LEARNING OBJECTIVES
After reading this article, you should be able to:

+ Describe the composition, applicability, and performance characteristics of optical coatings, such as iridescent and metallic finishes for architectural projects.
+ List key performance standards, air-quality concerns, and applicator considerations in the use of iridescent and metallic coatings.
+ Discuss performance, sustainability, and durability issues related to color matching with common coating formulations.
+ Describe high-performance coatings used to protect building structures and building materials.

High-performance coatings encompass a range of paints and finishes that serve a variety of architectural applications:

1) **Structural and material protection** typically demands a coating specification that matches the substrate’s behaviors and weaknesses, whether for steel, cast concrete, concrete masonry, or drywall. Some finishes have active properties, such as self-healing or self-cleaning, that afford unique performance advantages.

2) **Color** is an important performance consideration, particularly custom color matching, color retention, and color consistency.

3) **Specialty colors and optical effects** make up another high-performance category, which includes iridescent, metallic (or metalescent), and pearlescent finishes. These reflective materials change color depending on the way visible light reflects off the materials. They look different depending on the viewer’s angle to...
the surface, the intensity of the light source, and
the angle of incidence of the light source (such
as the sun).

Iridescence, metalescence, and similar optical
effects can also be achieved with recently
introduced architectural plastics, ceramics, and
wallpaper, as well as films that can be applied to
substrates, such as glass.

The technology underlying decorative com-
pounds is changing rapidly, creating more
specification choices and aesthetic options
than ever before. But some traits of specialty
coatings probably will never change, says Jim
O’Keefe, Vice President, Precision Coatings,
Springfield, Mo. “Metallic and iridescent fi nishes
are generally translucent or clear resin systems
with three-dimensional pigments that lay out in
a pattern that is dependent on the application
technique employed,” he says. The applicator’s
skill in providing consistent air supply and steady
flow of pigment through the spray gun largely
determines the success of the resulting optical
effects. “Many applications are handled in the
shop for best control, but increasingly they are
field-applied,” says O’Keefe.

Iridescent coatings are generally defined as
those containing a certain percentage of irides-
cent particles. When the coating is applied, the
particles become visible in the dried coating fi lm.
The precise code defi nition of iridescence can
vary from state to state. For example, Utah clas-
sifi es as iridescent any coating with “more than
48 grams of pearlescent mica pigment or other
iridescent pigment per liter of coating as ap-
plied,” or more than 0.4 lb/gal. Other standards
and codes defi ne these formulations as having
more than fi ve grams per liter, or 0.042 lb/gal. of
iridescent particles. Other optical additives that
may fi gure in the defi nition of iridescent include
powdered or flaked metals, such as aluminum,
and compounds like magnesium fl uoride.

For architectural uses, the finishes are often
applied as the components are being fabricated;
this helps maintain the tight tolerances required
for consistent optical effects and for compliance
with air-quality rules, says O’Keefe. Some formu-
lations are approved for field application.

As for aesthetics, some common coating types
present a diffractive rainbow that appears to
move over a silvery metallic base, while others
appear silvery with a diamondlike sparkle or
satin fi nish. At the molecular level, the fi lms
or particles in the coatings have unique surface
textures that produce rainbowlike visual effects.
The coatings also have an aluminum core layer
that creates an opaque and highly specular, or
mirrorlike, fi nish, according to manufacturer Viavi
Solutions. The iridescent effects are possible
not only with mica but also with compounds that
exhibit a high refractive index, such as cerium di-
oxide—and also, counterintuitively, those with a
low refractive index, such as magnesium fl uoride.

Architectural fi nishes with these optical ef-
fects are available in gloss, semi-gloss, satin,
eggshell, and matte versions. Since metallic and
iridescent coatings are widely regulated at the
state and local level, it is important to under-
stand and document the types of high-perfor-

EXPLORATION TOWER’S
SHIMMERING FAÇADE

The $23 million Exploration
Tower at Port Canaveral is clad
in aluminum wall panels with a
color-changing, iridescent fi nish.
The shimmering façades of the
seven-story structure are treated
with a color mica coating speci-
fied by GWWO Inc./Architects
to recall the variegated hues of
Florida’s Space Coast.

