



# 04: ALUMINUM FROM ANODIZING TO ZINC

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# DEVIL'S DETAIL

## ALL ABOUT ALUMINUM

Earlier Devil's Details probed into the history and evolution of glass, milestones in the development of metal frames, and various performance and thermal improvements now offered by manufacturers of curtain wall and storefront systems. The time it takes to produce the complex glazing assembly that ultimately shows up at the project site is often misunderstood. To fully appreciate it, let's look at how glazing products are manufactured.

Most commercial architectural glazing products designed and installed today are made up of a combination of extrusions. High quality aluminum extrusions begin with high quality aluminum alloys. Aluminum doesn't start out as an entirely corrosion-resistant metal. Even though aluminum's position on the Galvanic Series (Figure A) indicates a reactive metal, aluminum's corrosion rate is an extremely slow or static state. Aluminum is very active and tends to oxidize quickly to form a white, chalky passivating film. Ironically, very few metals are more reactive than aluminum; however those metals are not typically used in building construction. Beryllium, potassium, sodium, and magnesium are examples. Aluminum's rapid oxidation is not all bad because the aluminum oxide film forms a strong bond to the aluminum surface and seals the aluminum from further oxidization. For this reason, aluminum offers excellent resistance to corrosion and provides years of maintenance-free service in the natural atmosphere. This is the opposite of common steel corrosion, where the oxidized metal – rust – flakes off and exposes more metal to corrosion.

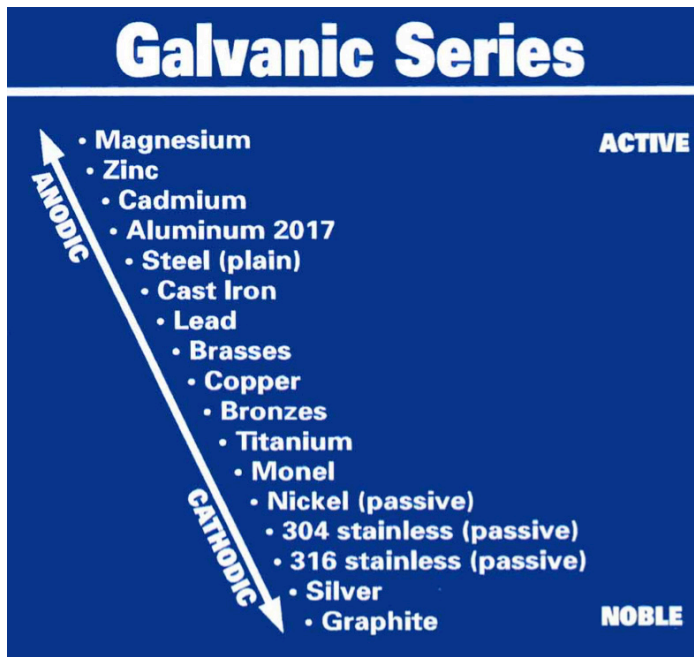


Figure A: The Galvanic series is a useful guide for selecting metals that will come into contact with each other. In general, the farther apart the materials are on the galvanic series, the higher the risk of galvanic corrosion. In other words, the farther one metal is from another, the greater the corrosion will be. The Galvanic series does not provide any information on the rate of galvanic corrosion and should serve as a basic qualitative guide only.



Type 6063 is the most widely used type of aluminum alloy used for extruded shapes. This alloy has a small amount of magnesium and silicon added to the aluminum, which results in easily extruded and highly anti-corrosive metal. The raw aluminum starts out as a billet – a length of metal with a round or square cross-section of a specific area. Aluminum alloy billets are made by a melting process and preheating to around 450°C before they are loaded into the container of the extrusion press. High pressure pushes these billets through a die with a specific cross-section (Figure B).

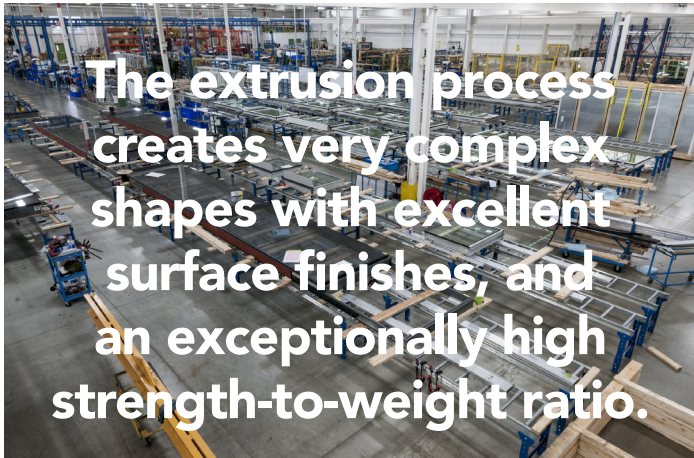


Figure B: Curtainwall glazing production

## FAB FINISHES

A number of methods are available for the surface treatment of architectural aluminum members, including anodizing, coating, or a combination of the two. Each method has its own advantages. Finishes shield materials from harmful environmental factors, help withstand environmental conditions, and complement the unique aesthetic of a building.

Paint is a common surface treatment. In liquid form, paint is comprised of three principal ingredients: resin, pigment, and solvent. Pigment and resin are blended in different proportions; the darker the color, the lower the relative pigment content. The pigment provides color and conceals the primer and substrate. The resin binds the coating to the substrate and provides the weather resistance and durability properties desirable in architectural coatings.

