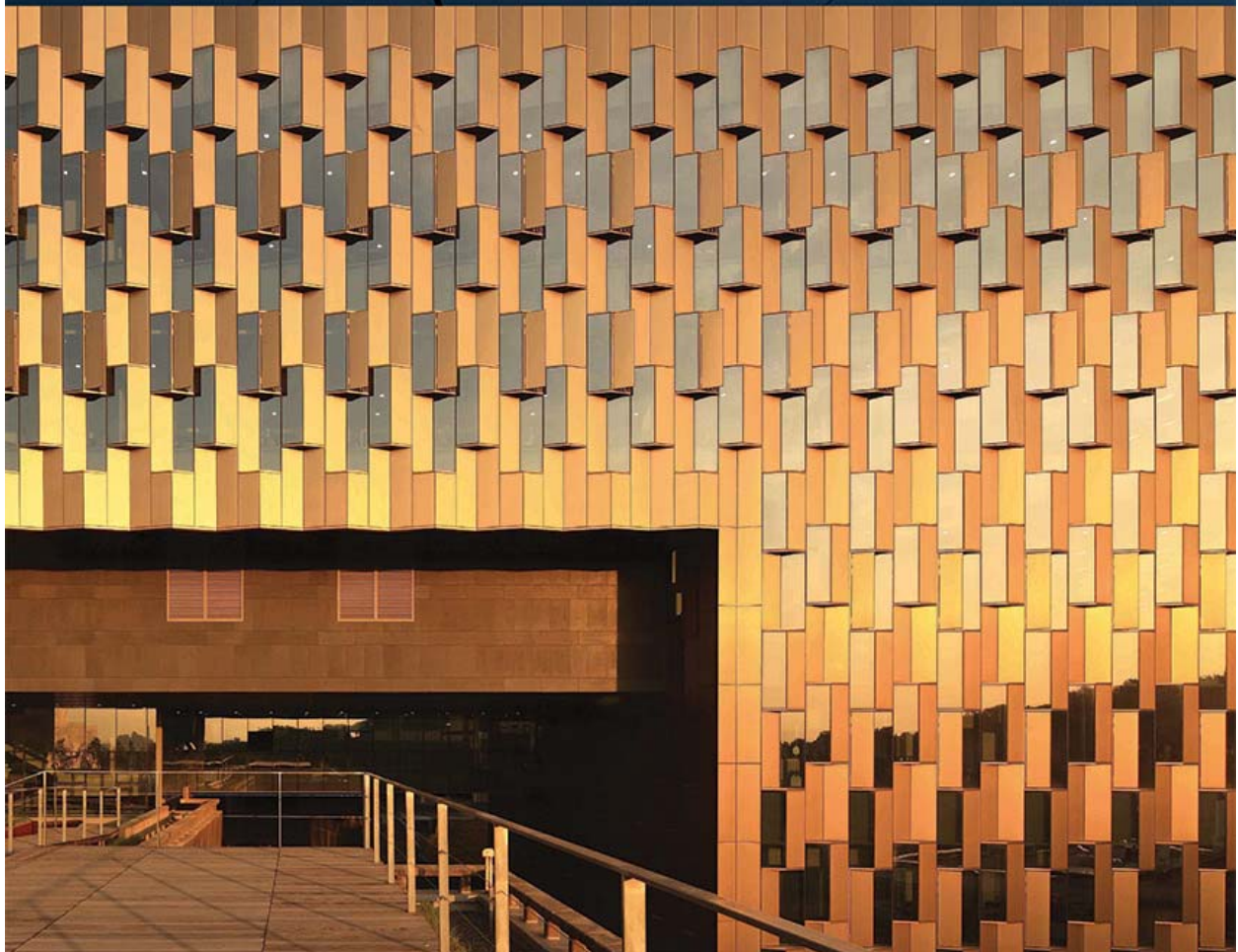


LORIN

# ARCHITECTURE GUIDE TO ANODIZED ALUMINUM

UNLEASH THE POTENTIAL



# Architectural Guide to Anodized Aluminum

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## Architectural Guide to Anodized Aluminum

### *Understanding the challenges*

At Lorin, we understand the challenges you face. You are asked to create beautiful projects, made from high quality materials that deliver a consistent look and finish. These products you use for these projects must be durable; able to be formed into a variety of shapes for different cladding, roofing, ceiling, wall or accent elements; be strong, yet lightweight to help reduce construction costs; and if possible these products should be made from sustainable materials made by sustainable processes.

Don't worry, at Lorin, we have you covered!

### *Section 1A: See It, Dream It, Believe It*

Imagine your most inventive forms. Design your grandest of installations. For whatever signature look you desire, make the potential possible with anodized aluminum. Color match any hue under the sun, expose the natural metallic brilliance or have both in one finish. In addition to aesthetics, the long-lasting performance is the same: three times tougher than the raw material, 60 percent lighter than competing metals and corrosion resistance that lasts.

If you want to capitalize on the desire for products that have a natural metals look, then Lorin can provide a myriad of natural metal looks, without adding the extra weight and hefty price tag that comes along with those metals.

Perhaps the most important attribute of anodized aluminum is its beauty. The anodic layer of aluminum oxide is a translucent crystalline structure that enhances the natural metallic beauty of the aluminum beneath. This three dimensional sapphire crystalline structure reflects and refracts light in unique ways helping the material come alive in a way that paint cannot match.

Paint, as a coating applied to metal, is more one dimensional and flat in appearance. It simply cannot reproduce the natural metallic look of real aluminum. Conversely, paint covers up the natural metal below.

**Paint**

**Anodized**



Painted aluminum is not metallic to the touch, and cannot be distinguished from any other painted material, resulting in a lack of natural metal feel and visual effect.

***1B: Lots of Color and Finish Options That Are Designed to Last***

Lorin has the ability to create custom colors, as well as match almost any color that can be imagined, especially for interior finishes. In addition, these colors can be applied to finishes that are brushed, embossed, bright or matte.

With Lorin's continuous coil process, every square inch or millimeter of the entire coil spends the same amount of time in each part of the process. This allows Lorin to create an unmatched level of consistency, assuring that the colors and finishes look the same throughout all of the coils produced. Lorin carefully controls, measures, and records the color so it can be repeated on subsequent orders.

Lorin offers a wide variety of UV stable colors that can mirror or match natural metal looks, including stainless steel, brass, gold, zinc, pewter, bronze, copper, and muntz. Some of these metal looks are also available in pre-patina or antique versions. Examples of Lorin's long lasting colors:

**Church roof in N. Muskegon, MI after 30 years**



**Stored roof shingle placed on top of existing roof**



While paint can offer many colors, like any organic coating, it will fade because it is simply an applied coating, using pigments or dyes that have limited life in terms of color-fastness due to UV rays breaking down the chemicals within the coating.





The cost of clear anodized, per square foot or meter, is comparable to a high quality PVDF paint. For a true bronze, copper, or zinc look, anodized aluminum may be a little more expensive than paint, but it does not appear flat like paint, and is much more affordable than the natural metals it is replacing.

