MITSUBISHI PLASTICS COMPOSITES AMERICA, INC.

Painted Finish Considerations of ACM/MCM in Today's Architecture

An overview of aluminum and natural metal composite panels, finish options, details of paint and resin systems, application methods as well as weatherability and durability tests.

ALPOLIC® MATERIALS

Let's Build

Learning Objectives

Aluminum and Metal Composite Material
Structure of ACM/MCM
Finish Options
Painted Aluminum
    Projects
American Architectural Manufactures Association (AAMA)
Paint Options
    PVDF
    FEVE
Application Methods
Color Measurement
Weathering and Durability
Warranties
Visual Consistency

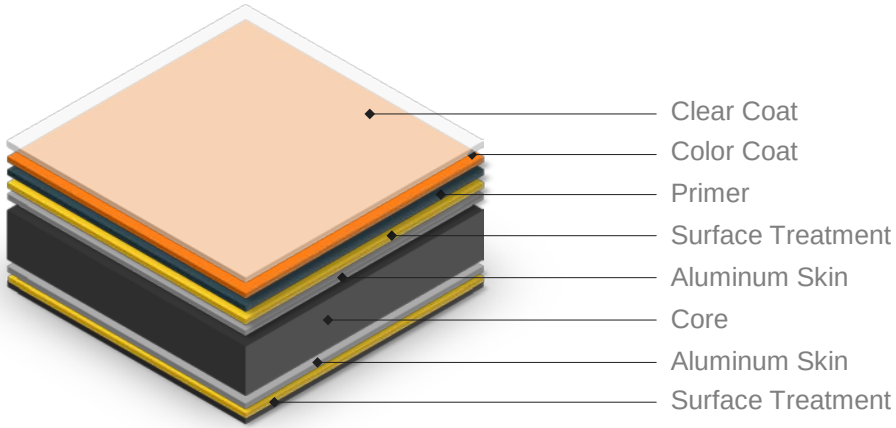
Aluminum and Metal Composite Materials

ACM/MCM

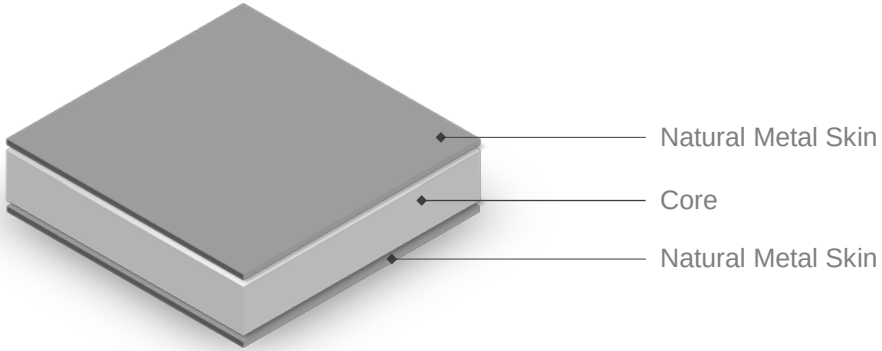
Composite materials are produced by the continuous bonding of two thin (same or similar) metal skins, under heat, pressure, and tension, to either side of a thermoplastic core. The thermoplastic core allows for uniform expansion and contraction of both metal skins ensuring thermal stability and product performance.

Structure of ACM/MCM

ACM



MCM



Finish Options

The options for finishes and surfaces, available with Metal Composite Materials, are always expanding. New finishes are constantly being introduced into the market providing the design community with the ability to create exciting visual effects.