Under the direction of Skanska
USA (GC) and exterior wall sys-
tem subcontractor Kenpat USA,
the metal panels for Exploration
Tower were manufactured using
BIM data and applied over the
parabolic building’s curved struc-
tural framing. Prior to erection,
the applicator Linetec fi nished
the metal panels with a color-
changing paint (in this case, Val-
spar Blue Pearl II) containing 70%
PVDF (polyvinylidene fluoride), a durable exterior metal coating formulation that meets the American Architectural Manufacturers Association’s AAMA-2605, considered to be the most stringent exterior architectural specification in the field, according to the manufacturer.

Exploration Tower is coated with a primer, basecoat, and color coat with mica flakes and a blend of ceramic and inorganic pigments. The coating system is compatible with both extrusion and coil-metal building components. GWWO also specified a clear coat over the optically dynamic finish for enhanced durability against the salty air, strong sun, and frequent rain in the seaside location.

For Exploration Tower, applying the coating correctly became a trial by fire. “No one had sprayed this coating before,” says Linetec’s paint plant manager, Paul Bratz. “There was some trial and error during the process. It was critical that each paint run maintained the same parameters. The spray conditions, paint prep, and application consistency of the paint itself were all critical. The slightest change could have altered the look of the paint.”

To complete the 23,000-sf, sail-shaped structure, the coating manufacturer prepared the paint in a single batch—not the usual approach for building projects—for four application phases.

Standards and Application Factors
Several minimum standards guide expectations for high-performance optical coating uses. The American Architectural Manufacturers Association’s AAMA-2605 requires paint coatings to meet baseline testing performance standards, including more than 2,000 hours of cyclic corrosion (per ASTM G85 annex 5) and heat and humidity resistance. AAMA-2605 also requires that the coating maintain its film integrity, color retention, chalk resistance, gloss retention, and erosion resistance properties for a minimum of 10 years, no matter where the structure is located.

Consideration should also be given to surface preparation, equipment, and applicator skills, as well as estimating the application and material costs of applying special-effects coatings, advises Precision Coating’s O’Keefe. He recommends using applicators and coating contractors that have automotive market-grade coating experience.

In a typical application, a light coat is applied to provide a base layer for subsequent passes of the coating to adhere to. About 10 minutes after the first pass, another thin coat—a so-called wet-on-wet application—is applied. Additional coats follow, until a total dry thickness of 2–3 mils is obtained. “It’s a slower application,” says O’Keefe. He cautions that the spray gun must always remain perpendicular to the coated surface for correct application.

Since the production rate is typically a fraction of the rate expected for most opaque architectural paint applications, metallic and iridescent finishes are highly dependent on application technique, consistency of the air supply, and steady flow of pigment through the gun. The geometry of the substrate is also a factor, since the angle of the spray gun is so critical. Mockups are strongly encouraged when shop applications aren’t possible. You must also keep in mind that, since many metallic and iridescent coatings are translucent, the primer or basecoat must be able
to withstand ultraviolet light penetrating through the topcoats. Conventional epoxies and alkyds are not effective unless a UV-blocking intermediate coat is specified.

**HIGH-PERFORMANCE AIR AND COLOR**

In U.S. applications, recent state rules provide guidance on limits for volatile organic compounds (VOCs) and other hazardous air pollutants (HAPs), defined as “pollutants known or suspected to cause cancer or other serious health effects, such as reproductive effects or birth defects, or adverse environmental effects,” according to the American Coatings Association (www.paint.org). Based on typical state rules in California and elsewhere, VOC content limits for general high-performance coatings on metal architectural parts are typically given as about 3.5 lb/gal. for baked and air-dried products. For metallic and iridescent coatings, however, the limit may be 3.0 lb/gal. for baked products and 3.5 lb/gal. for air dried.