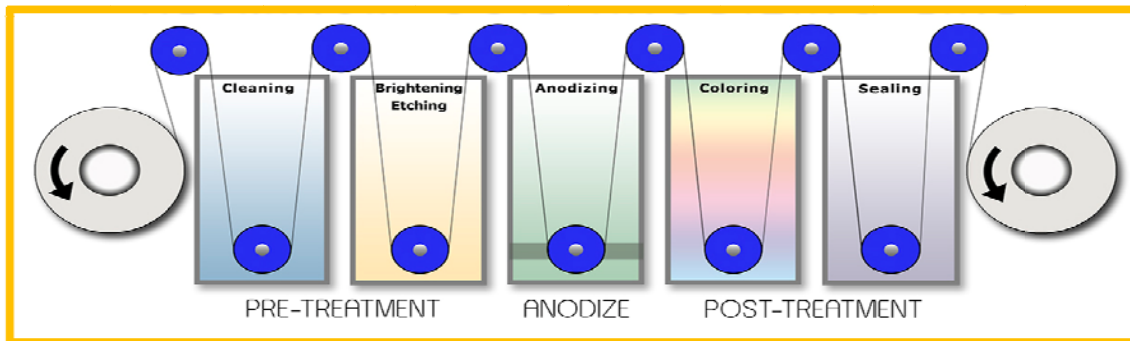
## Section 2: Performance, Durability and Functionality

### 2A: How We Do It

Coil anodizing is an electrochemical process, not an applied coating. The end result is nothing short of scientific magic with nearly limitless design possibilities and coil-loads of efficiencies. To let you in on the secret, here's how it works.

#### THE COIL ANODIZING PROCESS

Coiled raw aluminum is unwound and pulled through a series of tanks, each playing a vital role where we clean, anodize, color, and seal the aluminum before we rewind the coil. Afterwards we can cut and deliver ready-to-fabricate coils all in one stop.



#### Step 1: Cleaning

Raw aluminum is covered in grit and grime. The cleaning tank is exactly that: ensuring all contaminants are washed away so the final surface is flawless.

#### Step 2: Pre-treatment

Depending on the desired finish, the pre-treatment wash could be chemically:

- Etched, removing a thin surface layer creating a matte look.
- Brightened to smooth the surface and heighten its reflectiveness.
- Electropolished as a more eco-friendly alternative for a chrome aesthetic.

### Step 3: Anodizing

Using sulfuric acid electrolyte, an electrical current chemically builds grows an anodic film from the aluminum surface. The new layer is hard and porous—perfect for coloring.

### Step 4: Coloring

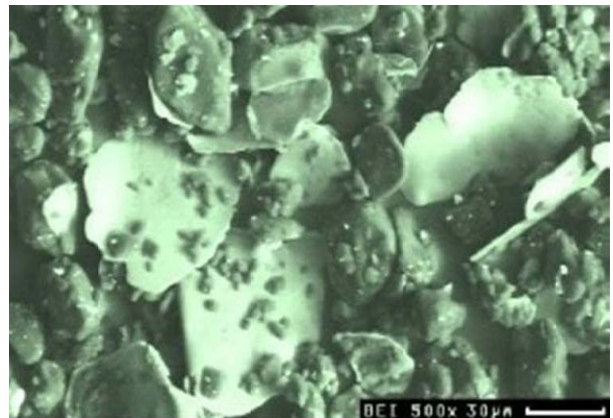
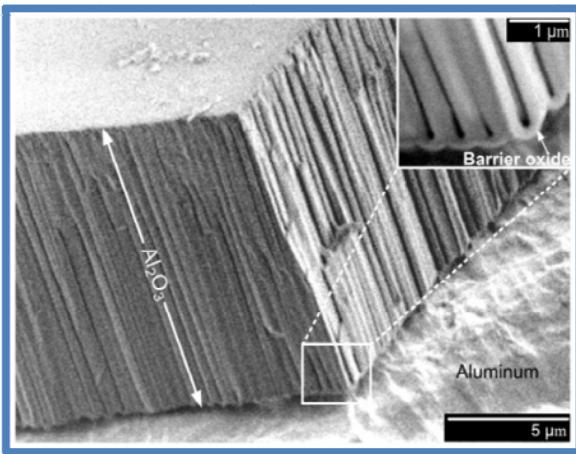
For vibrant colors, but not necessarily UV stable colors, dyestuffs of any hue are absorbed directly into the anodic layer. For a UV stable metallic look, metal salts are electrolytically deposited. Both leave unmatched color intensities you never thought possible.

### Step 5: Sealing

Here we close the pores, lock in the colors, and create a tough, resilient, finished surface.

**Anodic Layer viewed under a microscope**

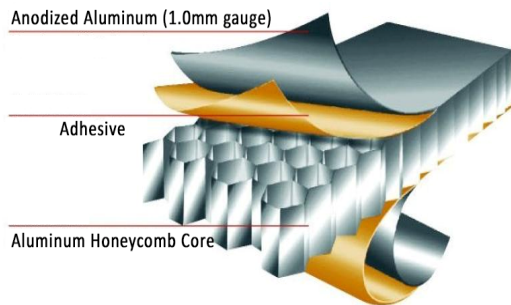
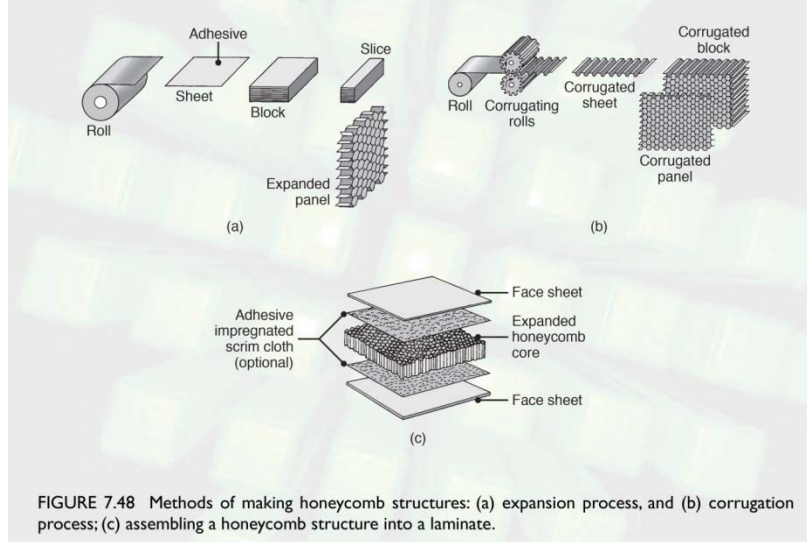
**Paint viewed under a microscope**



### 2B: High Strength-to-Weight Ratio

We understand that in architecture, there is pressure to use lightweight, but strong materials for cladding and roofing that can save money on the supporting structure. Also, it is important for weight reduction for elevators to reduce energy consumption. Aluminum's high strength to weight ratio is no secret. After all, aluminum honeycomb panels have been used for aircraft wings, aircraft and rail car interior walls and floors for decades. Lorin has solutions to improve bonding of aluminum to various substrates, including honeycomb panels. See image below for honeycomb panel construction.