Painted ACM

Solid, Metallic, Mica, Prismatic Finishes

Faux Finishes: Stone & Timber

Decorative: Brushed, Reflective

Two Color

Anodized Colors/Natural Metal Skins

(The anodized / natural metal finishes are detailed in a separate AIA presentation)

Anodized, Copper, Zinc, Stainless Steel, Titanium

Painted Aluminum

Solid Color:

2 Coat

Primer/Color Coat

Mica:

2 Coat

Primer/Color with Mica Flake

Metallic:

3 Coat

Primer/Color Coat With Aluminum/Mica Flake / Clear Coat

Prismatic:

3 Coat

Primer/Color Coat/Clear Coat with Specialized Mica Flake

Painted Aluminum

Stone/Timber:

3 Coat + Image Transfer Layer

Primer/Color Base Coat/Image Transfer Layer/Clear Coat

Decorative:

1 Coat

Clear Coat over a Specially Treated Aluminum Coil

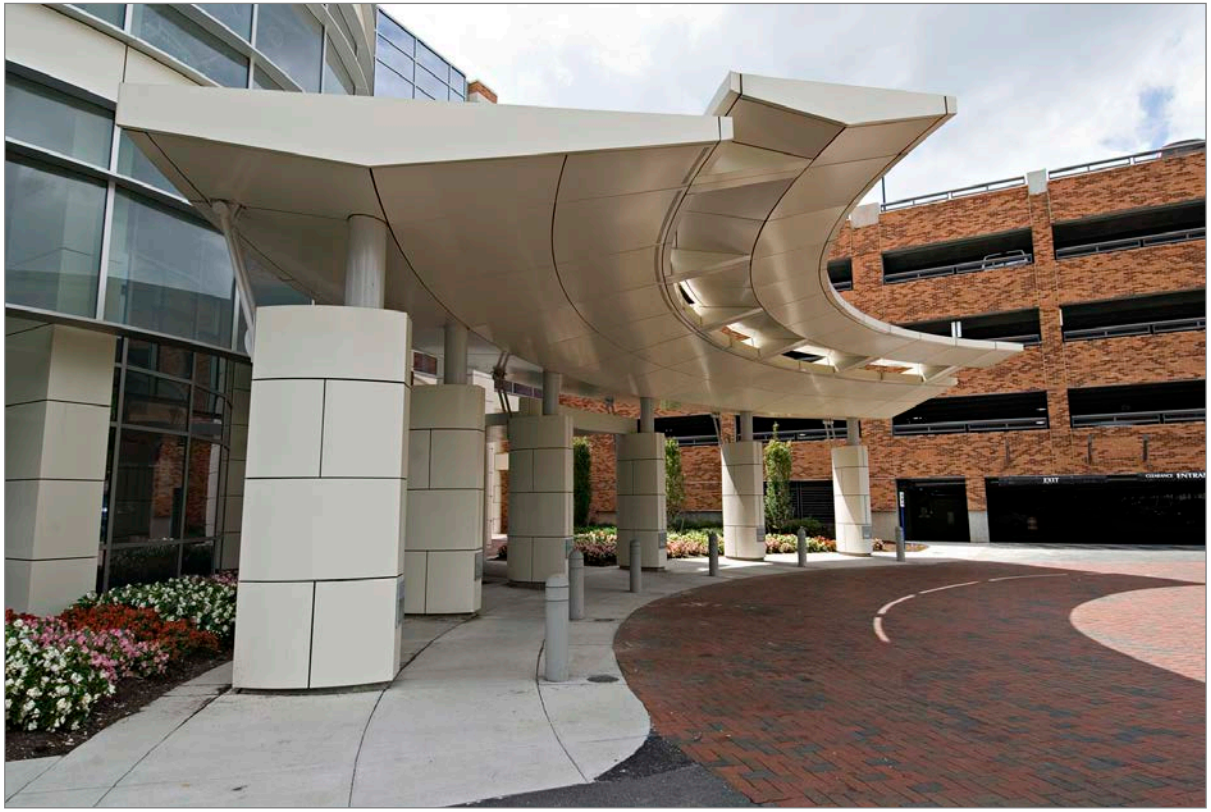
2-Color:

3 Coat

Primer/Color Coat/Partial Web Color Coat

Solid Color

St. Mary's Medical Office Building



Mica

Atlantic Ford

Metallic

Bethel Korean Church

Prismatic

Coss Y Leon Office Building

Stone/Timber

H&M Store

Decorative

Mark Sweeney
Buick/GMC Dealership

Two Color

Jiffy Lube

American Architectural Manufacturers Association

(AAMA)

Establishes voluntary standards for building materials and systems performance.

