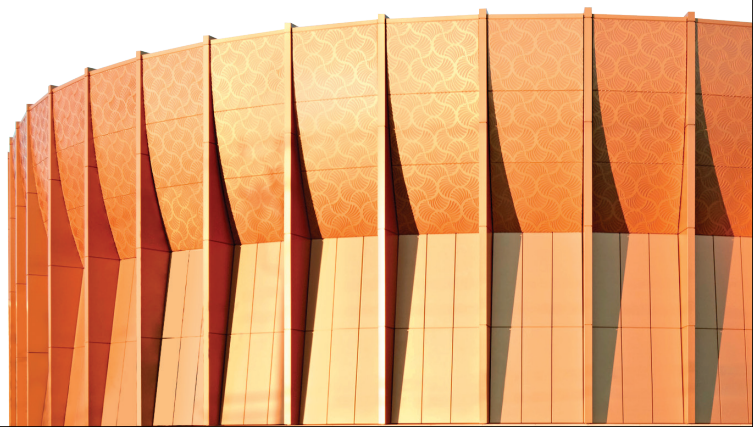
DATA-DRIVEN COATINGS INNOVATION

SHERWIN-WILLIAMS FLUROPON® CONTINUUM™
DELIVERING MAXIMUM PERFORMANCE
AND AESTHETICS IN JUST TWO COATS

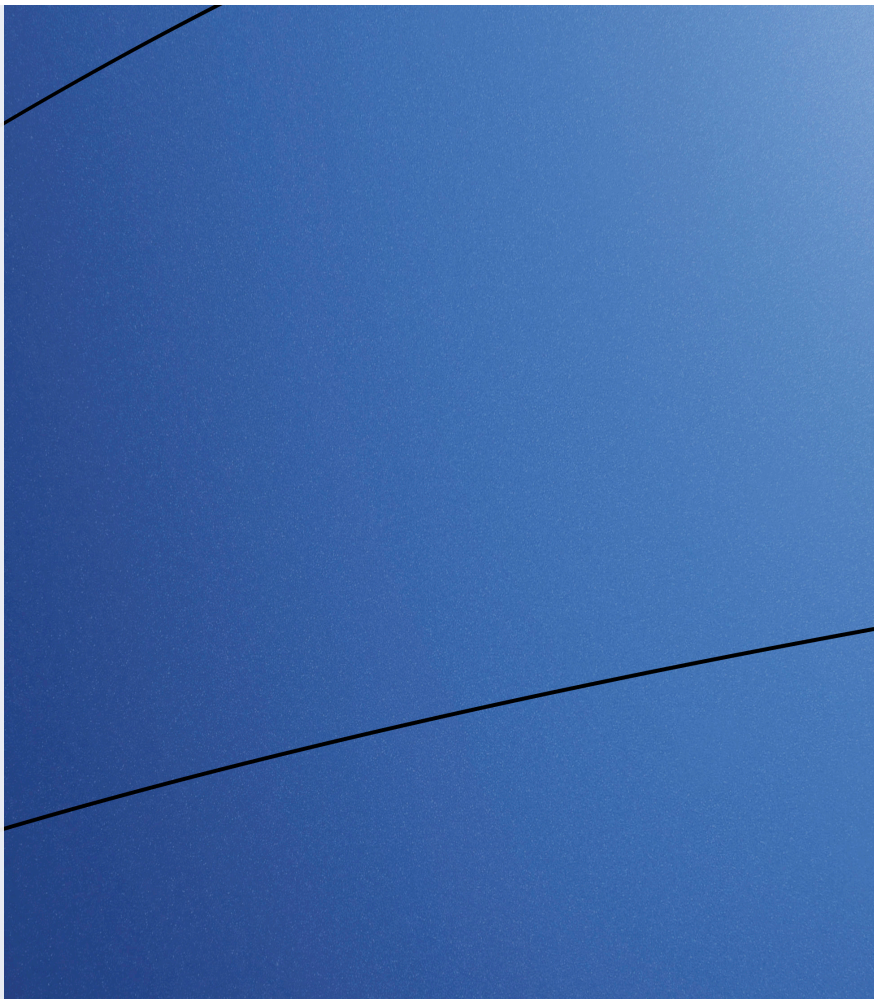
Science of Spirituality International Meditation Center | Lisle, Illinois
Architect: Gensler | Photo Credit: ©Tom Harris by Gensler