## Honeycomb Structures

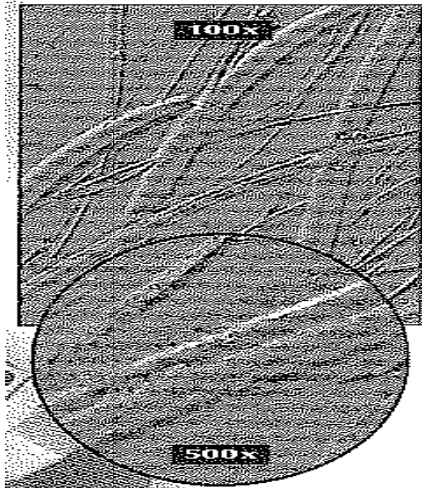


### 2C: Adhesion Enhancing Solutions

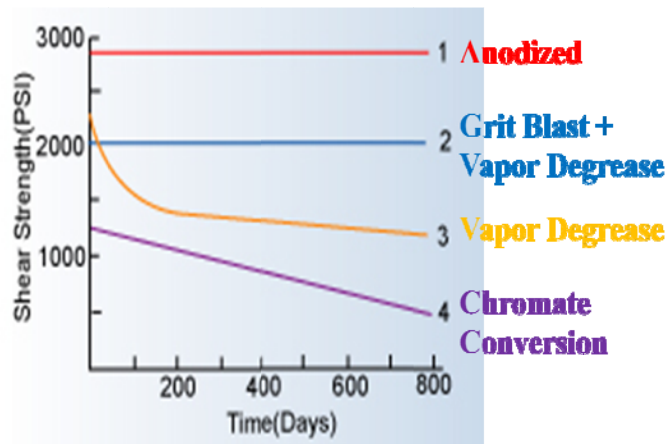
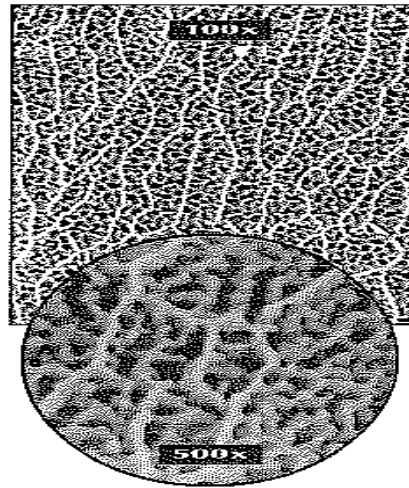
No matter what surface anodized aluminum needs to adhere to, Lorin has a patented solution for that. If you require surfaces that need to be painted, bonded (like for composite or laminated panels), screen printed, powder coated or virtually any other type of coating or bonding with aluminum or anodized aluminum, you need Lorin.

When you need an adhesive promoting surface on both sides, (like for adding a wood veneer to a strong, but lightweight substrate), AnoGrip® ensures no de-lamination. When you want the beauty of anodized aluminum on one side and some laminated component on the other (like with composite panels), Adhere® enables gluing without primer.

Typical “scuffed” surface of painted aluminum taken with electron microscope. Note the minimal ridges and valleys formed by pieces of grit.



AnoGrip on surface of raw aluminum taken with electron microscope. Note extensive number of surfaces to which coatings can attach.



**Aluminum/Epoxy Joint Strength – H2O Immersion**

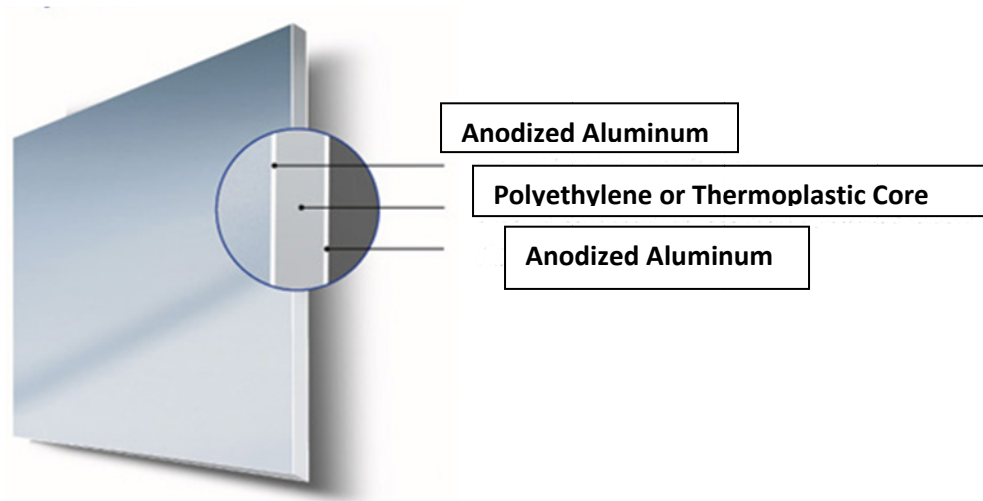
**AnoGrip®** is a special anodizing process applied to functional coil-anodized aluminum leaving both sides of the aluminum sheet with millions of microscopic pores that lock in paints, powder coats, adhesives and more - creating a permanent molecular bond.

**Adhere®** is a Lorin patented post-anodizing process applied to the backside of decorative coil-anodized aluminum that leaves the back of the sheet with an adhesive friendly, open pore, no primer needed structure allowing for quick, solid attachment - perfect for anything like resin soaked papers, MDF board, composite or honeycomb panels, or foam insulated or various sound deadening materials.

**2D: Applications for Adhere® and AnoGrip®:**

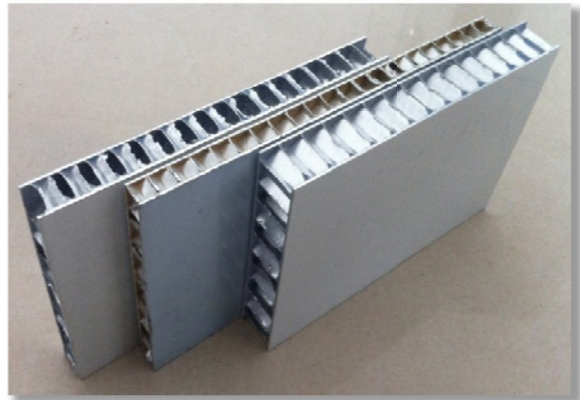
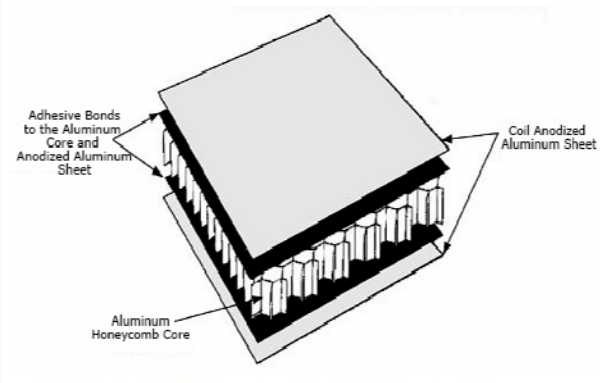


