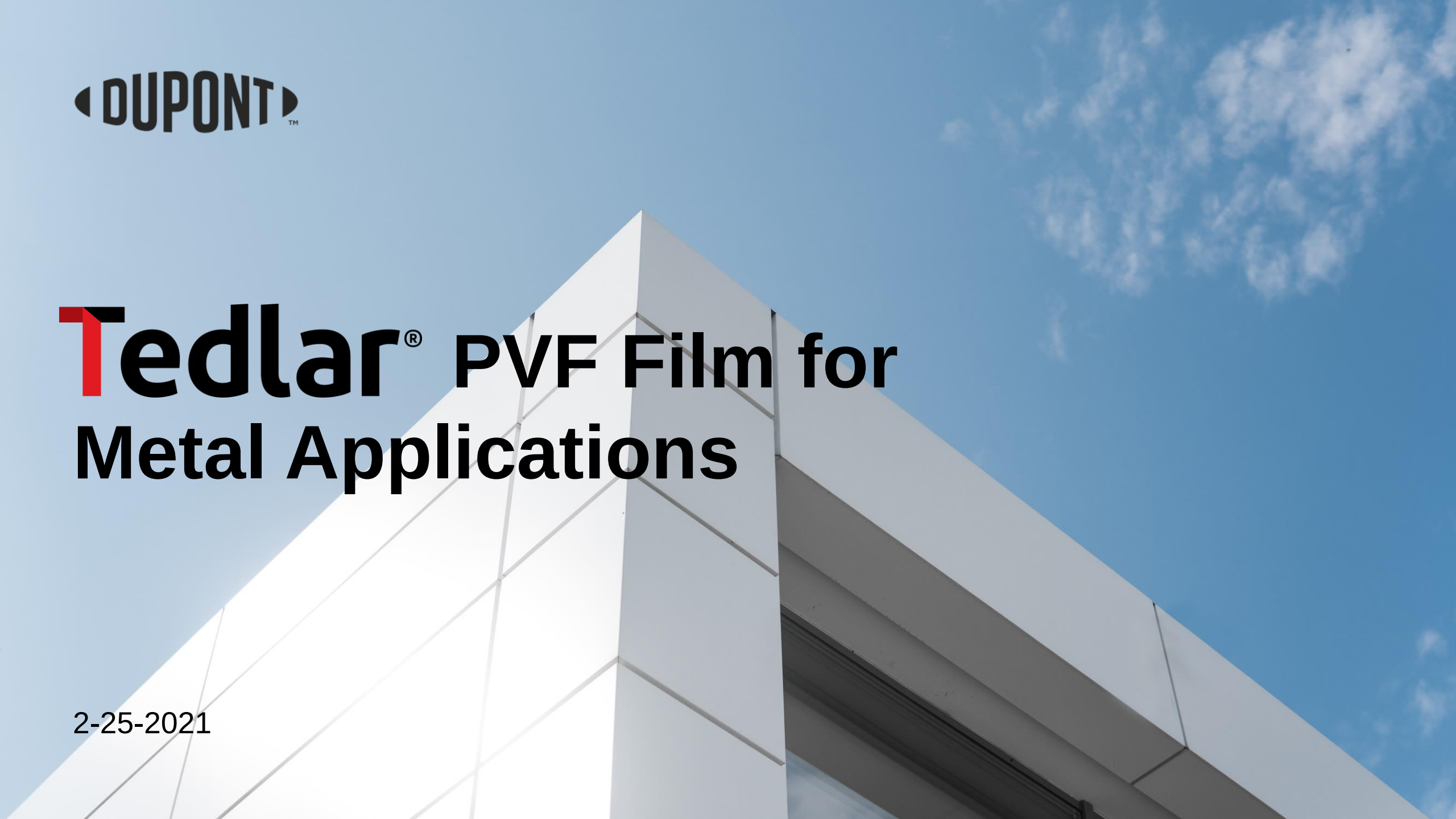

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Tedlar® PVF Film for Metal Applications

2-25-2021

Agenda

- Tedlar® PVF Overview
- Value Proposition of PVF vs. PVDF in Metal Applications
- Tedlar® PVF Metal Lamination introduction and performance

