Powder coatings contain no solvents when they are applied, so no VOCs are given off during or after application.

For specification of powder coatings, the same AAMA standards can be referenced (2603, 2604, and 2605) as those that apply to liquid-type coatings.

Paint or Anodize Performance Comparison

The following chart summarizes, in general, these performance and appearance aspects of anodize and the major paint systems used for architectural metals:

Finishing Up

In evaluating factory-applied finishing options for architectural aluminum, environmental, the architect and specifier will need to weigh performance and aesthetic considerations. Early communication and collaboration among architectural product manufacturers, finishers, applicators, architects, and the entire building team will help deliver the desired appearance and durability for the project. ■



The performance strengths and limitations of paint are summarized as follows:

Strengths of Paint

- Color retention (UV resistance)
- Salt-spray resistance
- Many color choices
- Field touch-up/repainting capabilities
- Small-batch and custom color capabilities—fast and cost-effective

Limitations of Paint

- Fair hardness
- Cost of high-performance products
- Potential for inconsistent appearance of "metallic" paints

Powder Coatings

Powder coating is the same basic

Paint/Anodize Performance Comparison

	Finish Options				
	Paint Systems			Anodize Systems	
	Baked Enamel	50% Fluoropolymer	70% Fluoropolymer	Class I	Class II
Weathering Performance:					
Color & Gloss Retention	Poor	Good	Excellent	Excellent	N/A
Chalk Resistance	Poor	Good	Excellent	Excellent	N/A
Color Options	Extensive	Extensive	Extensive	Few	Few
Gloss Options	10-90	25-35	25-35	40 – 804	40 – 804
Hardness	Very Good	Good	Fair	Excellent	Very Good
Salt Spray Resistance	Poor	Fair	Good	Very Poor	
Chemical Resistance	Fair	Good	Excellent	Good	Fair
Effect of Poor Substrate Quality	Moderate	Moderate	Moderate	Significant	Significant
Initial Cost	Low	Moderate	High	Low	Very Low



ALA Continuing Education Questionnaire - “Introduction to Coatings: Field Performance and the Application Process”

Learning Objectives:

- Explain how multiple paint coatings and anodize finishes rate when compared to architectural specifications
- Describe the application process of Kynar® paint, baked enamel, anodize, and powder coat
- Understand what finishing type to use for long-lasting performance and sustainability that will best suit your project

The program compares the field performance of architectural Kynar paint, anodize, and powder coat finishes. Application processes for a quality finish are also discussed.

Program Title:

“Introduction to Coatings: Field Performance and the Application Process

ALA/CEP Credit: This article qualifies for 1.0 LU's of State Required Learning Units and may qualify for other LU requirements. (Valid through Feb. 2010.)

Instructions:

- Read the article using the learning objectives provided.
- Answer the questions.
- Fill in your contact information.
- Check whether logging of ALA/CEP credit (ALA members with logging privileges only) or certificate of completion is desired.
- Sign the certification.
- Submit questions with answers, contact information and payment to ALA by mail or fax to receive credit.
- Article and tests are also available online: www.licensedarchitect.org

QUIZ QUESTIONS

1. What type of metal is deposited into the anodic pore to give anodize material its color?
(a) Stainless steel
(b) Tin
(c) Aluminum
(d) Magnesium
2. In the paint process, which of the following is not a test conducted on the test panels?
(a) Impact resistance
(b) Mil thickness
(c) Humidity resistance
(d) Adhesion
3. The anodizing process thickens the natural oxide film resulting in hardness similar to a _____, the second-hardest substance on earth?
(a) Opal
(b) Emerald
(c) Sapphire
(d) Ruby
4. What step must be completed before material reaches the anodize tank?
(a) Cleaning
(b) Etching
(c) Desmut
(d) All of the above
5. Failure in the _____ causes paint to chalk?
(a) Resin system
(b) Solvents
(c) Pigment
(d) Substrate
6. The anodize process forms _____ on the surface of the aluminum?
(a) Resin
(b) Aluminum oxide
(c) Etch
(d) Chromium phosphate
7. In order to be environmentally friendly, finishers need to destroy _____? This is done with a thermal oxidizer.
(a) Solvents
(b) Pigment
(c) Resin
(d) All of the above
8. Which paint type is best suited for interior application, where color retention is not required?
(a) 70% fluoropolymer
(b) 50% fluoropolymer
(c) Baked enamel
9. The _____ determines the properties and performance of the paint?
(a) Solvent
(b) Pigment
(c) Resin
(d) Color
10. Which finish offers the best resistance to salt spray?
(a) Anodize
(b) Baked enamel
(c) 50% fluoropolymer
(d) 70% fluoropolymer

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