## Aluminum Composite Material Panels

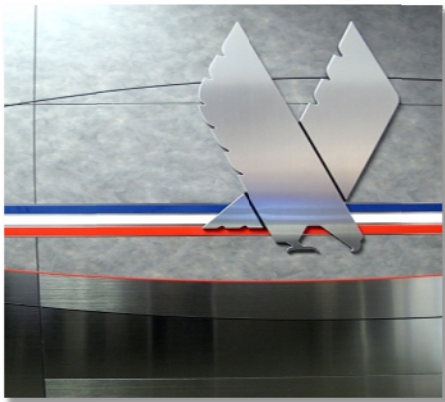


## Honeycomb Panels

Figure 1: Typical composite laminate/honeycomb sandwich structure



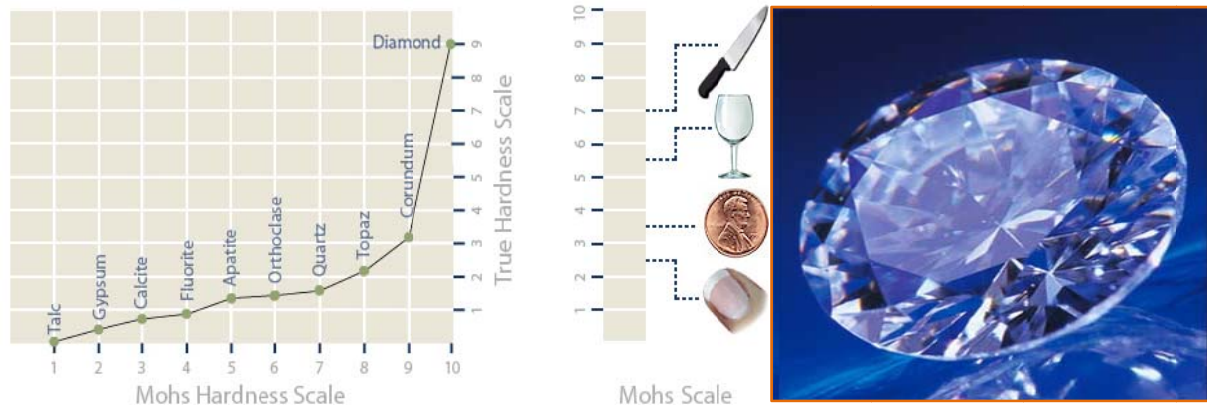
## Laminating



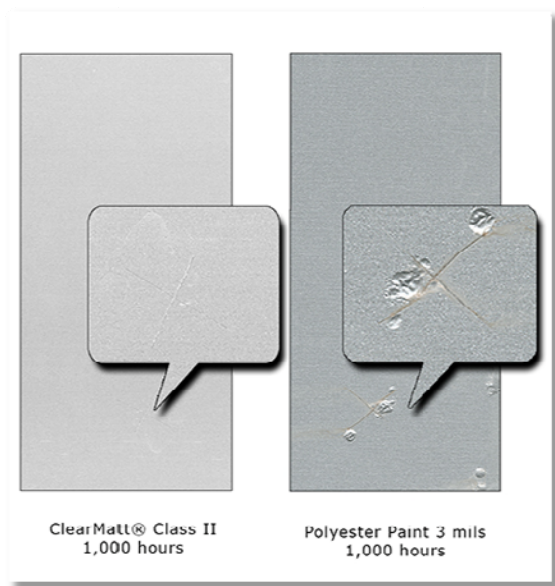


## 2E: Unmatched Abrasion/Corrosion Resistance

Aluminum Oxide is part of the Corundum family of gemstones, like a sapphire, and is second only to diamonds in terms of hardness. The hardness of the anodic layer makes it very abrasion resistant, outperforming paint in Tabor abrasion and pencil hardness tests, which means a more durable product with a better Return on Investment.



The sapphire hardness of aluminum oxide protects and preserves the aluminum surface from corrosion in harsh weather environments, including coastal areas. Salt spray is ph neutral, so it has little impact on the anodic layer, and the anodic layer's hardness helps keep the aluminum beneath from being damaged. This is why anodized aluminum is often used for marine parts.



ASTM B 117 Resistance to Salt Spray Exposure

AAMA 611-12 Architectural Anodized Standards

Because paint is a coating that is either rolled or sprayed onto the base aluminum, it relies on the surface tension it creates with the metal, or a primer, for adhesion. This surface tension can break down over time, causing the paint to lose adhesion, leading to chalking, chipping, flaking and peeling. This loss of adhesion can creep over time, causing more and more of the surface area to lose its paint.



***Anodized will not chip, flake, peel or rust.***

If the anodic layer is breached all the way to the raw aluminum underneath, the aluminum will self-heal by creating its own protective oxide layer, ensuring that the damage will not creep beyond the initial damage point. This mitigates the need for costly repairs.

## ***2F: Compared to other metals***

Unlike copper, zinc, steel or brass, anodized aluminum will not patina, rust or succumb to the elements.

Lorin Antique Copper ColorIn – UV Stable

Natural Copper patinas over time



## ***2G: Easy to Maintain***

The anodic layer is easy and safe to clean without special chemicals, which results in low maintenance costs. Paint can easily be scratched or chipped. Damage to the painted surface can lead to corrosion under the paint, causing the damage to “creep” over time. This results in painted metal having higher maintenance costs than anodized aluminum. Other metals patina (corrode/oxidize) over time the oxidation elements run down and cling to other building materials that require additional maintenance time and money.



### ***Section 3A: Formability***

Any material that is bent or stretched will have micro-fractures along the bend, also known as crazing, because nothing is infinitely flexible, including paint. Crazing occurs because the outer side of the bend is stretched more than the inner side, and appears as a frosted effect. (See our white paper on Forming and Crazing and additional detail in the following section). While a bent anodized surface may exhibit visible crazing, it is often naturally obscured because of the way light reflects off a bend to create a brighter, frosted type effect. In the hands of a skilled former, bent anodized parts can be made to look great whether roll-formed, formed in a break press, aluminum composite panels, honeycomb panels, stamped, or perforated.



**Roll Forming Operation**



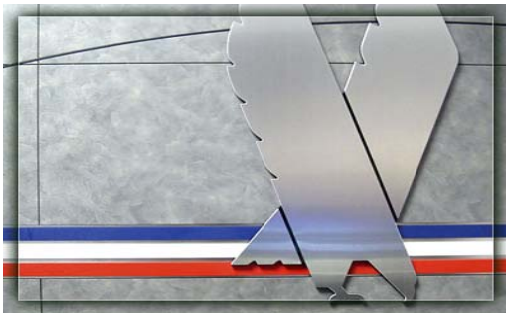
**Stamping**



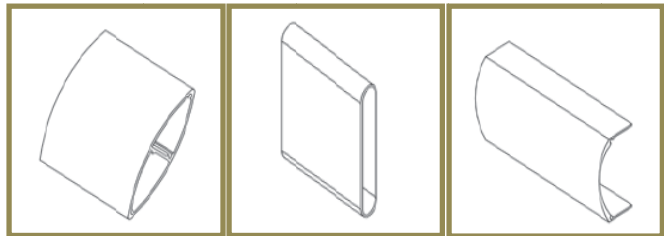
***Laminating***



***Perforating***



### ***Brake Press Machine and example shapes***



### ***3B: Forming Considerations with Various Panel Types***

#### ***3MM Solid Panels***

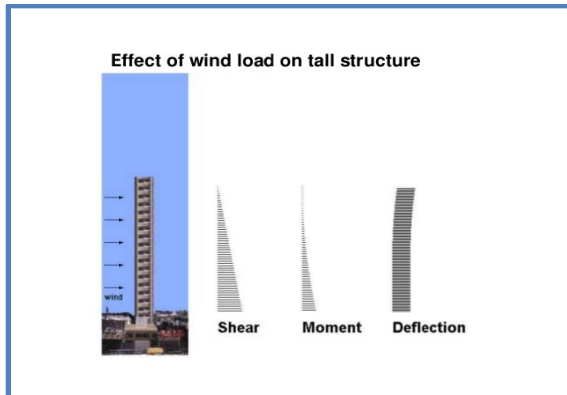
#### ***Perceived Advantages:***

Industry Standards (such as in the Peoples Republic of China) specify a 3mm gauge minimum 'solid' panel construction for high-rise structures. They have also approved 2.5 MM officially, but unofficially have approved and paid for multiple buildings with alternative panel thicknesses and designs.



