Some of the world’s most distinguished buildings—from the Smithsonian’s new National Museum of African American History and Culture, to Dubai International Airport in the United Arab Emirates—share one common feature: a coated metal exterior. These exteriors can be vibrant, richly toned, shimmering, elegantly muted, or even have a color-shifting appearance that changes with the lighting. Metal coatings not only provide weathering performance for the building’s exterior, but also allow nearly unlimited aesthetic options. From classic colors to innovative new special effects, metal coatings are extremely versatile and can even replicate the look of other building materials such as wood or marble. Coating selection criteria ranges from aesthetic options to performance specifications. While there is a wide range of metal coating options, for most architectural projects the selection is between 70 percent PVDF liquid coatings or polyester powder coatings.

Liquid coatings are the standard technology for aluminum extrusions in North America. More than 90 percent of the time aluminum extrusions for monumental buildings are coated with liquid coatings. For more than 50 years, 70 percent polyvinylidene fluoride (PVDF) resin-based liquid coatings have enhanced the appearance and performance of exterior metal building products on North America’s buildings. Polyester powder coatings are the popular finish choice in Europe for aluminum extrusions and have been evolving over the past 40 years. The drivers for this choice include cost and environmental consciousness. The markets in Asia and the Middle East are divided between liquid coatings and powder coatings.

This course compares many factors when considering PVDF liquid and polyester powder architectural coatings for exterior buildings.
CONTINUING EDUCATION

metal building products. These include: suitable uses, composition and application, color choices and appearance, performance specifications, sustainability, maintenance and warranty.

SUITABLE USES

Architectural coatings are specified and applied to exterior metal building products to convey an intended appearance and to provide durable performance. Examples include:

- Curtainwall systems
- Aluminum window and door framing
- Roofing, soffits, gutters, and fascia
- Metal wall panels and façade cladding
- Sunshades, louvers and grills

COATING TYPES AND METHODS

Coil Process and Coatings: Liquid Coatings for Aluminum or Steel

Coil-coated, architectural building products start out as coils of metal. Substrates may include pre-treated, hot-dip galvanized steel (HDG), steel sheet coated with aluminum-zinc alloy (Galvalume®) and pre-treated aluminum. In a continuous process, the coil is unwound, cleaned, treated, primed and painted before being rewound on the other end and packaged for shipment. After arriving at the fabricator, the coils are unrolled into flat, pre-painted, metal sheets and are formed into shapes, such as roof panels, wall panels and gutters. In general, liquid coatings are more flexible and allow for post forming while powder coatings are more appropriate for pre-formed metal building products.

Extrusion Process and Coatings: Liquid or Powder Coatings for Extruded Aluminum

The aluminum extrusion process forms the metal products by pushing a heated billet of aluminum through a die before a finish is applied. The shape of the die determines the shape of the extrusion. Fenestration products are among the most common examples of extruded aluminum, such as framing for windows, curtainwall, storefront and entrance systems.

Liquid Spray-Applied Extrusion Coatings

Liquid coatings are spray-applied in a factory-controlled environment to aluminum extrusions or preformed metal panels to be used on buildings ranging from monumental

CASE STUDY:
THE NATIONAL MUSEUM OF AFRICAN AMERICAN HISTORY AND CULTURE

Bronze colored panels cover the tiered exterior of the building. perforated in patterns that reference the history of African American craftsmanship. Photo credit: Alan Karchmer

With its nearly 400,000 square feet of space on 10 levels, and its 33,000 pieces of artwork and historical objects inside, the newly opened the National Museum of African American History and Culture has received a surprising amount of attention for what’s on the outside.

Situated on the last open site on the National Mall, the museum’s three-tiered envelope is covered in 3,600 filigreed cast-aluminum panels. A corona reminiscent of an African crown is colored bronze with an advanced PVDF liquid coating that has won praise from critics.