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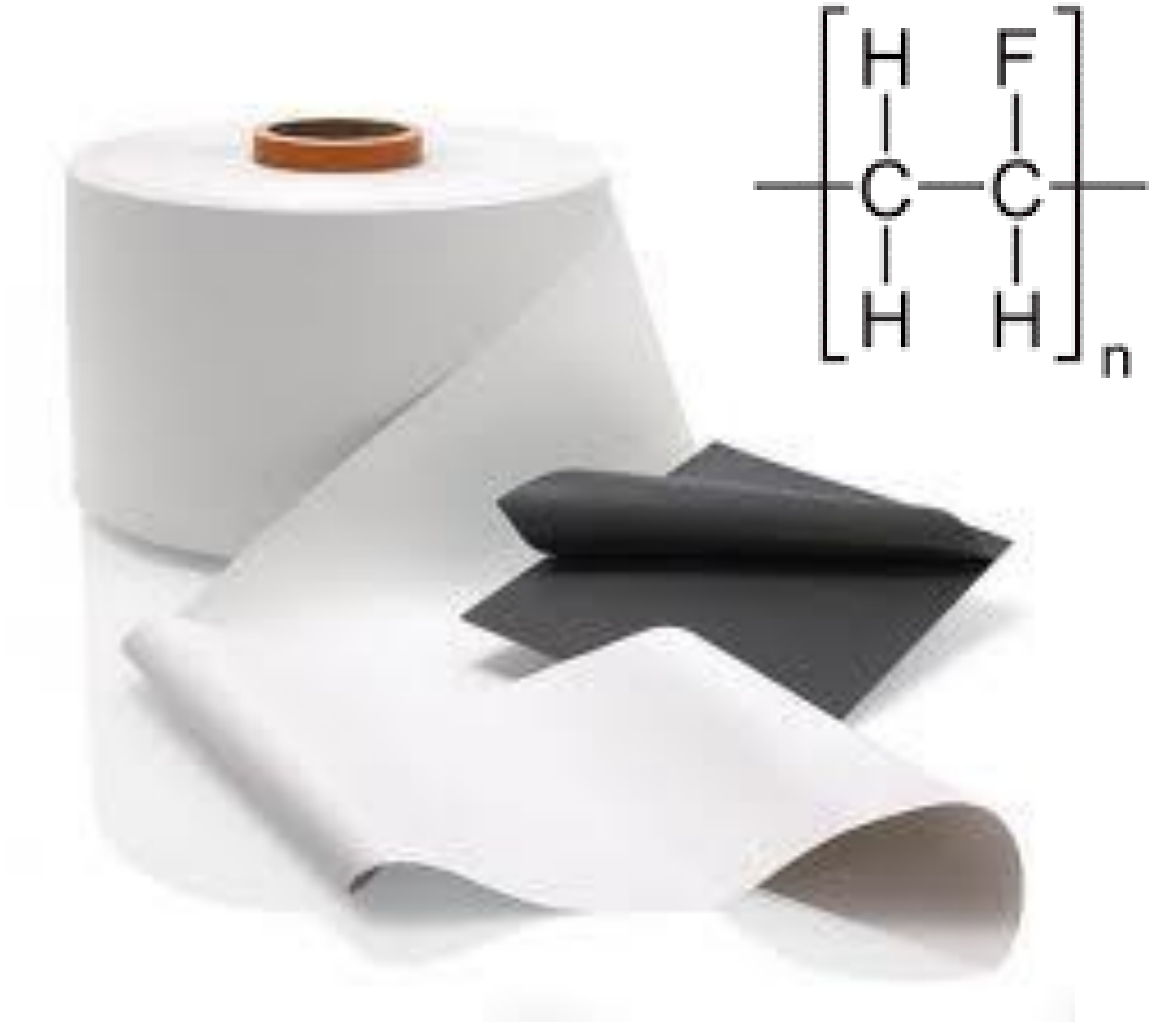
What is Tedlar®?

Tedlar® is a registered trademark for a **highly versatile polyvinyl fluoride (PVF) film** that provides a long-lasting finish to a wide variety of surfaces exposed to harsh environments; while its inert, non-stick properties make it an excellent release film.