SHERWIN-WILLIAMS®
Coil Coatings

OVERVIEW

Metalescent coil and extrusion coating systems have long been specified for their classic aesthetics and lasting performance. Three-coat 70% PVDF metallic systems have been widely accepted as the industry standard for monumental architecture. Over the last 30+ years, Sherwin-Williams has tested thousands of metalescent coating formulations on natural outdoor exposure to develop an innovative new coating system with enhanced performance and expanded aesthetic options using only two coats. This white paper provides a brief history of metalescent coating systems, debunks common myths relating to these systems and offers an in-depth look at the latest coating innovation in the industry: Fluropon Continuum 70% PVDF Coating System.

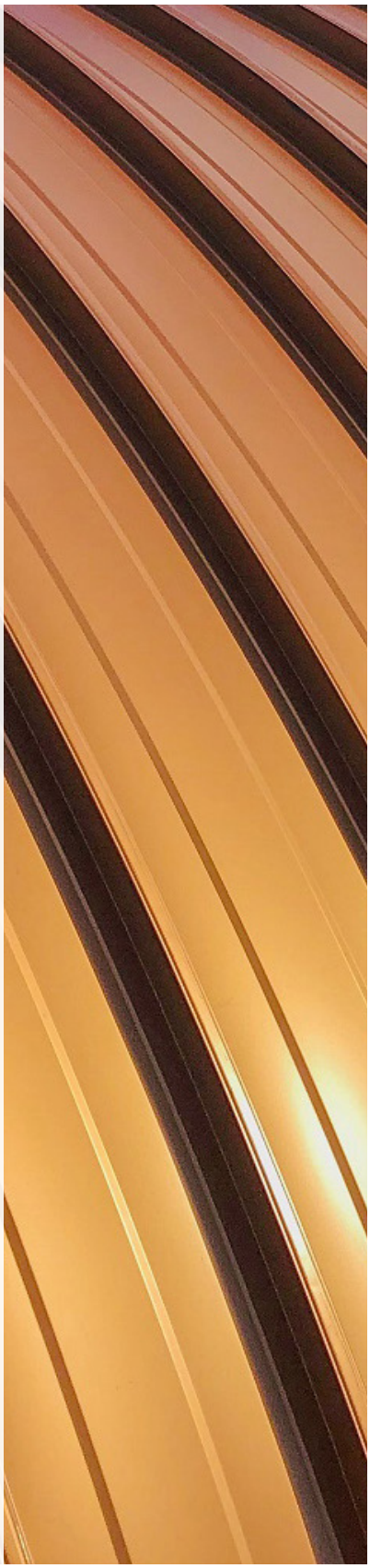


Defining Metalescent Coating Systems

The terms mica and metallic are often used interchangeably in the industry to describe a sparkling aesthetic effect despite notable differences in the material composition between the two types of pigmentation:

- Metallic systems create the sparkle effect using primarily aluminum flakes, which require a clearcoat to prevent oxidation.
- Mica-based systems achieve a sparkle effect using the inert mineral mica and do not require a clearcoat.[1]

WHEN GENERALLY REFERRING TO BOTH SYSTEMS THROUGHOUT THIS TECHNICAL PAPER, WE WILL USE THE TERM “METALESCENT” TO ENCOMPASS BOTH MICA AND METALLIC PIGMENTATION TYPES.



THE EVOLUTION OF METALESCENT COATING SYSTEMS

When metal coating technologies were introduced in the 1960s, flakes of aluminum were used to create reflective qualities. These flakes reflected light in a myriad of angles, creating a desirable shimmering effect. Traditional metalescent coating systems consisted of three coats: a primer, the metallic colored base coat and a protective clearcoat. The protective clearcoat prevented the aluminum flake from oxidizing and changing color when exposed to outside elements but also added to the overall coating cost.

Over time, the chemistry of metalescent coatings has evolved. Chemists started to combine mica with aluminum and other pigments to offer more durable coatings in a wider color range. Mica is the name for a group of 37 different mica minerals that are physically and chemically similar. They form in distinct layers in the earth, are heat-resistant and do not conduct electricity. Mica minerals come in an array of colors and are chemically inert, so the color of the mica remains stable when exposed to light, moisture and extreme temperatures.