AAMA 2603, AAMA 2604 and AAMA 2605 apply to coatings which are coil or spray applied and oven cured.

AAMA 2605 is the most commonly referenced architectural standard.

AAMA 620 was previously for coil coating and is to be obsolete

Paint Options

There are three basic families of paints which are commonly used for building panels:

Urethanes

Polyesters

Fluoropolymers

Urethanes

Urethanes are generally spray applied and not coil coated

Paint is cured by chemical cross-linking of the resin chains

Paint achieves bright colors and high gloss, but weaker performance compared to polyester paints

Generally this paint meets AAMA 2603 performance standard

Polyesters

Utilize polyester and melamine resins

Paint is cured by chemical cross linking of the resin chains

Three types of Polyesters:

Basic

Siliconized; Silicone is added to improve weatherability and durability

High Performance; Various additives are introduced to further improve paint performance

Paint achieves bright colors and high gloss, but weaker performance compared to fluoropolymer paints

Generally this paint meets AAMA 2603 performance standard

Some High Performance polyesters can meet AAMA 2604

Fluoropolymer

(PVDF + FEVE)

Latest of the paint systems to be introduced

Two basic paint types:

First Generation: PVDF

Second Generation: FEVE

Resins contain a carbon (C) and fluorine (F) bond. The strength of this bond provides exceptional weatherability and durability based on high ultraviolet light and chemical resistance.

These paints meets AAMA 2605 performance standard.

Only exception is when PVDF paint ratio is less than 70% PVDF resin
This paint only meets AAMA 2604

Fluoropolymer PVDF

PVDF: Poly Vinylidene Fluoride

Polymer made of a chain of identical monomers

Patented in 1948

Resin based paints introduced in the 1960’s

Fluoropolymer PVDF

PVDF: Poly Vinylidene Fluoride

At full strength, PVDF based paints are a dispersion of 70% PVDF resin and 30% acrylic resin

Acrylic resin is necessary in order to formulate PVDF into a coating

As the ratio of PVDF to acrylic resin drops the crystallinity in the paint film and the performance of the paint drops off rapidly

The crystallinity is what gives the paint film it’s excellent durability properties

Fluoropolymer PVDF

PVDF: Poly Vinylidene Fluoride

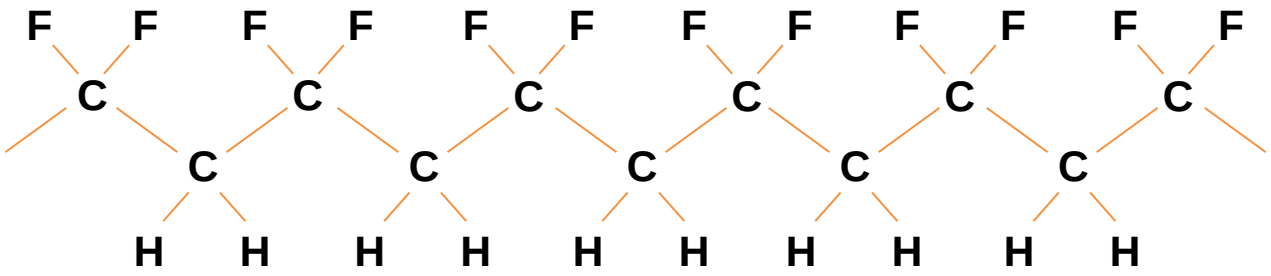
The paint film is created by fusing the PVDF at high temperatures. No cross-linking with the acrylic resin occurs. Under high temperature and pressure the paint film can remelt. Thermoplastic - Thermally fused

The PVDF acts as a matting agent in the acrylic resin. Gloss, as measured by a 60 degree gloss meter is limited to a 30 to 40 range.