3mm Solid Panels are usually attached to the building with stud fasteners. Advantage - The backside panel fasteners used for 3mm gauge solid panels are typically Spot Welded and WILL NOT show through to the top good-side of the sheet.

Advantage: The 3mm solid panel is *usually* sufficient enough to withstand high rise building wind load requirements.



Disadvantage: The flatness is very difficult to control on larger panel sizes going through cut-to-length lines or coil flatteners and without any additional forming or bending to increase rigidity.

Disadvantage: The rigidity of a 3mm solid panel is often still not enough for high rise structures (depending upon specific building codes) and will usually require a stiffener on the backside of the sheet adding more cost and weight.

**Below: 3mm Solid Panels produced without any bending to improve rigidity have warped**



A stiffener is still no guarantee that the panel will remain flat due to differences in thermal coefficients of expansion between the stiffener metal and the panel.





Other Disadvantages using a Stiffener:

- Adding stiffeners will not only increase the fabrication and processing costs, but will increase the panel weight.
- The extra weight may cause a bowing effect on horizontally attached panels if not fastened adequately.
- The fabricator will have a more complex and expensive fastening system to deal with. When using 3mm solid panels on High-Rise Buildings over 600 feet, the fabricator will require a full width stiffener to make the panel strong enough, resulting in even higher costs.
- The fabricator or installer will have more processing time waiting for the stiffener glue to dry – approximately 72 hours – delaying project completion

***Bending a 3mm Panel for Rigidity on High-Rise Buildings:***

Bending can be done successfully, if the fabricator cuts a slot at the inside-diameter at the bending point on a 90° bend. In theory, cutting a 3mm solid aluminum sheet with a cutting depth of 1.5mm (50% of gauge), the fabricator should not have a bending problem.



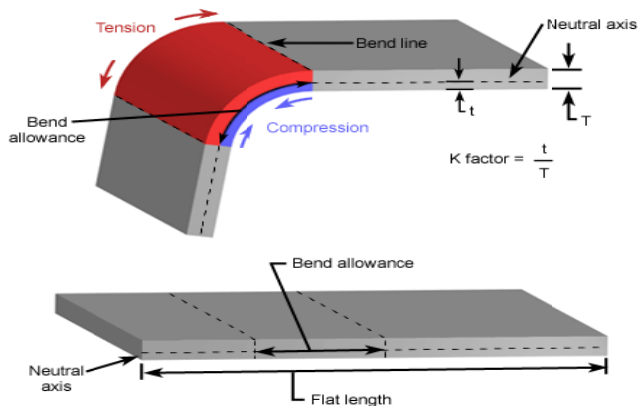
**HOWEVER – ONE SHOULD USE CAUTION - When bending a 3mm Panel using a cut slot at the inside diameter of the bend:**

- The remaining 1.5mm aluminum has been weakened.
- The rigidity of the panel design has also been compromised at the bend.
- The bending edge is more subject to cracking and should only be used for low level buildings or vertical interior decoration.
- The risk is very high when using this method on high-rise buildings and horizontal decorations based on those weakened bent edges for support.



### **Bending a 3mm Panel – Without a cut slot – Is more likely to crack at the bend:**

**Disadvantage:** When forming a flat sheet into a 90° bend, the outside diameter of the sheet is longer (stretches or expands) than the inside diameter (compresses or shrinks) of the sheet. In other words, the length of the outside diameter will always be longer than the length of the inside diameter and more subject to cracking of the aluminum during the bending operation unless the fabricator applies an adequate radius.



## Bending Mechanics

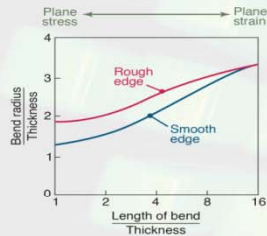


FIGURE 7.16 The effect of length of bend and edge condition on the ratio of bend radius to thickness for 7075-T aluminum sheet. Source: After G. Sachs and G. Espey.

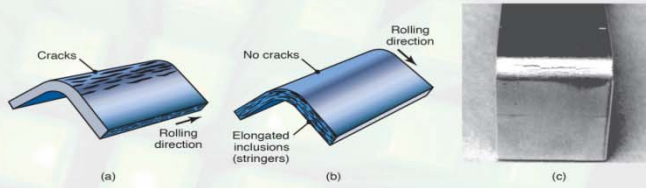


FIGURE 7.17 (a) and (b) The effect of elongated inclusions (stringers) on cracking in sheets as a function of the direction of bending with respect to the original rolling direction. This example shows the importance of orienting parts cut from sheet to maximize bendability. (c) Cracks on the outer radius of an aluminum strip bent to an angle of  $90^\circ$ ; compare this part with that shown in (a).



Manufacturing Processes for Engineering Materials, 5th ed.  
Kalpakjian • Schmid  
© 2008, Pearson Education  
ISBN No. 0-13-227271-7

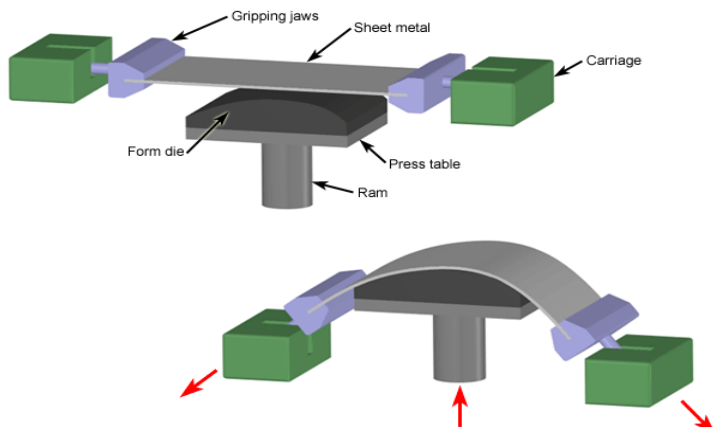
## Double Curve Designs

Using a 3mm solid aluminum panel to create a double curve design is a very difficult and complex process unless you put in a lot of thought and preparation. In order to do it correctly the fabricator must consider several fabrication methods.

Using a machine press to mold the metal into the double-curve is the best option for a consistent panel. However, this fabrication method is only suitable for a fixed panel design.

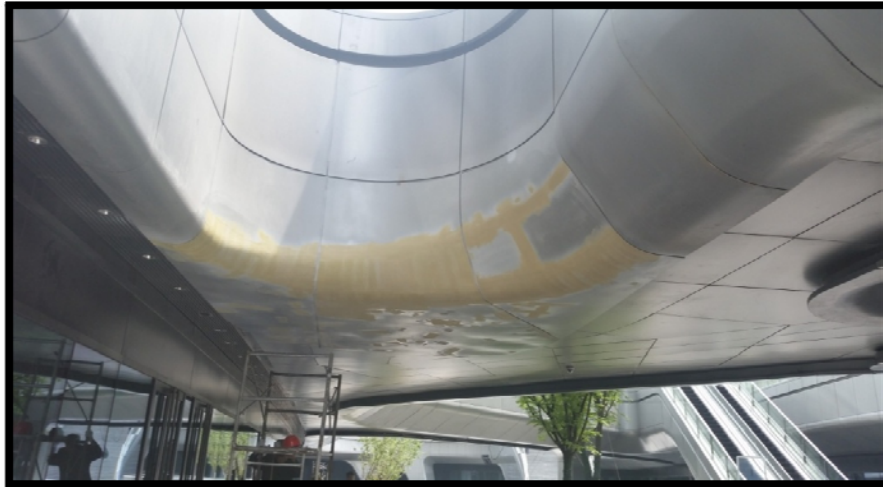
**Disadvantage:** If the design requires multiple molds, the cost can be astronomical.