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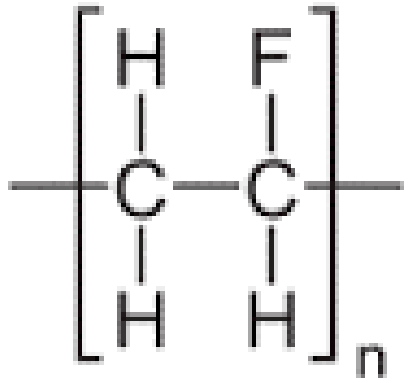
Fundamentals

PVF is Poly (vinyl fluoride) CAS # 24981-14-4



- DuPont is the only significant manufacturer in the world
- Polymer is made by polymerizing VF (Vinyl Fluoride)
- PVF is not soluble in any known solvent at room temperature
  - PVF will dissolve and coalesce in some latent solvents at elevated temperature
- PVF is not melt processable
  - Latent solvents suppress the melting point and allow for processing
- Peak crystalline melting point of PVF is 191-193□C

Background

- **DuPont invented polyvinyl fluoride (PVF) polymer** in the 1940s, and by the 1950s began developing products based on the material.
- In 1961, DuPont **registered the Tedlar® brand name** in the US and construction started on its **first production facility** in Buffalo, NY. Completed a **major capacity expansion** in 2012.
- More than fifty years later, Tedlar® film is recognized as **the high-performance standard for surface protection**, with proven durability in harsh operating environments.
- We have a **robust R&D, Technical Service, and Customer Service team** to support customers in enabling use of PVF in their specific products and applications.

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Why Do Customers Use Tedlar® PVF Film?

Core Attributes

- Chemical /solvent resistant
- Stain / graffiti resistant
- High mechanical strength
- High elongation (conformable)
- Accepts tight bend radii
- UV & weather stability
- Mold & mildew resistant
- Low toxicity & volatiles
- Light weight / thin
- Sound transmitting
- Hydrolytic stability
- Heat sealable
- High dielectric constant
- Low gas/vapor permeability

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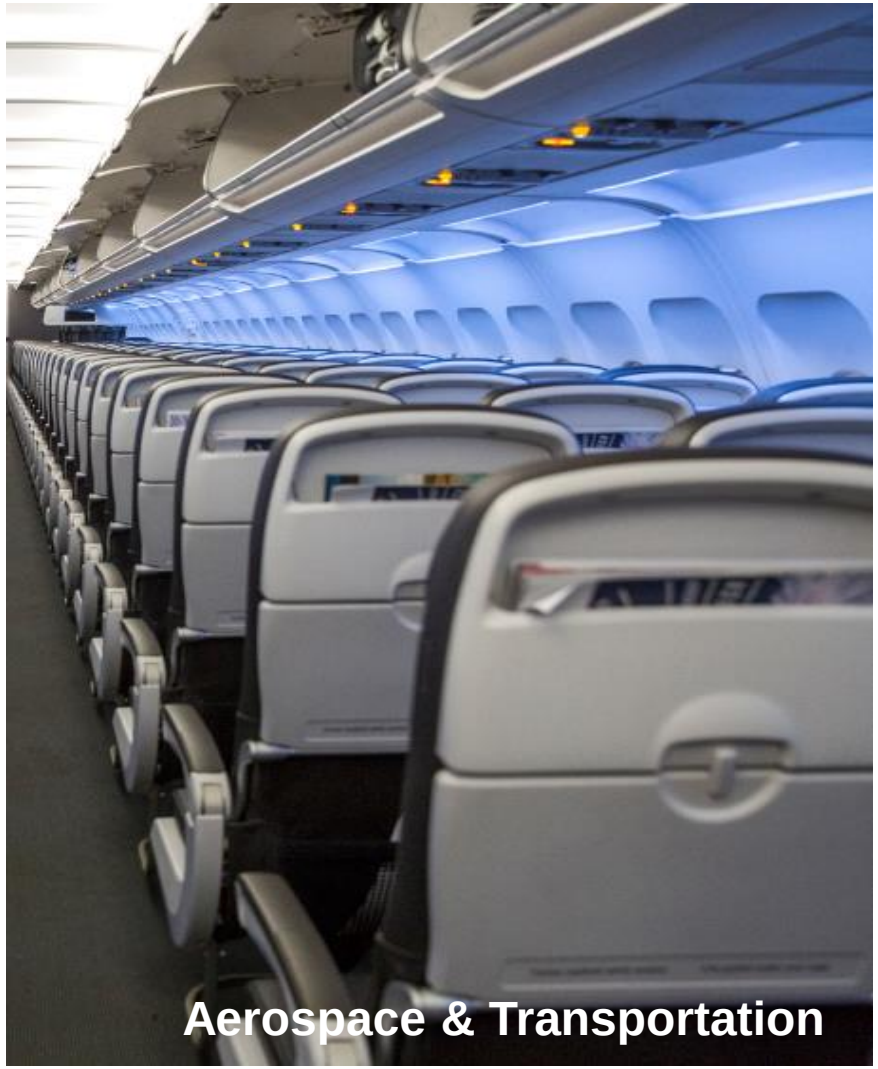
Tedlar® PVF Applications