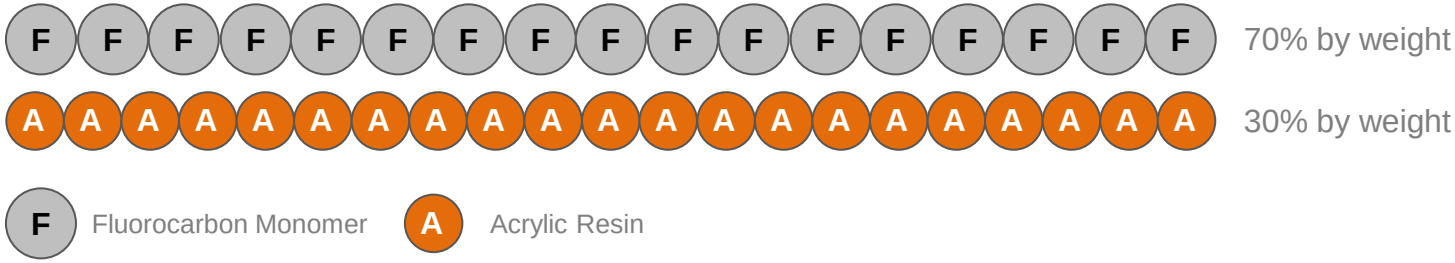
Because of the opaque nature of the dispersion the color palette is somewhat muted and limited in selection/offering.

Fluoropolymer PVDF

PVDF: Poly Vinylidene Fluoride



Poly Vinylidene Fluoride



Fluoropolymer FEVE

FEVE: Fluoroethylene – Vinyl Ether

Copolymer made of a chain of alternating fluoroethylene (FE) and vinyl ether (VE) monomers

Introduced in 1982 by ASAHI Glass

Fluoropolymer FEVE

FEVE: Fluoroethylene – Vinyl Ether

These paints are a homogeneous solution of 100% FEVE resin.

The fluorocarbon component of the system is integral to the base resin backbone.

“R groups” are chemical molecules attached to the resin backbone to give the paint film specific enhanced performance attributes.

Fluoropolymer FEVE

FEVE: Fluoroethylene – Vinyl Ether

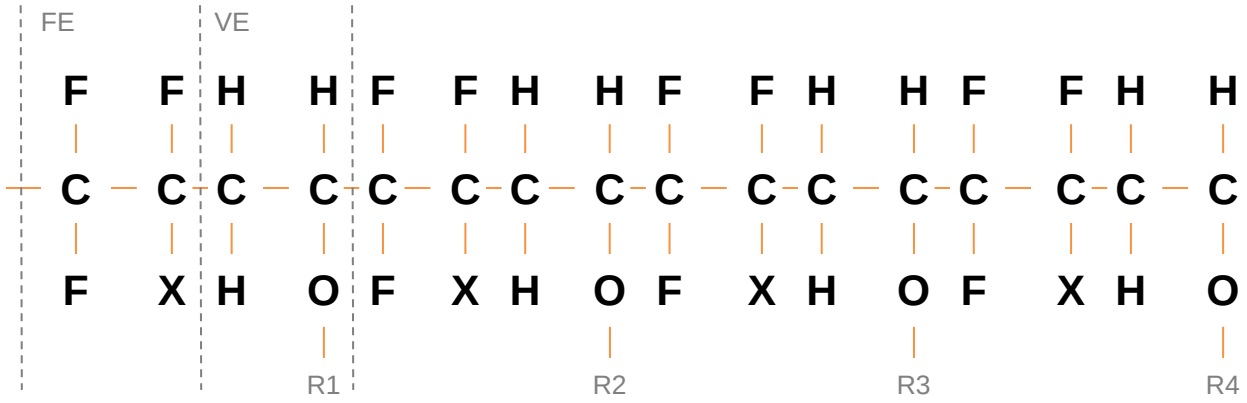
The paint film is formed by cross linking the resin chains. The paint film, once set, will not remelt under high temperatures and pressures. Thermoset – Chemically Crosslinked

Since the fluorocarbon component is integral to the resin's backbone it does not act as a matting agent and 60 degree glosses ranging from 30 to as high as 70 can be achieved.