### Stretch Forming or Press Mold



Copyright © 2009 CustomPartNet

Even with post painted panels formed to fit, the paint has peeled off because of the stress of the double curve design. They actually used an automotive bonding material to repair part of the SOHO Galaxy building in Beijing.



### ***Honeycomb Panel Forming Considerations***

An alternative to using a 3mm Solid Panel Design is the use of a 20mm (0.75") Aluminum Honeycomb Composite Panel. Honeycomb Panel composites are used widely in many industries, such as aerospace, architectural, transportation, furniture, packaging and logistics. The strength of laminated or sandwich panels depends on the size of the panel, facing material used and the number or density of the honeycomb cells within it.




	Solid Material	Core Thickness $t$	Core Thickness $3t$
			
Stiffness	1.0	7.0	37.0
Flexural Strength	1.0	3.5	9.2
Weight	1.0	1.03	1.06

Figure 2 shows the relative stiffness and weight of sandwich panels compared to solid panels



**Advantages:** According to K.Kantha Rao, K. Jayathirtha Rao, A.G.Sarwade, M.Sarath Chandra / International Journal of Engineering Research and Applications (IJERA) ISSN: 2248-9622 [www.ijera.com](http://www.ijera.com) Vol. 2, Issue 3, May-Jun 2012, pp. 365-374 365 - Strength Analysis on Honeycomb Sandwich Panels of different Materials, the use of Honeycomb Sandwich Panels in construction typically eliminates the need for welding. The conventional single skin or 3mm Solid Aluminum Panel structure, which is reinforced with main frames and stiffeners, normally necessitates a lot of welding, and has a considerable length of weld seams.

Further, the lighter but thinner plates (less than 3mm gauge) employed tend to increase weld distortions that may in some cases require more fabrication work to rectify. More weld seams also mean a greater number of fatigue initiation locations as well. More welds also increase the cost of fabrication.

Honeycomb sandwich construction, with a honeycomb core is better able to cope with such challenges.

Advantages: When bending a Honeycomb panel there is no need to cut a slot on the underside of the top-sheet. The mechanical performance of the top sheet (1.0mm gauge) is fully completed at the bend and the panel does not crack.



Advantages of an Aluminum Honeycomb Composite Panel – according to an aerospace engineer for Lear Jets - having been crushed - will increase in strength. The gauge of the cell has a direct impact on how much strength can be realized.

Another advantage is that a honeycomb panel can be formed into a double-curve significantly easier, at a lower cost, with better overall quality than a Solid 3mm Aluminum sheet.

- The fabricator can use a non-metal mold at a reasonable cost.
- There is no need for a high cost machine press or punch equipment.
- The finished panel provides excellent rigidity.
- Achieve multiple-curve designs at a reasonable cost as compared to a 3mm Solid Panel.
- Will not damage the anodized aluminum top face plate.



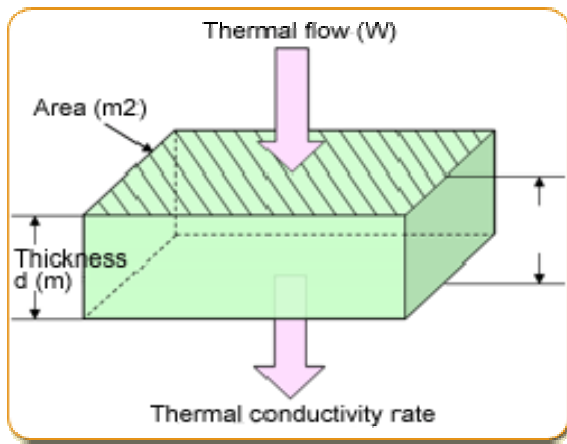


An additional advantage is that the top-side face sheet of an Aluminum Honeycomb Composite Panel (1.0mm) will not show as much visible crazing like a 3mm Solid Panel. Increasing the gauge of the aluminum will require the fabricator to increase the bend radii which will inevitably show more crazing.

Honeycomb Aluminum Panels have excellent Thermal insulating properties. The core has a certain level of vacuum as a result of the fabrication process. This reduces the heat transfer caused by air currents.

- Thermal Conductivity:
  - 20mm Honeycomb Panel is  $1.7 \text{ W}/(\text{M}\cdot\text{K})^{-1}$
  - 3mm Solid Aluminum Panel is 155 to  $222 \text{ W}/(\text{M}\cdot\text{K})^{-1}$

Unit:  $\text{W}/\text{m} \cdot \text{K}$  (Watts per meter Kelvin)



A Honeycomb Aluminum Panel has better sound absorptive properties. A Honeycomb Panel can reduce sound by 20 to 30 dB (100-3200 Hz) which is significantly better than Solid Aluminum. Sound travels much better through solid materials.

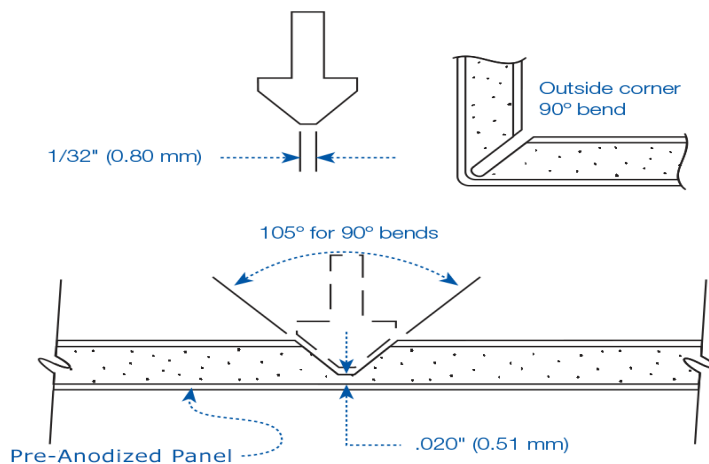
Comparative Analysis Chart showing differences between a 20mm Honeycomb Aluminum Panel and 3mm Solid Aluminum Panel. The Honeycomb panel has a 1.0mm top face aluminum sheet and a 0.8mm backside face aluminum sheet. It is recommended that a 1.0mm gauge aluminum is used for the backside face plate.

Product Attribute	Honeycomb Panel	3.0mm Solid Panel	Comments
N-mm Rigidity Coefficient	$1.23 \times 10^7$	$1.7 \times 10^5$	Honeycomb panel is 72.3 times stronger than the Solid panel
$\text{N}/\text{mm}^2$ Bending Coefficient	14.7	1.5	Honeycomb panel nearly 10 times greater than the Solid Panel
$\text{kg}/\text{m}^2$ Area Density	6.2	8.2	Honeycomb panel is $2 \text{ kg}/\text{m}^2$ lighter than the Solid panel

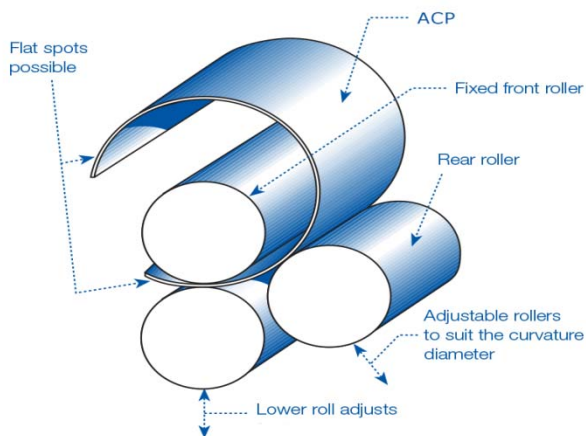
## Aluminum Composite Panel (ACP) / Aluminum Composite Material (ACM) Panel

ACPs are a high performance wall cladding product consisting of two sheets of 0.5mm (0.020") aluminum, each permanently bonded to an extruded thermoplastic core. An ACP is highly formable, and flat, with an excellent strength-to-weight ratio. The ACM/MCM panel manufacturers typically offer a polyethylene (PE) core or a Fire Resistant (FR) or A2 core.