In the late 1980s, Sherwin-Williams Coil Coatings (formerly Valspar) introduced a two-coat mica system for coil and extrusion products that eliminated the need for a protective clearcoat. When first launched, there were limited colors available in this system. As the popularity of these coatings grew, Sherwin-Williams continued to invest in research and development to expand color options into brighter and more vivid color spaces that could deliver equal performance to the neutral color options.

MICA MINERALS COME IN AN ARRAY OF COLORS...THE COLOR OF THE MICA REMAINS STABLE WHEN EXPOSED TO LIGHT, MOISTURE AND EXTREME TEMPERATURES.

THE FUTURE OF METALESCENT COATING SYSTEMS

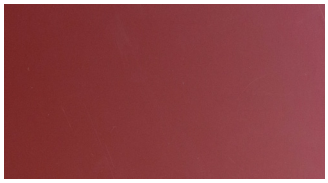
Today, Sherwin-Williams Coil Coatings draws from over 40 years of experience refining metalescent coating formulations to introduce Fluropon Continuum, the next significant innovation in mica-based coatings for metal architecture. As a result of decades of data gathered through outdoor weather exposure of thousands of coating panels combined with accelerated laboratory testing, Continuum's proprietary formulation offers industry-best weathering performance in a wider range of aesthetic options than ever before.

The key behind this new product innovation is the selection of raw materials and a proprietary resin system. "We've tested thousands of different metalescent formulations over several decades, and the data we've gathered has allowed us to improve our formulations, resulting in superior performing products," said Channing Beaudry, Technical Director for Sherwin-Williams Coil Coatings. "We use strict guidelines and the right combination of raw materials to maximize weathering performance in this new coating."

COLOR FADE COMPARISON: SOLID VERSUS MICA FLUOROPOLYMER COATINGS

SOLID VERSUS MICA WEATHERING RESULTS 10 YEARS SOUTH FLORIDA EXPOSURE

SOLID



Control Panel (Non-Exposed)

10 Years Exposure
Delta E = 5.88

MICA

Control Panel (Non-Exposed)

10 Years Exposure
Delta E = 1.51

Delta E is a measurement in the change in visual perception between two colors.

Meet Channing Beaudry

Channing Beaudry leads the Global Research and Development Group for the Sherwin-Williams Coil and Extrusion coatings division.

With dual degrees in Chemistry and Chemical Engineering from the University of Minnesota and over 20 years of experience in the paint and coatings industry, Channing has led the development of a wide range of innovative coating systems across a number of industries including general industrial segments and building products.

Channing works with architects and customers to understand their unique needs and develop coatings for metal building products that meet any aesthetic or specification while lasting long into the future.

UNDERSTANDING WEATHERING PERFORMANCE AND AESTHETIC BENEFITS OF MICA-BASED COATINGS

To develop a superior performing mica coating in a broad color spectrum, Sherwin-Williams chemists tapped into decades of data collected at its state-of-the-art testing facility in South Florida. At this testing site, tens of thousands of painted metal panels are subjected to the most extreme weather conditions of intense UV rays, heat, humidity and salt spray. These panels are tested regularly to understand how they perform under these harsh conditions over time.

Conducting an in-depth analysis of this natural weathering data and using it along with accelerated lab testing, Sherwin-Williams chemists have found a way to formulate mica-based coatings that deliver performance that is equal to or better than three-coat metallic formulations.

The Role of Resins in the Coating System

Metal coatings are comprised of pigments, solvents and resins. Resins contribute most to the overall weathering performance of the coating. 70% PVDF resins offer the best long-term weathering for exterior exposure.

Fluropon® Continuum™ in Punchy

SHERWIN-WILLIAMS CHEMISTS HAVE FOUND A WAY TO FORMULATE MICA-BASED COATINGS THAT DELIVER PERFORMANCE THAT IS EQUAL TO OR BETTER THAN THREE-COAT METALLIC FORMULATIONS.

This new coating formulation provides several interesting and unique qualities over traditional metallic coatings and earlier versions of mica coatings. Through extensive weathering research and testing, Sherwin-Williams chemists have discovered that a specific mica formulation used with 70% PVDF resins can enhance the performance of the coating against harsh outdoor elements compared to traditional metallic coatings and earlier evolutions of mica coatings. This innovation was possible through the investment of millions of research and development dollars along with decades of test data Sherwin-Williams has gathered through its outdoor weather testing facility.