The resin is translucent and allows for an extensive, bright / clean, color palette including brighter - cleaner finishes.

Fluoropolymer FEVE

FEVE: Fluoroethylene Vinyl Ether



R1=Clarity, gloss and hardness
R2=Flexibility
R3=Cross-linking site
R4=Pigment compatibility

Fluoroethylene Vinyl Ether

FE Fluoroethylene

VE Vinyl Ether

Fluoropolymer PVDF + FEVE

FEVE Resins

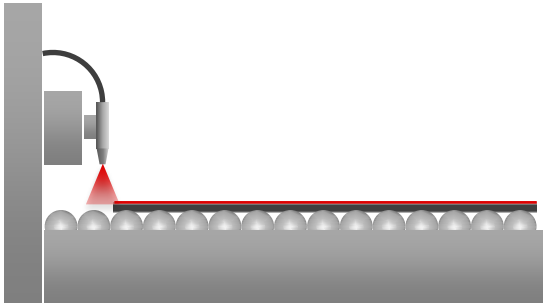
100% FEVE
Clear resin
Homogenous Solution
Gloss range 30 – 70
Wide color range
Muted & bright colors
Thermoset

PVDF Resins

70% PVDF + Acrylic
Milky resin
Dispersion solution
Gloss range 30 – 40
Moderate color range
Muted colors only
Thermoplastic