Sawing and Routing Pre-Anodized ACPs are relatively easy processes that can be done with ordinary commercial metal and woodworking equipment. Manufacturers of ACPs recommend at least an 8" diameter, extra fine, carbon-tipped, 60 tooth blade for a Straight Line cut to make the correct groove for bending. The heat from sawing will not affect the aluminum oxide layer.



ACPs can be brake-press formed from 0° (flat) to 90° (right angle). To avoid damaging the pre-anodized aluminum surface, it is recommended that the center part of the die be filled with 60 durometer rubber up to the edges of the die. ACPs can also be roll-formed to curved configurations for column covers, architectural bull-noses, radius-building corners and other applications requiring radius forming.



### **General advantages for ACM panels:**

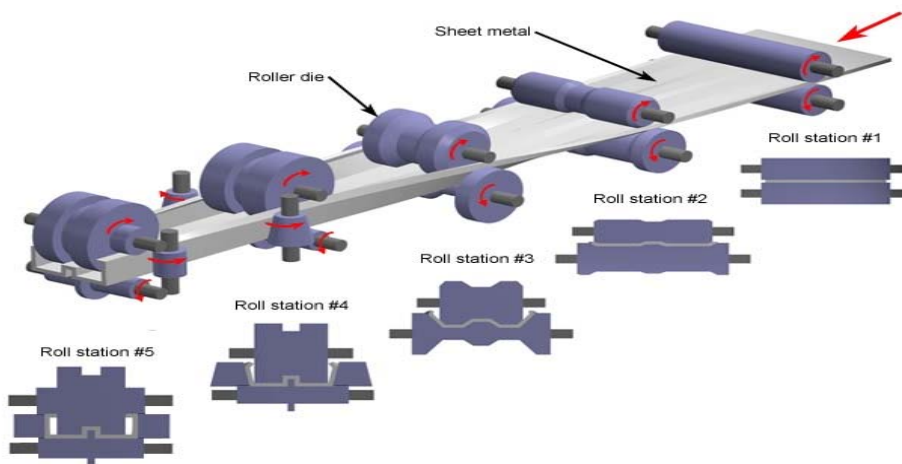
- Exceptional Flatness for creating smooth, monolithic surfaces
- Virtually eliminates oil-canning
- Exceptional Load-bearing capacity Flexural Strength (a material's ability to resist deformation under load).
- Easy to fabricate and install
- Lighter than Solid Panel designs (6mm thick ACP PE core weighs 1.5 lbs/ft<sup>2</sup> , 3mm solid panel weighs 1.7 lbs/ft<sup>2</sup>)
- Pre-Anodized ACPs having been sheeted and permanently bonded to the PE or FR core will not craze to the same extent as a continuous coil ACP process.

### **Disadvantages of ACM Panels**

- Pre-Anodized ACP produced with some continuous coil processors may craze significantly - at least so far - a combination of thermal and mechanical crazing, but there are many successful suppliers
- ACPs without stiffeners or edge forming designs, need to be handled very carefully. Longer sheets will sag at the center.
- When Line cutting or Routing, FR core ACPs may produce fine airborne particles that pose a health hazard.

### **Roll Formed Panels**

A Roll-Forming operation is a continuous bending of a long strip of coiled aluminum sheet into a desired cross-section or profile.



Roll forming of aluminum is not as difficult as forming steel, but more attention has to be paid to setting and adjusting roll gaps, and applying the right type of lubricant to prevent pickup of aluminum on the rolls. Using well-designed and polished rolls along with a good lubricant will make the roll-formers job a lot easier. To specify the material simply as aluminum is one of the most common mistakes made by

designers who are unfamiliar with metals. There are many different aluminum alloys, as with steels, with vastly different forming properties.

Roll Forming Product Dimensional Tolerances and Anodized Surface Finishes are affected by many factors:

- Variations in the aluminum gauge and width.
- Variations in the physical properties of the aluminum.
- The quality of the tooling.
- The type of lubricant.
- The roll forming machine condition.
- The skill of the operator.

Resource: SME, Fundamental Manufacturing Processes Study Guide



### ***3C: Product Applications***

**INTERIOR APPLICATIONS:** Entry wall panels, entertainment centers, kitchen back-splashes, easy swing restaurant doors, and computer room flooring systems are just the beginning when it comes to interior architectural applications. There are many ways you can give your interior project the beauty and performance characteristics of anodized aluminum.

**EXTERIOR APPLICATIONS:** Column covers, fascias, store fronts, soffits, perforated parking garage screens, and hurricane screens are just the beginning when it comes to interior architectural applications. Here are many other ways you can give your exterior project the beauty and performance characteristics of anodized aluminum.