EXAMPLE 1: TWO- VERSUS THREE-COAT WEATHERING DATA COMPARISON

The data below shows a similar pewter color in a three-coat and two-coat formulation and the results of the weathering process. Fluropon Continuum shows better gloss retention and about the same fade as the traditional three-coat system and has been weathering nearly a year longer. They both exceed AAMA 2605, the standard exterior specification for high performance coatings in the fenestration industry, which requires that the fade is no more than 5 Delta E after 10 years natural exposure. As you can see in the chart below, both samples are well below 5 Delta E color fade. Sherwin-Williams also measures gloss retention to help assess the aesthetics of a coating over time. In this example, the two-coat system retained more gloss than the three-coat system.

Product Type	Color	Color Measurement Delta E	% Gloss Retention at 60°	Total Months Exposure
Fluropon® Classic three-coat metallic	Pewter	2.79 Delta E	65%	177 months (14.75 years)
Fluropon Continuum two-coat mica	Pewter	2.86 Delta E	78%	185 months (15.4 years)

EXAMPLE 2: FLUROPON CONTINUUM TEST RESULTS

The following data shows weathering results for a variety of color samples that far exceed AAMA 2605 standards. All six color samples are below 1 Delta E after 21 years, which is a color fade that is not perceptible by the human eye.

Color	Color Measurement Delta E	Total Months Exposure
Champagne	0.23 Delta E	258 months (21.5 years)
Silver	0.25 Delta E	258 months (21.5 years)
Charcoal	0.29 Delta E	258 months (21.5 years)
Dark Gray	0.82 Delta E	258 months (21.5 years)
Seafoam Green	0.99 Delta E	258 months (21.5 years)

LESS THAN 1 DELTA E IS NOT VISUALLY NOTICEABLE BY THE HUMAN EYE.[2]

Warranty Backed Performance

Manufacturers are commonly asked to provide warranties that exceed industry standards, which are typically written to provide a base-level guideline. The AAMA 2605 coating standard written by the American Architectural Manufacturers Association is designed for coatings ideally suited for long-life external use on monumental high-rise structures and pre-engineered buildings' exterior architectural aluminum products. The standard requires that the coating maintains specified standards of film integrity, color retention, chalk resistance and gloss retention after enduring outdoor weathering exposure in South Florida for a period of 10 years.

Fluropon Continuum's advanced performance is backed by a 25-year warranty for extrusion applications and a 35-year warranty for coil applications. For additional warranty details, contact your end product manufacturer directly.

EXPLORING COATING AESTHETICS

High-performance coil and extrusion coatings are specified not only to protect the metal substrate from corrosion but also to provide a beautiful aesthetic to the building's façade. Fluropon Continuum offers a number of aesthetic benefits versus traditional two- and three-coat metalescent systems:

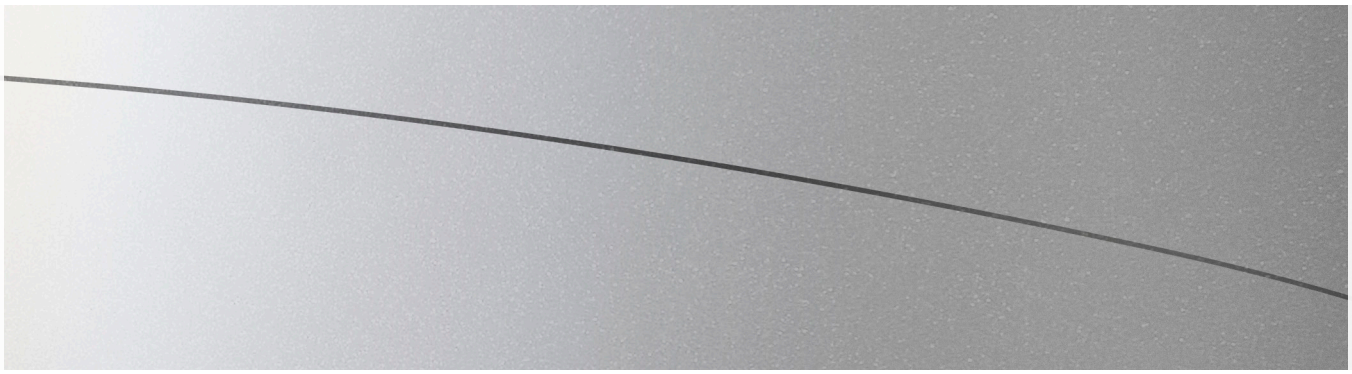
EXPANDED COLOR SPACE

Brighter, more vibrant color spaces are now available. Traditional metalescent coatings offered a limited color range of silver, gold, bronze and champagne. As technology evolved, some shades of oranges, reds, blues and other bright colors were achieved, with performance equal or better than traditional metalescent coatings. With Fluropon Continuum, an even wider spectrum of color can be achieved. Viewing these coatings on the exterior of a building in direct sunlight adds to the brilliance and depth of the color.

SPARKLE AND COLOR INTENSITY

The mica flakes in Fluropon Continuum act as tiny mirrors. When light hits the mica particles, it is partially reflected out and partially absorbed. As the light travels into the particles and the various layers of oxide surrounding them, a sense of visual depth is created.

Science of Spirituality International Meditation Center | Lisle, Illinois | Architect: Gensler | Photo Credit: ©Tom Harris by Gensler



CONSISTENT FLAKE ORIENTATION

There is a much less dramatic "flop of flake" effect with mica than there is when applying a metallic coating. When electrostatically spray-applied, the statically charged aluminum flakes in the metal coating can follow the direction of the spray equipment as it's applied, creating an inconsistent appearance or a lower or higher level of sparkle and brilliance than desired. Mica flakes are inert, which means they are not prone to the "flop of flake" effect, allowing the amount of shimmer to be controlled in formulation with no impact to that effect during the application process.

VISUAL APPEARANCE OF TWO COATS

In almost all cases, there is not a way to visually distinguish between a two- and three-coat system.

COATING COMPARISON

Fluropon Continuum	Traditional Metallic Systems
2-Coats	3-Coats
Primarily Mica-Based	Primarily Aluminum-Based
Improved overall color consistency	Prone to "flop of flake" effect
Less expensive due to fewer coats	More expensive due to more coats
25-Year Warranty for Aluminum Extrusions	20-Year Warranty for Aluminum Extrusions
35-Year Warranty for Coil Applications	30-Year Warranty for Coil Applications
Expanded color range and depth	

Color Customization

Fluropon Continuum is highly customizable to meet a wide range of color and sparkle intensities by manipulating the flake size, roughness of the particles and gloss. Our team of chemists work directly with architects and designers to develop custom colors for building projects. In 2019, our Coil and Extrusion labs matched over 5,000 custom color matches!

FLUROPON CONTINUUM OFFERS BEST COATING PERFORMANCE, AESTHETICS AND OVERALL VALUE FOR MONUMENTAL ARCHITECTURE

Sherwin-Williams research has shown that architects value metalescent coatings for their consistent, controlled color, not only when first installed on a building exterior but also for the longevity of the color over time. From an aesthetic standpoint, metalescents offer added color depth and a classic look. Many architects appreciate greater control over long-term performance and appearance when using a coating versus using raw metal, which can significantly alter in visual appearance over time.

APPLICATION CONSIDERATIONS

It is important to note that three-coat applications can be more difficult to apply in some instances versus two-coat systems. When a clearcoat is added, the overall color can shift. Over time, the clearcoat can turn yellow, which can be very noticeable over lighter color spaces. In addition, some coaters and applicators may need to run the metal through the coating line a second time to apply the clearcoat, which can add time and cost to a project.

WHY NATURAL EXPOSURE TESTING IS CRITICAL IN VALIDATING COATING PERFORMANCE

A state-of-the-art weather testing program is a crucial step in reducing potential product failures and in providing the data to continue to innovate. Below are a few of the key potential coating failures that are tested.

GLOSS RETENTION

Gloss retention is a coating's ability to retain its gloss level over time. Gloss refers to a coating's ability to reflect light in the specular (mirror-like) direction. Direct UV exposure can degrade the gloss and luster of the topcoat over time. Two-coat systems demonstrate superior gloss retention versus three-coat systems that include a clearcoat.