“In full shadow it’s a workmanlike brown, the color of shoe leather,” wrote Christopher Hawthorne, the Los Angeles Times architecture critic. “In direct sunlight the shade is closer to bronze. Late in the day its western edge, turned toward the Washington Monument and the Lincoln Memorial, begins to reflect the setting sun and turns a surprisingly bright gold.”

To ensure the success of this prominent project, many partners were called together to work collaboratively during the design and construction phases; each brought a different expertise to the project. Three American architecture firms, The Freelon Group, architect of record and design team leader (and now part of global design firm Perkins+Will), Davis Brody Bond, with extensive experience in museum projects, and the local D.C.-based firm SmithGroup, joined forces. David Adjaye, lead designer of London-based Adjaye Associates, was the last to join and brought an international design element to the project. Together, they formed a group named “Freelon Adjaye Bond/SmithGroup” (FABS) and worked cohesively to create a world-renowned museum that would accurately tell the story of the African American experience.

The building design features three distinct elements: the shape and form of the corona (the three-tiered filigree envelope that wraps around the structure), the porch extension that merges the building into the surrounding landscape, and the bronze color of the corona that provides a distinctive look and strong presence on the National Mall.

The bronze wash of the metal panels was a monumental component of the design. Lead project manager Zena Howard AIA, of Perkins+Will, explained that the color choice was discussed over the course of many years with all parties involved in the design process. Ultimately, bronze was selected as the team determined it would remain “an enduring and permanent color that would command respect for the building and the exhibits housed inside.”

Once the final color idea was identified, the new challenge of obtaining the perfect hue began. Three custom shades and one standard shade of black coating were used on the massive aluminum panels, each weighing around 200 pounds and stretching 4 by 5 feet.

Each 4-by-5 foot panel, weighing 200 pounds, was custom cast and finished with five different coating layers. Layering these five different colors was the method used to achieve the exact bronze shade desired by the design team. Eventually, the final color was created and earned the name of “Artisan 3.5.” The individual coatings needed to hold their color across every layer on the panels, as each new additional color is built off of the last to create the final shade. The 70 percent PVDF resin-based liquid coatings was the best product for this complicated job due to its durability and color retention, which will help showcase the vivid color for many years.

Extensive testing was done during the coating application process due to the size of the panels, and because of the intricate design already cut into each piece. The coating was applied entirely by hand, and each color layer was carefully inspected to make sure every part of the coating process was on track.

The coatings team worked to finish the panels in an identical fashion and ship them from the workstation in Portland to the project site in Washington D.C. After a bit of back and forth, the panels and their many layers of custom colors were approved and were deemed ready for installation. “What we ended up with gave us the look of real bronze, a luminous feeling that created a dynamic and beautiful façade,” said Howard.

The filigree is an eye-catching adornment that both draws visitors in and sets the stage for the rest of the journey throughout the museum. It combines polish, artistry, creativity and persistence, just like the art, history and culture memorialized within the building.

The museum itself is a work of art, one that stands out among the historic structures to its left and right, and will act as a physical representation of the historical past of African Americans.
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To meet the industry's needs, liquid coatings—specifically formulated for either spray applications used on aluminum extrusions or for coil applications—can offer an environment for corrosion, especially in seacoast environments. These coatings are typically composed of proprietary acrylic formulations developed by the coatings' manufacturers. Pigments, solvents and additives also are included in the formulated liquid product. Solvents maintain the liquid state and influence the ease of application. During the curing process, solvents evaporate, while the resin system adheres to the metal.

A 70 percent PVDF liquid coating may be formulated for either spray applications used on aluminum extrusions or for coil applications. Regardless of the application method, PVDF resin-based liquid coating systems begin with pretreatment to clean the metal and prepare it for the coating process. This is followed by a two-coat system:

1. Primer: enhances corrosion resistance and determines adhesion quality.
2. Topcoat: determines the color, contributes to weathering performance, and can provide other coating characteristics.