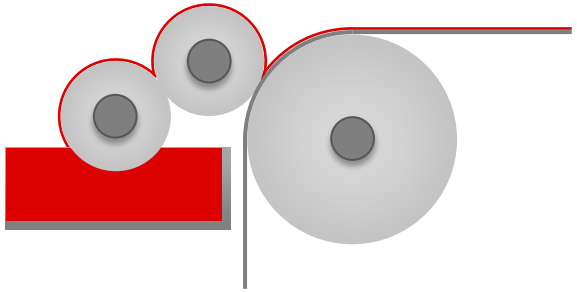
Application Methods

Spray

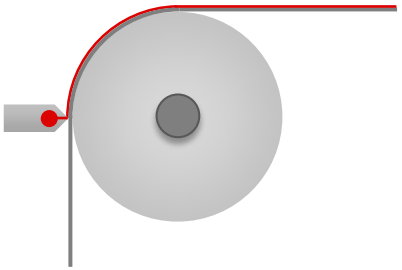


Coil Coating

Roll Coating



Die Coating



Application Methods

Spray

Typical single sheet batch process

Low volume and speed

Low control over paint thickness

Coil Coating

Roll Coating Method

High volume and continuous process

Good control over paint thickness

Quality coating, roping marks normal

Low coating investment

Die Coating Method

High volume and continuous process

Excellent control over paint thickness

Smoothest coating possible

Expensive coating investment

Color Measurement

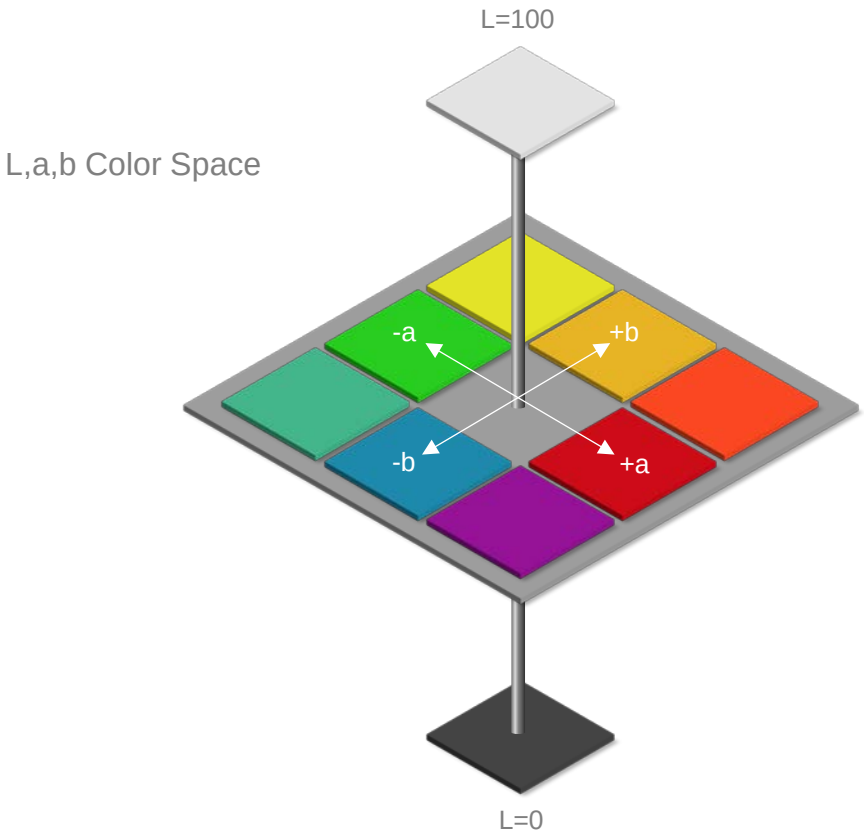
Color is measured in 3 dimensions

The L axis measures light to dark

The a axis measures red to green

The b axis measures blue to yellow

Delta E or DE combines the offsets in all three planes to one number. The higher the number the greater the color shift. DE is an absolute value so it can not be plus or minus.



Weathering + Durability of Paint Finishes

Paint performance is based on chemical and ultraviolet light resistance.

Real time South Florida exposure is the standard test method for determining a paint systems durability.

Accelerated testing can be used as a relative comparison of products. The translation of accelerated testing to real time performance is a matter of much debate.

Weathering + Durability of Paint Finishes

Accelerated Testing:

Some test equipment exposes the samples to an intense level of light which incorporates the short wavelength ultraviolet portion of the spectrum. Carbon Arc, QUVA, QUVB, Xenon Arc, etc.

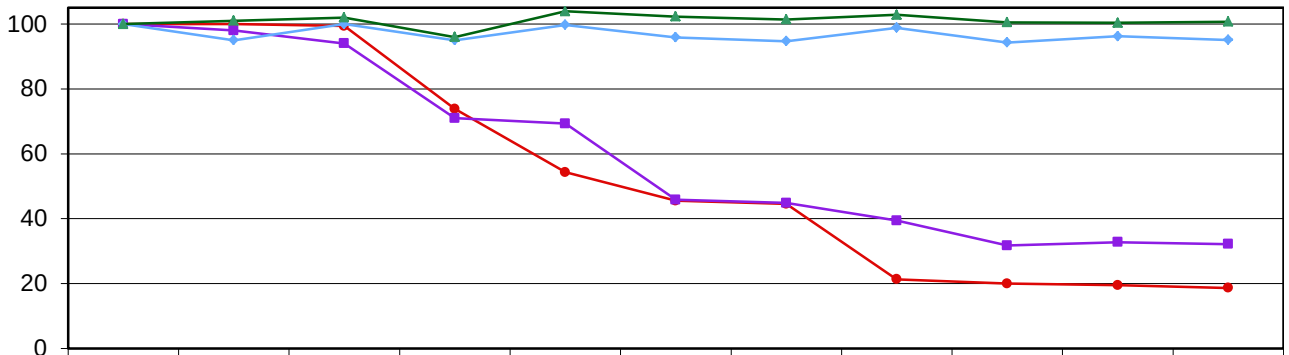
EMMAQUA testing uses banks of mirrors in the Arizona Desert to focus the sun light on a small sample, exposing the sample to a concentrated dose of natural sunlight while also providing sample cooling.