## Application Images

### Stamped Ceiling Panels



### Stamped Gold Nuggets



### Chemical Etching- Elevator Doors



### Elevator Cab Interiors



### Swing Doors



## Perforated Panels

### Univ. of Louisville Soccer Stadium (Perforated)



### Perforated Garage Screens – Multiple Colors - Austin





**Perforated Sun Shade Exterior Cladding – Austin Central Library Lorin Dark Antique Copper Color**



***Ceilings and Column Covers***



***Perforated Ceilings***



## ***Aluminum Composite Material Panels***

***ACM Panels: Lear Jet Headquarters – Kansas City Lorin ClearMatt***



**Hyundai New Global Dealer Standards – ACM panels with Lorin Medium Bronze ColorIn**



**Lotte Mall, Seoul, South Korea - ACM panels with multiple Lorin ColorIn colors**

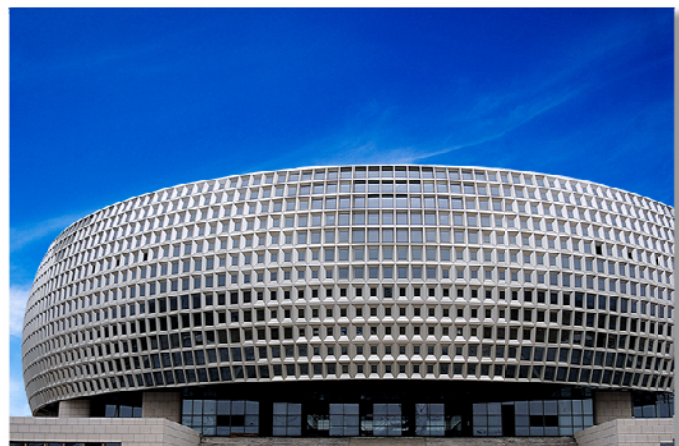


## ***Honeycomb Panels***

***Nanjing Youth Olympic Towers (Honeycomb)***



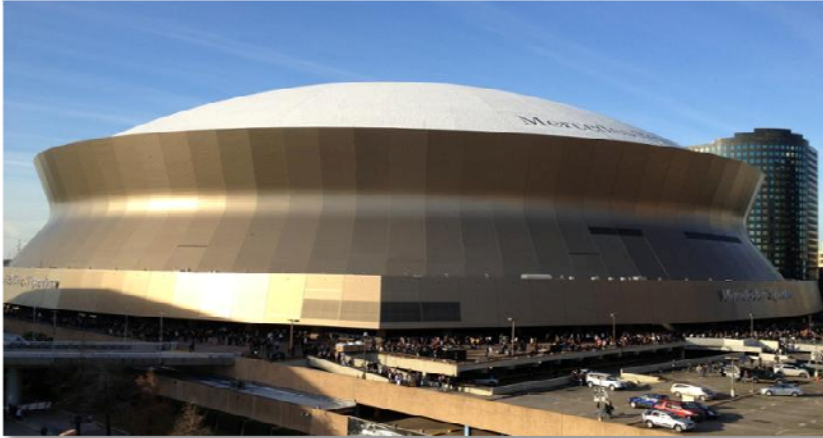
***Puyang Library (Honeycomb)***





## ***Roll Formed Panels:***

***MERCEDES-BENZ SUPERDOME - New Orleans, LA 400,000 ft<sup>2</sup> Custom Light Bronze, Stucco Embossed***



***Roll Formed Corrugated Panels – Shake Shack multiple locations, multiple Lorin Colors***



***UT Dell Medical Center: Roll Formed Shingle Style panels, Lorin AnoZinc® with Arconic Tectur-Al™***



## ***Break Press Formed Panels***

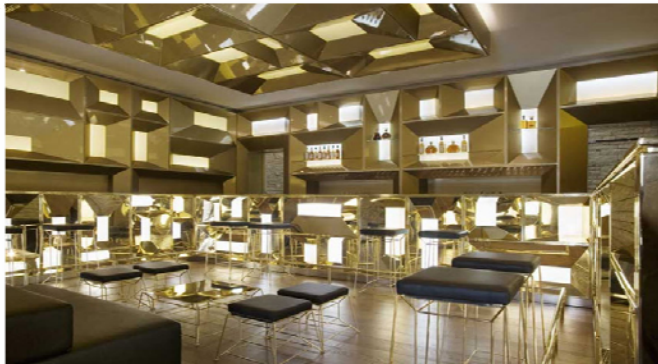
***Winspear Opera House Sun Shading – Dallas***



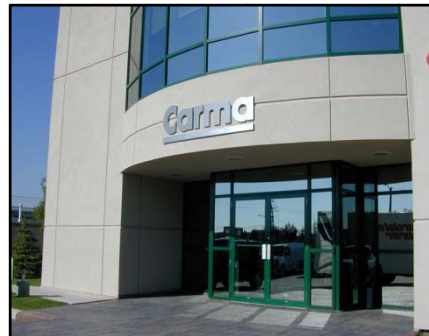
***Sewanee University Dining Hall***



## ***Interior Decorative Elements***



## ***Commercial and Business Park Signage***





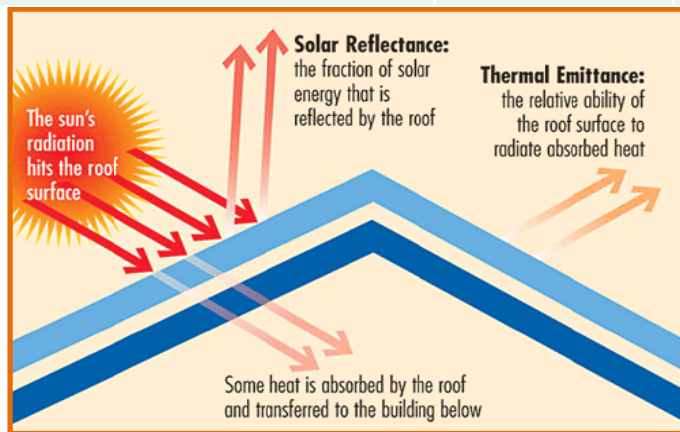
## Section 4: Sustainability

Anodized aluminum remains pure aluminum, with nothing that can create VOCs or off-gassing. There are no red list items in anodized aluminum, and it meets ROHS standards.

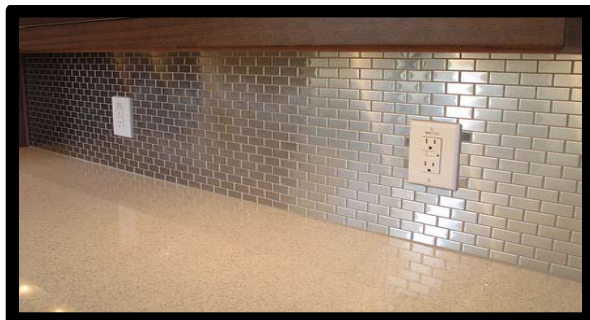
### Cool Roofs:

Clear Anodized Aluminum has a higher Solar Reflective Index [SRI] for Cool Roof Designs than white PVDF paints helping to reduce the heat load of the building, reducing building energy consumption, reducing pollution and heat island effects, and contributing to LEED Points.

Product	Anodic Layer	Solar Reflectance Index [SRI]
ClearMatt ® Architectural Class II	11 µm [0.450 mils]	92
PVDF Paints (PolyVinylidene Fluoride)	Silver Metallic	67



Although it may not be directly important, a further sign of the safety of anodized aluminum is that clear anodized aluminum is approved for direct food contact by the National Sanitary Foundation (NSF 51), and all colored anodized aluminum is approved for splash zone food areas. Additionally, aluminum oxide is often used in products such as baking soda and antiperspirant. What this means to you is an added level of assurance about the safety of anodized aluminum for use in products you design and engineer.

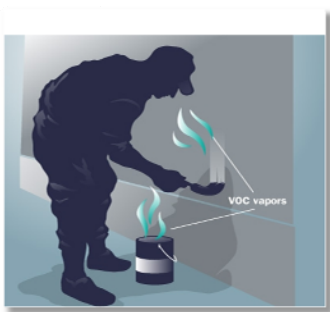




The anodizing process is environmentally friendly, creating no hazardous waste. The process uses high and low pH chemicals that combine to create an environmentally neutral by-product. Lorin actually extracts and recycles most of the chemicals used in its process. Lorin's waste water treatment facility returns water to the city, with no additional treatment required. Additionally, Lorin has its own clean energy natural gas powered co-generation power plant to be more environmentally responsible, and to lessen the city's power burden during peak demand hours.

Aluminum, even when anodized, is one of the only metals that is 100% recyclable, and can be repeatedly recycled through simple re-melting.

Paint contains chemicals that include VOC's, which are dangerous to humans, animals, and the environment. Additionally, painted aluminum requires further processing before it can be recycled. Chrome is a known carcinogen and is an environmental disaster to produce. Stainless steel uses chromium as part of its formulation and neither can be completely recycled.



### ***Section 5: Summary***

With functional benefits of a high strength-to-weight ratio and superior durability, and the aesthetic benefits of a beautiful natural metal look in a variety of colors, anodized aluminum is uniquely suited to bring innovative architectural designs to life.

If you want a material that is very durable, offers a natural metal look, is available in many colors and finishes, is environmentally responsible, can be formed into many shapes or parts, offers a great ROI, and is truly beautiful in unique ways that paint and other coatings cannot match, then Lorin's anodized aluminum is a product that you need to try. We would love to help you reflect your vision, and your signature result, with ease.