Beyond two-coat systems, some liquid coating systems have a three-coat process that includes an additional paint layer or clear coat to enhance color or weathering performance. However, testing according to real-world exposure demonstrates that many two-coat systems weather equivalent to a three-coat system. Both two- and three-coat metallic coatings in liquid formulations offer outstanding weathering. Metallic coatings are known to have excellent weathering performance and can look new even after 20 years of outdoor exposure.

**Powder Coatings**—For ease of application, polyester powder coatings are typically one-coat systems that rarely use primers or clear coats. Powder coating is a dry film process, using finely ground particles of resins, pigments and additives. The solvent used in liquid coatings is omitted. The mixture is melted, extruded, cooled, cut into chips and ground into powder. The powder is electrostatically charged and sprayed onto the electrically grounded extruded aluminum. The charged powder particles adhere to the metal, and are held there until melted and fused into a uniformly flowing coating in a cure oven.

To create a bright metallic powder coating, a clear coat is required to seal the aluminum particles and keep them from oxidizing. Using a clear coat with powder coatings is impractical. It can make the total coating system too thick for the extrusions to fit together properly and, in many cases, will lead to cracking and filament corrosion. In addition, such an approach would be too costly compared to available liquid coating alternatives.

**AESTHETIC APPEARANCE**

Color, form, space and light are principle components of an architectural project. Color is the one element that most affects the others. It is the first thing that people see and influences their experience of a space. For exterior architectural building components, colors trend toward a more conservative, classic palette. Limited Performance. Exceptional hardness makes powder coatings appropriate for high-traffic areas.

**LIQUID AND POWDER COATING COMPARISON**

<table>
<thead>
<tr>
<th>LIQUID PVDF 70%</th>
<th>POLYESTER POWDER</th>
<th>PERFORMANCE</th>
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<tbody>
<tr>
<td></td>
<td>Exceptional hardness makes powder coatings appropriate for high-traffic areas.</td>
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<table>
<thead>
<tr>
<th>LIQUID PVDF 70%</th>
<th>POLYESTER POWDER</th>
<th>AESTHETICS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Standard color range available with slight orange-peel texture.</td>
<td>Available in nearly limitless aesthetic options, including standard colors, bright metallics, special effects, varying gloss levels, and more.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>LIQUID PVDF 70%</th>
<th>POLYESTER POWDER</th>
<th>SUSTAINABILITY</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Powder coatings have sustainability advantages such as zero VOCs at the application site.</td>
<td>Liquid coatings require less energy to manufacture than powder coatings, and do produce VOCs, but they can be captured and reused in an energy-efficient manufacturing process.</td>
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<table>
<thead>
<tr>
<th>LIQUID PVDF 70%</th>
<th>POLYESTER POWDER</th>
<th>MAINTENANCE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Cannot be applied outside of a factory setting. Can be touch-up with liquid coatings, although it is not recommended due to possible color differences.</td>
<td>Touch-up options may be available with liquid coatings in the same technology and offering similar performance.</td>
</tr>
</tbody>
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<thead>
<tr>
<th>LIQUID PVDF 70%</th>
<th>POLYESTER POWDER</th>
<th>WARRANTY</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>Up to 25 years with limitations and restrictions.</td>
<td>Up to 30+ years. Depending on coating manufacturer, warranty covers full cost of claim plus color and gloss retention.</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>LIQUID PVDF 70%</th>
<th>POLYESTER POWDER</th>
<th>APPLIED COST</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>Lower applied cost compared to liquid PVDF</td>
<td>Higher applied cost than polyester powder due to the higher price in superior-performing PVDF resins.</td>
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</tbody>
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color chart.

custom color and selecting from a standardized palette. Whites, beiges, metallics and grays have been the most popular color choices for many years, but bolder colors are increasingly being used for accents on framing and larger surfaces including cladding and roofing.

High-performance architectural coatings should be specified to ensure the colors maintain their intended appearance.