CHALKING

Chalking is caused by degradation of the resin system on the surface due to ultraviolet (UV) ray exposure. As the system breaks down, resin particles take on a white, chalky appearance and embedded pigment particles lose their adhesion to the film. Chalking is tested by transferring the chalk to a fabric or adhesive tape and comparing it to a photographic reference standard (ASTM D4214). Chalking is measured on a scale of 10 to 1, with 10 showing the least amount of chalking and 1 showing the presence of extreme chalking.

THE TESTING METHODOLOGY AT SHERWIN-WILLIAMS IS RIGOROUS. THE COMPANY OWNS A 6.25 ACRE OUTDOOR TESTING FACILITY IN FORT MYERS, FLORIDA, WITH MORE THAN 100,000 PAINTED METAL PANELS ON EXPOSURE.

COLOR FADE

Delta E (dE) is a single number that represents the distance between two colors. One color is always the standard — the starting point for the calculation. The second color is the weathered panel. The Delta E number will provide the color change that is expected due to fade and loss of gloss after exterior exposure. The lower the number, the lower the amount of color change. The higher the number, the higher the amount of fading.

A STATE-OF-THE-ART WEATHER TESTING PROGRAM IS A CRUCIAL STEP IN REDUCING POTENTIAL PRODUCT FAILURES AND IN PROVIDING THE DATA TO CONTINUE TO INNOVATE.

BLISTERING

Blistering represents a localized loss of adhesion and lifting of the coating film from the underlying surface. This is caused by heat and moisture or a combination of both. The condition eventually leads to peeling and corrosion. Surface blistering can sometimes be caused by improper drying or curing of the coated material.

CRACKING/FLAKING

Cracking/flaking begins as hairline fractures in the coating that eventually split, crack, flake and peel away from the substrate. Improper application, poor surface preparation, or improper paint selection for the environmental conditions can all cause cracking or flaking in a coating system.

CONCLUSION

The performance and aesthetics of metalescent coating systems for exterior building products can vary significantly. When architects and building owners are looking to maximize long-term weathering performance and aesthetic options for building facades, the Sherwin-Williams Fluropon Continuum coating offers an excellent solution. Sherwin-Williams chemists formulated the coating based on decades of weathering data from the Sherwin-Williams test fence facility in the harsh climate of South Florida. The coating's enhanced performance is backed by an extended warranty for chalk and fade. Fluropon Continuum also offers an expanded color palette ranging from traditional silvers and champagnes to new bright colors that have never before been achieved in mica-based PVDF coatings. **In addition to these benefits, Fluropon Continuum eliminates the need for a clearcoat, offering a more economical option when a sparkling metallic appearance is desired.**

To learn more and order color samples, visit coil.sherwin.com/continuum.

Appendix

[1] While mica-based coating systems rely primarily on mica minerals to create a sparkling appearance, they contain low volumes of aluminum pigmentation that are below the threshold needed to require a clearcoat to prevent oxidation.

[2] Source: DataColor.

Sherwin-Williams Fluropon Coatings History and Formulation

Sherwin-Williams first introduced its flagship Fluropon high-performance architectural coating more than 50 years ago. Since then, premium fluoropolymer coatings containing 70% Polyvinylidene Fluoride (PVDF) have become the AAMA 2605 standard for superior-performance coatings. These high-performance architectural coatings are used to deliver outstanding beauty and durability on monumental high-rise structures, pre-engineered buildings and high-end residential homes. With superior resistance to ultraviolet rays and other elements, buildings maintain their beauty for decades.

Chemists have continued to innovate using Fluropon coatings with a family of offerings for different coil and extrusion applications. The basis for this formulation is still the industry's best resin: 70% PVDF in a proprietary formulation from Sherwin-Williams.

The resin binds together all components of a paint formulation and is a key source of durability and performance. PVDF resins provide a carbon/fluorine bond, one of the strongest chemical bonds used in the coatings industry. Coatings made from PVDF resins are ideal for buildings where best-in-class color and gloss retention are critical. They provide superb protection against harsh outdoor elements including ultraviolet rays, dirt and stains, chemicals, heat, humidity and corrosion. Fluropon coatings are resistant to many elements found in the environment including air pollution, acid rain and general airborne dirt.

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