Weathering + Durability of Paint Finishes

The three main quantitative measures of a paint systems durability performance are:

% Gloss Retention: When the surface of the paint film begins to break down the gloss will tend to decrease. The % of gloss retention measures the integrity of the surface of the paint film.

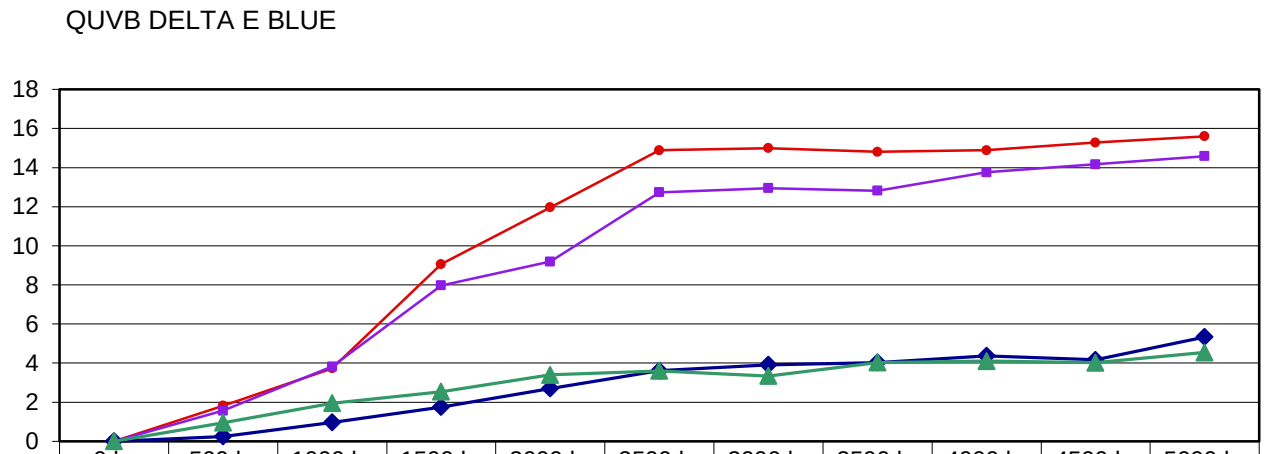
QUVB % GLOSS RETENTION BLUE



	0 hr	500 hr	1000 hr	1500 hr	2000 hr	2500 hr	3000 hr	3500 hr	4000 hr	4500 hr	5000 hr
HP Polyester Sapphire Blue	100	100	99.4	73.86	54.34	45.54	44.58	21.33	20	19.52	18.67
HP Polyester Chevron Blue	100	98	94	71	69.31	45.86	44.83	39.43	31.72	32.76	32.18
FEVE Sapphire Blue	100	95	100	95	99.75	95.88	94.7	98.86	94.32	96.21	95.08
FEVE Chevron Blue	100	101	102	96	103.91	102.31	101.42	102.85	100.53	100.36	100.71

Weathering + Durability of Paint Finishes

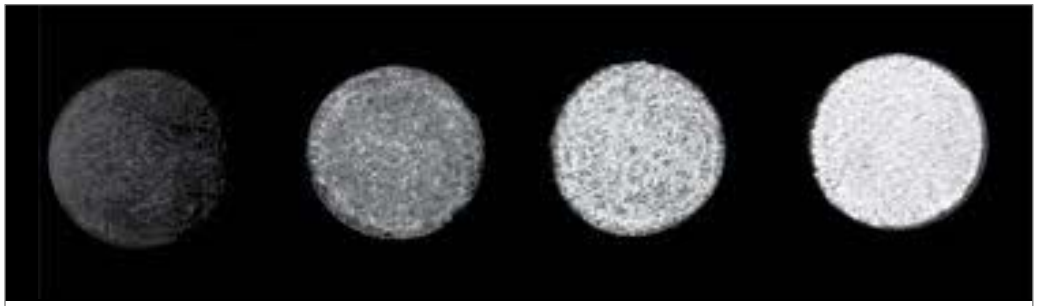
Color Retention: The exposure to the UV light and some chemicals can degrade the pigments causing the color to fade. This is measured as the distance between the color of the sample prior to and after testing in a 3-dimensional color space. It is expressed as “Delta E”.