Liquid coatings offer nearly unlimited color and aesthetic options. They are available in a wide range of colors, gloss levels, effects and textures. A wider range of aesthetic options are available with liquid coatings than powder coatings, especially with metallic, special effects colors, and gloss levels. Liquid coatings can achieve a very smooth finish that appeals to architects.

Polyester powder coatings are available in a range of solid and pearlescent colors. The method of powder adhering to aluminum creates a slight orange peel texture. Compared to liquid coatings they are more aesthetically limited due to the lack of metallic and multi-layer capabilities available with powder coatings.

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In Europe, most suppliers keep an inventory of RAL stock colors in powder coatings. RAL is a color matching system used in Europe that is created and administrated by the German RAL Institute. In the middle east, preferences are divided between custom color and selecting from a standardized color chart.

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Photo Credit: Derek Skalko

The Aspen Art Museum features an iconic, composite geometric screen that drapes the museum’s bright glass and white metal exterior on two sides. The curtainwall, window, sliding door and skylight systems were finished by 70 percent PVD coatings.

SPONSOR INFORMATION

For over 200 years, Valspar has been a leader in the art and science of coatings that excel in both beauty and function. Our expansive range of superior quality coatings comes to life through a full palette of colors and textures to meet the most demanding environmental conditions and designs.

This article continues on http://go.hw.net/AR1216Course4. Go online to read the rest of the article and complete the corresponding quiz for credit.

CONTINUING EDUCATION

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When children and their parents visit the Buerger Center for Advanced Pediatric Care in Philadelphia, they are treated to lively, whimsical, color-infused architecture that adds cheerfulness to what can be an otherwise frightening event.

The 12-story building and six-story wing are composed of stacked, undulating forms and a palette of primary colors that offer families an uplifting, interactive setting for treatment. The curving curtainwall systems feature high-performance PVDF coating systems in nine bold colors selected by the architects to give the exterior a vibrant, welcoming appearance. Along the waiting areas, floors are offset to create light-filled public spaces. The undersides of the floors are exposed, each revealing a single bright color.

“For families coming to a health care facility, it’s very stressful. It’s very stressful for parents and guardians. It’s very scary for the children. We wanted the building to provide positive distractions—fun [and] interest to the visit,” Thomas Dole, senior vice president of outpatient and clinical services, told the Philadelphia Tribune.

Designed by Pelli Clarke Pelli Architects and FKP Architects, the 700,000-square-foot ambulatory care center is the focus of the new South Campus. The center opened in 2015 as the newest addition to The Children’s Hospital of Philadelphia (CHOP) campus, which serves more than 200,000 patients each year.

Working with the architect and general contractor on the $425 million project, a metal products company designed and manufactured the curtainwall and another company managed the installation.

Five types of unitized curtainwall systems were customized for the center. It included 4,219 shop-assembled and -glazed units, encompassing 151,000 square feet and incorporating segmented radius layouts. A finishing company painted all of the aluminum framing in 70 percent PVDF resin-based coatings to meet the strict requirements of the project and provide long-lasting performance and color retention.

“Using brightly colored PVDF coatings, a horizontal accent band smoothly blends the connection between curtainwall and soffits,” explains Jeff Alexander, vice president of sales for the global coatings company that supplied the coatings.

The colors change at each floor, alternating between orange, blue, red, yellow, green and purple. The primary colors match the child-friendly atmosphere of the hospital. Photo © Jeff Goldberg / Esto

“The colors change at each floor, alternating between orange, blue, red, yellow, green and purple. The primary colors match the child-friendly atmosphere, further expressed with the handprints in the glass’ frit pattern. It all adds up to create a cheerful welcome for the patients, staff and visitors.”

The finishing company applied the coatings to the building components one floor at a time, and would encounter up to six color changes in a single day to fulfill the requirements of final assembly in fabrication. The remainder of the metal framing on CHOP’s Buerger Center is finished in a silver pearl color using a four-coat system on the exterior building components and a three-coat system on the interior building components.