Various resin bases in paint include acrylic, epoxy, polyester, and urethane. Resin gives the finish its mechanical characteristics. Some resins are more flexible than others and will tolerate some conditions better than others. Resin also gives the film its gloss and gloss-retention characteristics as well as its resistance to abrasion,



Figure C:  
Above and right:  
Specular painted  
finishes are applied  
to create depth  
and relief within the  
glazing assembly.



Figure D: Color anodized aluminum

scratching, and dirt accumulation (Figure C). American Architectural Manufacturers Association (AAMA) Standards 2603, 2604, and 2605 govern performance standards for organic coatings.

## ANODIZING

Anodic films are another type of coating applied to protect aluminum alloys (Figure D). AAMA Standard 611 governs anodic finishes. Anodizing is typically used in many general exterior construction applications. It produces an oxide film that becomes an integral part of the metal surface and is excellent in hardness, abrasion, and corrosion resistance. Aluminum, however, is not strong against reactive alkali.

Aluminum members placed in contact with an alkaline substrate must be protected. Portland cement, for example, is alkaline when mixed with water as it has small amounts of sodium and potassium oxides. Some of this is rapidly soluble and due to the high concentration in the liquid portion of the concrete or mortar, it can often be very harmful when in contact with aluminum. The surface oxide film that develops naturally is also not effective in protecting the aluminum in a highly corrosive environment, such as in coastal zones or when in contact with masonry (Figure E).

Pitting is the most common type of corrosion. It occurs only in the presence of an electrolyte (either water or moisture) containing dissolved salts, usually chlorides (Figure E). Additionally, aluminum is often in proximity or contact with steel components that have been coated with zinc to prohibit rusting, such as steel bolts. Over time as the zinc coating wears away, or in the presence of moisture, the steel can aggressively attack the aluminum. The surface oxide film that develops naturally is also not effective in protecting the aluminum in a highly corrosive environment, such as a coastal zone.



Figure E: Corrosion: Top: Masonry salts leaching from the mortar can drip onto the aluminum window frame of the glazing system; Left: CAPTION; Right: CAPTION

## COATING CONCERNS

Since anodic films become very hard post-production, bending of anodized aluminum can cause the film to craze, producing a series of small cracks in the finish. Therefore it is recommended that all forming and bending be done prior to anodizing. Some manufacturers offer a composite film with a matte surface similar to that on a chemically sealed oxide film by employing an electrodeposition coating. This produces an excellent film with a uniform thickness on even a complicated shape. These coatings also have excellent corrosion resistance throughout the entire film. Consequently, it is desirable to have the aluminum member's surface covered by a composite protective film that consists of an oxide formed by anodizing and a corrosion- and chemical-resistant resin top coating on the oxide film.

The composite film is characterized by its hardness, abrasion resistance, and other physical properties that are attributed to the oxide film.



Figure F: Aluminum sun shade examples

## COOLER IN THE SHADE

The fenestration industry has focused on energy savings and building performance since World War II. Architects, owners, and manufacturers are taking the initiative to focus on conserving energy. In addition to the aluminum extrusion finish, aluminum and other materials can be used for shading and cladding devices. These can augment the aesthetic appearance of curtain walls and storefronts and reduce the solar loads on buildings. Shading systems are designed to improve comfort and lower energy consumption by decreasing solar heat gain. These components can be applied to both curtain wall and storefront façades to maintain a consistent appearance across the building envelope (Figure F).

Cladding the glazing system allows a designer to further augment the aesthetic appearance of the building's exterior. Cladding can be applied in many materials based on desired appearance and performance requirements. The glazing system typically becomes the backdrop over which the cladding is applied, and is designed to accept and support the additional structural requirements of the cladding system (Figures H and I).

There are many issues to consider when designing a glazing system that includes shading devices and/or cladding. Often routine maintenance requirements are overlooked due to the glazing units being inaccessible. Similarly, access to individual insulated glass units (IGUs) can be limited or obstructed, making glass replacement difficult. The advice of an experienced glazing contractor can be invaluable early in the design process as they can help to identify and resolve these otherwise unforeseen conditions.

## COMPLEX POSSIBILITIES

Aluminum extrusions offer a host of design possibilities for complex geometries desired by architects. Load-bearing aluminum mullions, for example, offer a very narrow profile and enable the glazing to read with a more uniform appearance. Aluminum extrusions also permit complex shapes not possible with steel.

On the recent 1430 Walnut Street project in Philadelphia (Figure G), AGI glaziers used silicone-glazed aluminum tubes to support intersecting corners of the building's stepped glass-box façade. Eureka Metal & Glass Services, Inc. collaborated with architects Bohlin Cywinski Jackson to achieve the desired appearance.

Figure G: 1430 Walnut Street  
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Figure H: Right and below: Structural members of the glazing system are engineered to support the cladding material.



Figure I: Left and below: The glazing system can be engineered to accommodate different geometries as well as support the cladding material.



## About the Devil's Details

The AGI educational series illustrates and describes common glazing challenges as a means to communicate best practices for the design and construction industry, not as a sole source for design guidance. AGI recommends design professionals consult with an AGI contractor regarding specific project challenges. AGI contractor profiles may be accessed at [www.theagi.org](http://www.theagi.org). To share a devilish detail of your own, contact [info@theagi.org](mailto:info@theagi.org).