Proven applications, globally, for over 60 years



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Tedlar® PVF Product Families

- Films
- Polymers
- PVF Dispersions
- Adhesives

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Tedlar® PVF Film provides a long-lasting finish to a wide variety of surfaces exposed to harsh environments

Tedlar® PVF Film:

- Tedlar® PVF film has been used in numerous commercial applications for over 50 years
- Tedlar® PVF film provides cost-effective long lasting aesthetic protection for architectural applications, even in extreme outdoor environments.
- Tedlar® PVF films can preserve and extend a building's appearance and lifetime by preventing building facades from fading, cracking or corroding.
- Tedlar® PVF films are stain resistance and easy to clean that to reduce maintenance costs to provide lower total life cycle cost of buildings

+50 YEARS

DuPont™ Tedlar® polyvinyl fluoride (PVF) film has been used in numerous commercial applications for over 50 years.

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Potential Applications

- Curtain Walls
- Roofing
- Corrugated paneling
- Flat paneling
- Commercial buildings
- Public Buildings
- Healthcare Interiors
- Industrial Plants
- Animal Husbandry
- Buildings in Coastal Regions

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Common Protective Systems Used for Architectural

- Fluoropolymer (PVDF)
- Silicon Modified Polyester (SMP)
- Polyester
- Vinyl-Plastisol-PVC
- Acrylic
- Polyurethane

Each resin offers different outdoor durability performance.

Environmental (Temperature, Humidity, Contaminants…)

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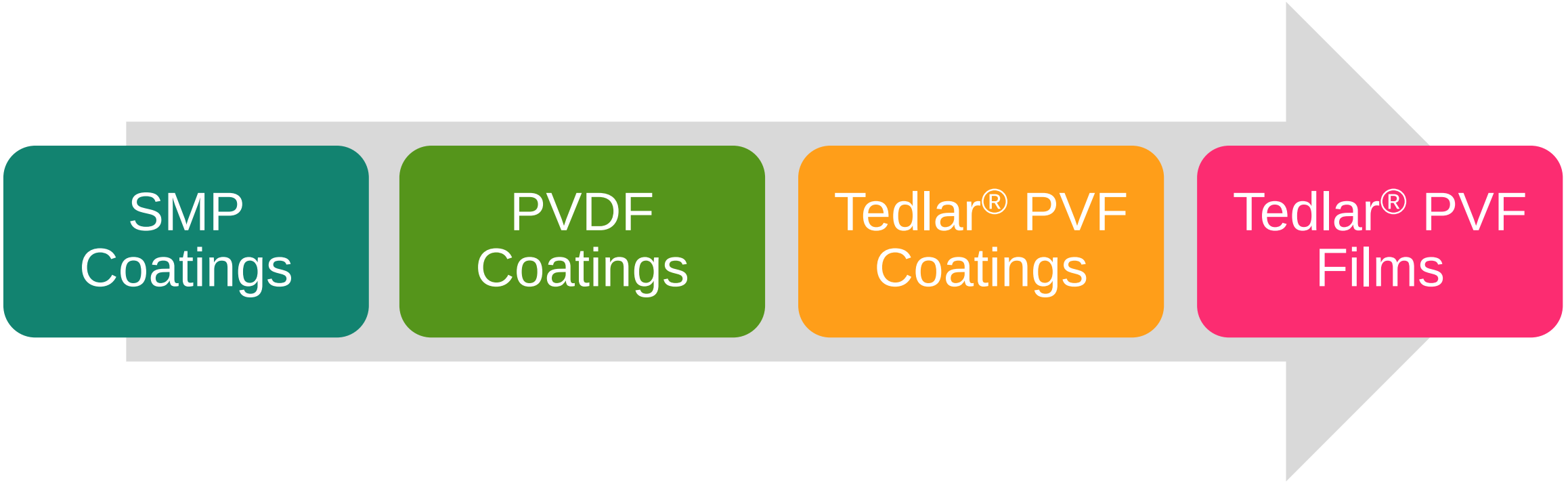
Performance



Increasing overall performance

Ultimate chemical and stain resistance

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Rust is the One of the Biggest Issue for Metals

There are three major factors that cause “RUST”:

- Product/Process Related
- Packaging & Handling Related
- Environmental (Temperature, Humidity, Contaminants, Coastal Areas, ….)