A finishing company spokesperson said: “We are confident that these colors will last for decades to come based on the superior coatings.”

Durable finishes contribute to the project’s longevity and reduce the need for maintenance throughout its life cycle. Seventy percent PVDF coatings meet or exceed the American Architectural Manufacturers Association’s stringent standard, AAMA 2605 high-performance exterior specification. The coatings demonstrate reliable performance including resistance to harmful ultraviolet rays, chemical degradation, abrasions and humidity. These attributes also support green building goals as the project sought a LEED® Silver certification.

In North America, the market favors custom colors. It’s possible for a custom liquid sample to be formulated, applied and shipped in a 24–48 hour period. That’s because producing a powder coating custom color sample involves essentially the entire production process—blending pigments, grinding the formulation into a powder, applying it electrostatically to a metal surface, and then analyzing the resulting color. With liquid coatings, on the other hand, colors are systematically added to a standard base formulation until the desired result is achieved. This process can be relatively simple and speedy compared with powder coatings.

**SPECIFYING FOR PERFORMANCE**

Both liquid and powder coatings are held to the same industry standards and specifications for architectural coatings on exterior metal building products. As mentioned above, AAMA serves as the leading authority on specifications, performance requirements and testing procedures for architectural coatings. These include:

Coatings on Aluminum Extrusions and Panels,” which typically pertains to conventional acrylic and high solids polyester liquid coatings, as well as durable polyester powder coatings.

- **AAMA 2604-13**, “Voluntary Specification, Performance Requirements and Test Procedures for High Performance Organic Coatings on Aluminum Extrusions and Panels,” which typically pertains to silicone polyester and 50 percent PVDF liquid coatings, as well as super-durable polyester powder coatings.


These three specifications apply to progressively more rigorous standards as indicated by South Florida outdoor exposure and laboratory accelerated testing. To meet AAMA 2605, the finishes are subjected to the equivalent of 10 years of South Florida exposure for weathering including gloss retention, fade-resistance to ultraviolet (UV) light, in addition to 4,000 hours of humidity and 2,000 hours of salt fog endurance for corrosion resistance. While both liquid coatings and superdurable polyester powder coatings can achieve the requirements of AAMA 2605, the resulting weathering performance of 70 percent PVDF liquid coatings far exceeds that of powder coatings.

**Liquid Coatings**—In North America, this new standard of performance continues to drive architectural specification of liquid coatings for exterior metal building products. Over 50 years of real world performance validates 70 percent PVDF resin-based architectural liquid coatings’ lasting durability. Ongoing market-driven innovations in PVDF liquid coatings include new aesthetic formulations with reduced hazardous materials. These are the best resin compositions commercially available for extended weathering performance.

Through the decades, these coatings have proven to have superior performance in resisting chalking, fading, and corrosion, and in retaining gloss, color and other performance factors under harsh conditions. They are very resistant to corrosion, even in harsh seacoast environments, as the primer system used in liquid coatings helps prevent filiform corrosion.

**Powder Coatings**—While there is a shorter history of real-world powder coating applications, it is known that they perform poorly in seacoast environments. Powder coatings are prone to filiform corrosion, especially along the cut edge because they are typically not used with a primer. Any chipping or cracking in the coating can allow the aluminum to corrode. The corrosion will creep underneath the coating, which can cause it to crack and pop off the metal.

Polyester resins have more limited performance than PVDF resins, but typically produce harder finishes. This imbues them with a high resistance to abrasions. This characteristic makes powder coatings a potential consideration for high-traffic areas especially for high volume projects.

While AAMA standards are the predominant standard in North America, QUALICOAT is a standard from Europe that is recognized in some other regions. GSB is a German standard that also is recognized in some of its neighboring European counties. QUALICOAT and GSB were developed for polyester powder coatings.