As for products that aren’t iridescent, pearlescent, or metallic: Solvent-based paints contain a high level of organic solvents which release VOCs during application and drying, typically from 2.5 to 6 lb/gal., according to coatings maker Finishes Unlimited. Waterborne coatings have much less organic solvent, leading to VOC levels as low as 1.5 lb/gal. Powder coatings also offer very low VOC levels, because the solvents are effectively replaced by air.

A relatively new category of products called “high-solids” coatings uses specialized resins instead of solvents. Some baked-enamel coatings with acrylic or polyester resins (or both) can provide ultra-low VOC levels of less than 0.05 lb/gal. They are particularly suited for waterborne direct-to-metal application.

To provide an environmentally sustainable solvent-based paint solution, some manufacturers, finishers, and applicators use a regenerative thermal oxidizer and a 100% air-capture system during application. This process breaks down the VOCs, so there’s “zero adverse environmental impact,” says Linetec’s Tammy Schroeder, LEED GA.

For architectural metals, baked enamel coatings and fluoropolymer-based products such as polyvinylidene difluoride (PVDF) are two of the most common finish specifications. Synthetic and natural pigments are added to impart color and lend certain properties to the coatings, such as colorfastness and gloss. Durability and resistance to corrosives may also be improved by the choice of pigments. Metalacents and iridescent pigments use particles of mica, aluminum, and certain synthetics to achieve the desired glittery, multicolor appearance. Other additives can be used to modify the paint’s film qualities, such as improving its hardness or UV resistance and overall stability. Specialized compounds can be added to resist graffiti.

Other new low-VOC and zero-VOC coatings have good performance attributes, including durability and resistance to wear and abrasion. These products also allow for custom color matching, color consistency, and long-term color retention.

Color matching and color consistency are critical considerations with coatings. A range of variables can cause undesirable color changes—temperature swings, high humidity, and direct sunlight, according to Dura Coat Products Inc. These environmental impacts can also cause blistering or chalking, mainly by degrading the performance of the resins. UV light and hydrolytic effects—where water combines with other compounds, often in reactions triggered by UV light—can lead to fading and degradation of the paint film and its topcoat luster.

These outcomes further illuminate why color matching and repainting of metal components can be affected by even seemingly minor changes to coating formulations. Combining two different coating types for a single building area—such as a PVDF finish on metal panels with a silicon-modified polyester (SMP) on nearby trim metals—may serve a building well in challenging weather conditions for some years. But SMP does not typically survive as long as PVDF, according to AkzoNobel Coatings. The SMP will resist impact better, while the PVDF will retain its gloss for longer. This produces different wear effects that may be detrimental in the long term.

It’s virtually impossible to make the 100% perfect color match. But custom color matching can still be fairly straightforward. You should pro-

**THE TECHNOLOGY UNDERLYING DECORATIVE COMPOUNDS IS CHANGING RAPIDLY, CREATING MORE SPECIFICATION CHOICES AND AESTHETIC OPTIONS THAN EVER BEFORE.**
vide your supplier with a physical sample for the color match, such as a chip or a paint number from a major manufacturer. (Color matching from a digital photograph is not recommended for high-performance architectural applications.) The manufacturer should know the intended use—e.g., curtain wall, interior wall, signage—as well as the square footage of the coated area.

Sample panels prepared and sent by the applicator should be reviewed by your team and the architectural product manufacturer, if possible. You should check not only the color match but also the technical specifications for the intended use. Bright and exotic colors tend to be among the hardest to match; they may also suffer from chalking and fading. Metalescent and iridescent finishes are also hard to match, if coil-coated metallic and spray-applied metallic finishes are being matched, says metals maker Alucobond. The two processes deposit the flakes and granules in different orientations, which can cause color variations and optical inconsistencies.