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Features of Tedlar® PVF Film Metal Laminate

Durable Protection	With excellent weatherability, corrosion and chemical resistance, suitable for applications in various environments, Tedlar® film maintains its color and gloss for a long time.
Environment & Safety	Excellent fire resistance, no support for bacterial growth on the surface of flame retardant materials , low VOC emissions during processing
Endurable Style	Ultra-low color differences, not easy to fade, uniform surface with good texture, matte surface with no light pollution, easy to process and form
Easy to Clean	Non-sticky and stain-resistant, it can withstand all types of dirt. Thanks to chemical inertness, it can be cleaned with various cleaning agents. Great self-cleaning property.

The Value Proposition of PVF Film Metal Laminate is to provide long lasting protection for Interior and Exterior Architectural Applications

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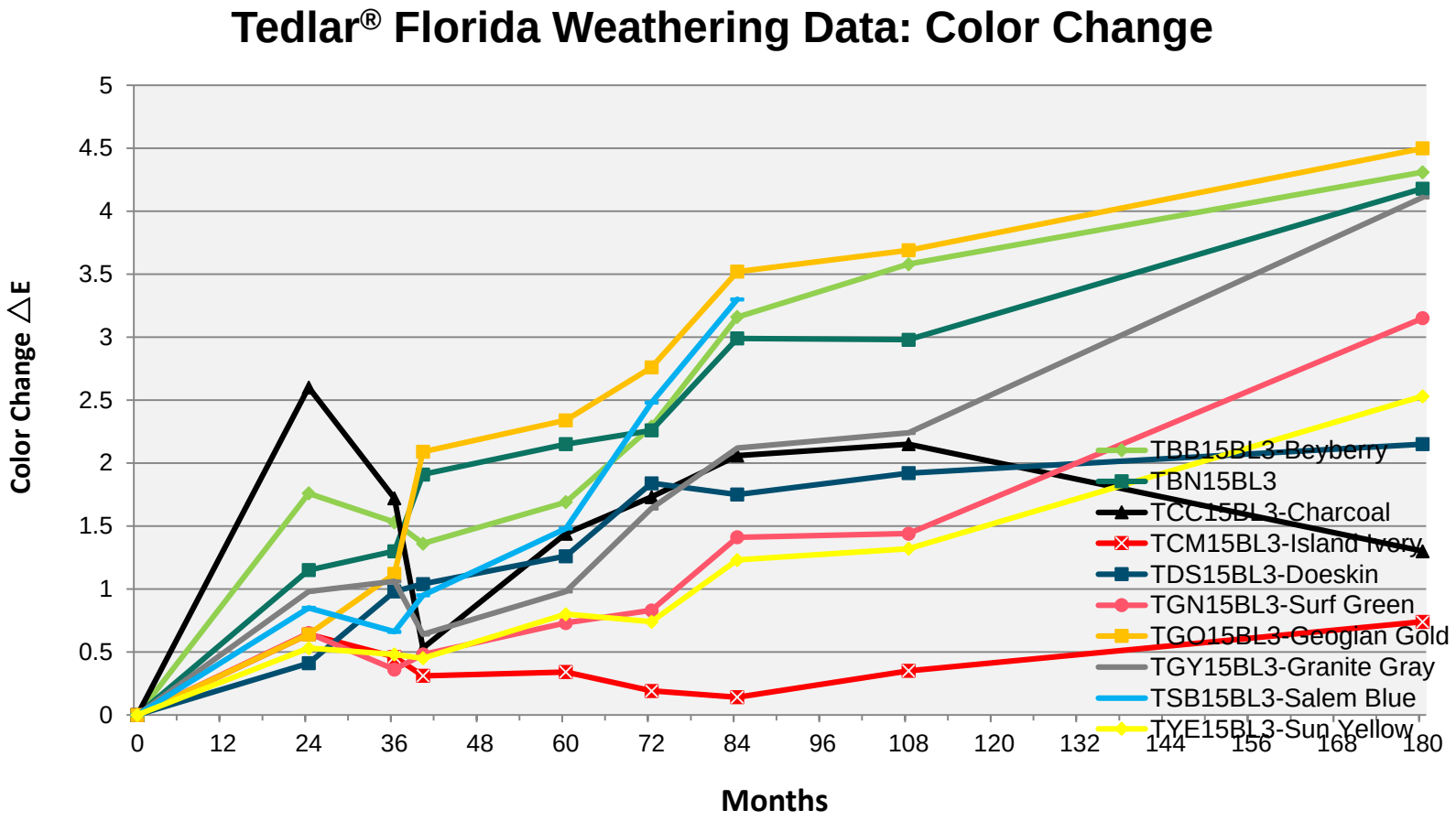
Durability – 15-year Exposure Test in Florida