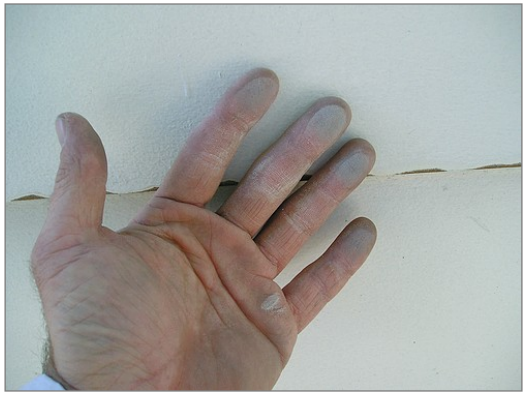
	0 hr	500 hr	1000 hr	1500 hr	2000 hr	2500 hr	3000 hr	3500 hr	4000 hr	4500 hr	5000 hr
HP Polyester Sapphire Blue	0	1.82	3.73	9.06	11.97	14.89	15	14.81	14.89	15.28	15.6
HP Polyester Chevron Blue	0	1.56	3.82	7.97	9.19	12.74	12.95	12.82	13.76	14.17	14.59
FEVE Sapphire Blue	0	0.25	0.97	1.75	2.7	3.61	3.91	4.03	4.37	4.17	5.34
FEVE Chevron Blue	0	0.95	1.95	2.54	3.4	3.6	3.34	4.03	4.1	4.02	4.54

Weathering + Durability of Paint Finishes

Chalking: As the paint degrades the surface of the paint develops a white powder. This is wiped with a black cloth and compared to a series of visual standards from ASTM D4214 Standard Method for Evaluating the Degree of Chalking. A number 8 indicates minimal chalking and a number 2 indicates high level of chalking.



No. 8 No. 6 No. 4 No. 2



Weathering + Durability (AAMA)

Attribute	AAMA 2603 Basic Pigmented Coatings	AAMA 2604 High Performance Coatings	AAMA 2605 Superior Coatings
Gloss Retention	No specification	5 Years ≥ 30%	10 Years ≥ 30%
Color Retention	Slight Change	5 Year Fade Delta E ≤ 5	10 Year Fade Delta E ≤ 5
Chalking	1 Year Chalk ≤ 8	5 Year Chalk ≤ 8	10 Year Chalk ≤ 8 Colors ≤ 6 White

Warranties (Fluoropolymer Paint Finishes)

Panel Warranties:

Typically issued from 2 to 10 years

Addresses panel integrity

Finish Warranties:

Typically issued for 10 years (AAMA2605)

20 – 30 year warranties are available based on paint color, product type, and location

Addresses Color Fade ≤ DE 5 and Chalk ≤ 8

Not all warranties are created equal. Not only the number of years but also performance limits should be reviewed.

Visual Consistency (Color Variation)

Lot to Lot Variation: Due to differences in pigmentation lots and variations in the process of the paint manufacturing and coating there will be variation between panels produced at different times and from different paint lots. This variation is more pronounced in coatings using flake finishes (Metallic, Mica, and Prismatic)

Typical acceptance limits for lot to lot variation are:

Solids: Delta E ≤ 1.0

Coatings containing flakes: Delta E ≤ 2.5

It is good practice to not mix lots on one elevation of a building.

Visual Consistency (Directionality)

ACM materials are manufactured with directional arrows on the surface's protective film and on the back skin.

It is recommended to have all panels installed with the directional arrows aligned in the same direction.

This is a very important consideration with reference to flake finishes, as appearance may not be consistent.

On some specific projects, the panels were purposely placed in a different orientation as a design element utilizing the expected appearance difference.

Questions?