GET THE SUBSTRATE RIGHT
For all architectural coatings, paying attention to the substrate is the primary path to high-performance specifications. Coatings can be essential to the protection of structures and materials, so their behaviors and weaknesses should inform the coating spec and applicator technique.

For steel surfaces, it is customary to employ a sequence of paints and coatings, each of which contributes unique and often symbiotic functions. Typically, a primer is followed by intermediate coats, then by finish coats; some or all of the coats are applied in a factory setting. Surface preparation is important for protecting metal architectural systems, including steel surfaces, according to the British Constructional Steelwork Association, which calls it “the most important factor affecting the total success of a corrosion protection system.” The main reason is that the existing surface condition of the steel element may have some rust or millscale that negatively impacts the coating’s ability to adhere. Abrasive cleaning of the steel surfaces is ideal for this task.

Abrasive cleaning also improves the ability of the protective coatings to adhere by creating a coarse and roughened surface. To achieve the best surface for the coatings, contractors

FRENCH REAL ESTATE FIRM’S HQ USES COLORFUL IRIDESCENT COATING

The LEED Gold amenities wing for the headquarters of French real estate company Société Foncière Lyonnaise employed a colorful iridescent coating to enliven the sun-reflecting roof and stainless-steel tiles, which form a curved fascia and overhanging eave detail. The building, originally a 1920s manufacturing facility, was embellished with a new 40,000-sf wing by design firms DTACC and Agence Jouin Manku.

The three-story wing centers on a concrete tower, with a snaking pedestrian bridge of white painted steel and timber to connect to other facilities. The diamond-patterned roof hovers above the façades of glass and vertical-slatted wood cladding. Though the metal roof is detailed in a tile pattern typical of the Paris region, the use of a factory-applied iridescent finish gives it a futuristic quality that also recalls natural forms, such as the body of a dragonfly.

To create its prismatic surfaces, DTACC conceived of the roof of the wing as a “colored envelope wrapping the building.” The stainless-steel panel coating appears green from the front view and moves toward a rainbow of blue, indigo, and violet as the angle of view changes.

The use of optically active surfaces is on the uptick. “Panels painted with iridescent colors, together with various panel profiles, offer an almost infinite number of available optical effects on façades,” says cladding maker Trimo. Such panels may emphasize vertical or horizontal color shades, changes in the building’s appearance due to the speed and direction of movement of passersby, or changes with respect to the lighting.
The newly-opened Smithsonian National Museum of African American History and Culture celebrates the struggles and triumphs of African Americans, supported by the building’s structure that is composed of customized metal panels coated in Valspar’s Fluropon® 70% percent PVDF metal coating.

This iconic building form pays homage to the nearby Washington Monument, closely matching the nearly 17-degree angle of the capstone while using the Monument’s stones as a reference for the NMAAHC panel proportion and pattern. Reaching toward the sky, the bronze clad corona is said to expresses faith, hope and resiliency.

The bronze wash of the exterior 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.” Valspar’s Fluropon 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.

Coatings should prevent moisture and oxygen from reaching the protected material’s surface. They also provide for interference of corrosion processes and may include elements that are sacrificed in order to protect the materials, such as zinc pigments, which take the impact of corrosion action in some zinc-heavy coatings.

Recently, the science journal Nature published a report (http://bit.ly/2g7nC1B) by scientists from the Kennedy Space Center and the University of Southern Mississippi describing alternatives to super-protective chromium finishes and solvent-based coatings. These “green” inhibitors and “self-healing” paint films are said to have “inbuilt capacity to maintain functionality.” According to the authors, bare metal can be protected by a uniquely designed surface oxide that repels corrosive anions by means of molecules that change the surface charge. These self-healing paint systems, particularly primers, can incorporate inhibiting agents in a range of delivery vehicles that release the inhibitor in response to external or internal triggers, resulting in the on-demand repair of corrosion damage. It sounds futuristic, and it is. The authors acknowledge that the field is still largely in its infancy and that a lot of research will have to be done in the formulation of the coatings as well as in establishing their durability.

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