**SUSTAINABILITY CONSIDERATIONS**

There are trade-offs between liquid and powder coatings when it comes to sustainability considerations. Powder coatings are perceived to be more sustainable because they contain little to no VOCs at the point of application; however, the process of manufacturing powder coatings is more intensive. Knowledgeable coatings manufacturers will work with their customers to help them understand what options are available for their building projects’ unique sustainability goals.

To promote sustainable and healthy environments, the U.S. Green Building Council’s LEED rating system, version 4 (LEED v4), offers credit for some low-VOC materials that are field-applied at the site of construction. There is a misperception that this includes exterior metal building products that have been factory-finished with liquid and powder coatings. Unfortunately, these are not included in this LEED credit.

However, special coatings formulated for environmentally sensitive projects may contribute to other credits in LEED v4. Coatings with solar-reflective pigments applied to metal roofing help obtain credit for Heat Island Reduction. Liquid coatings formulated for compliance to Living Building Challenge’s Red List assist in achieving Building Product Disclosure and Optimization credits.

**Liquid Coatings**—Liquid coatings are made with solvents that contain VOCs, but the emissions normally are contained and eliminated at the finisher’s factory with the use of high-tech, environmental-control systems, such as thermal oxidizers. A thermal oxidizer converts the VOCs into harmless water vapor and carbon dioxide, and reuses the heat generated from that process in the paint coating process.
Powder Coatings—Because powder coatings contain no solvents in their formulation, their application process emits negligible, if any, VOCs. Large batch, single color powder coatings also can incorporate material recovery systems to increase production efficiency, minimizing associated energy use and reducing waste.

**MAINTENANCE AND TOUCH-UP**

After the finished, exterior metal components have been installed on the building, some cleaning, maintenance and repair may be necessary initially and throughout its lifetime of use.

Liquid Coatings—Working with the coatings manufacturer, the original finisher and a knowledgeable repair and restoration team, touch-up options may be available with liquid coatings in the same technology and offering similar performance.

Powder Coatings—Powder coatings cannot be applied outside of a factory setting, which means they cannot be used for touch-up or repair after the finished building components have been installed. In some cases they can be touched-up with a liquid coating but it can be challenging to match the color between the two different technologies.

For both liquid and powder architectural finishes, simple washing with plain water using hoses or light pressure spray equipment is adequate in many cases. When heavy deposits of dirt or other contaminants dull surfaces, stronger methods may be needed. Wire brushes, abrasives or similar cleaning tools, will mechanically abrade the coatings’ surface. In addition, when using cleaning agents, test cleaners in an inconspicuous area first and do not use abrasive or caustic cleaners or solvents that might cause permanent damage to the finish. Always follow the manufacturer’s care and maintenance instructions as required per the warranty.

**WARRANTY CONSIDERATIONS**

Around the world, warranties will vary by location and company. The most important aspects to review are delta E color shift, chalking, gloss loss and remediation. Work with a trusted supplier to understand what is included in a specific warranty and who can advise on its nuances.

Liquid Coatings—Adhesion, chalking and color change usually are covered. It is important to carefully evaluate the warranty’s specified terms and length offered by a coating manufacturer.

Powder Coatings—A warranty for polyester powder coating generally is more limited and restrictive. Length of powder coat warranties and their coverage vary greatly depending on the supplier and type of powder coat. Due to varying coverage, job-specific powder coat warranties are issued directly from the powder coat manufacturer rather than by the finisher.

**APPLIED COST**

Polyester powder coatings have a lower applied coat than liquid PVDF coatings. This is due to the higher cost of superior-performing fluoropolymer resins used in liquid PVDF coating systems.

**CONCLUSION**

When choosing either liquid or powder architectural coatings for exterior metal building products, architects can ensure optimal appearance and durable performance by consulting a coatings manufacturer and applicator to select the ideal system for their project.

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**FOOTNOTES**