Tedlar® PVF Film shows minimal color changes after repeated exposure

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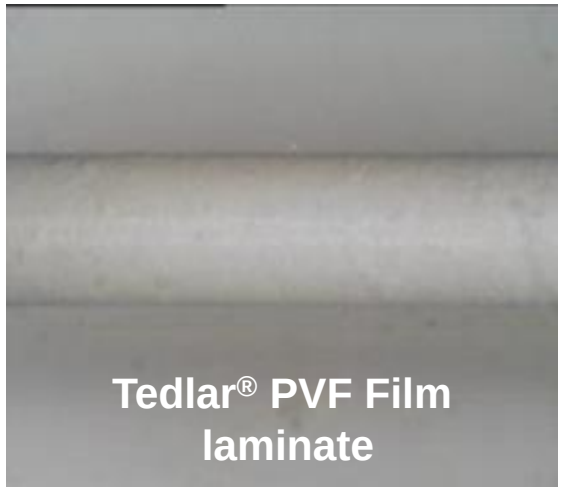
T-Bend Testing

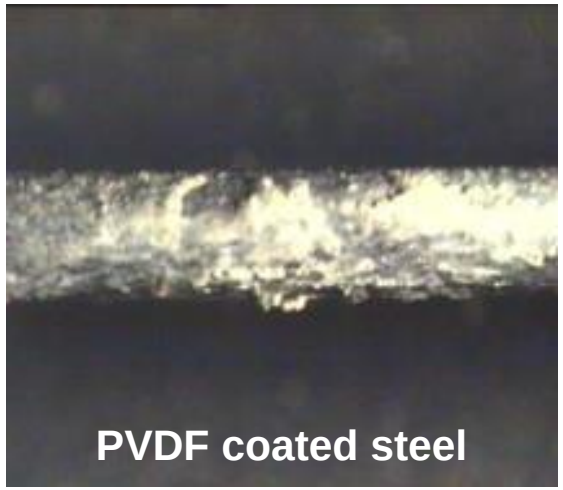
Bendability is important to metal fabricators. Having the flexibility to create bends at all angles allows fabricators to create designs for all applications. However, bending can create microcracks in certain coating systems. Over time, cracking allows the elements to penetrate the coil.

In this test, we compare the coil coated with different PVDF Coatings with the coil laminated Tedlar® PVF Film. Only the coil laminated Tedlar® PVF Film could be bended to a zero T-Bend without cracking allowing for the ultimate formability.

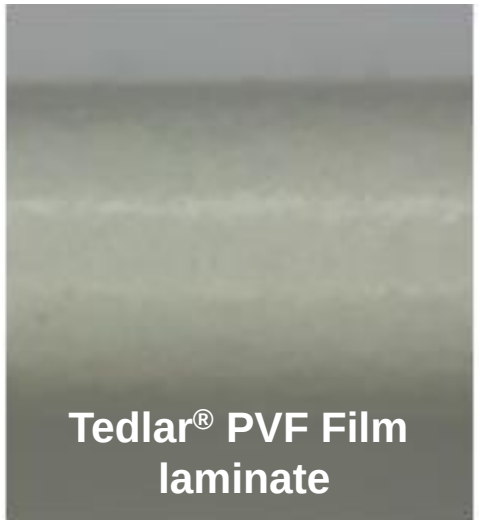
Superior Processability & Corrosion Resistance

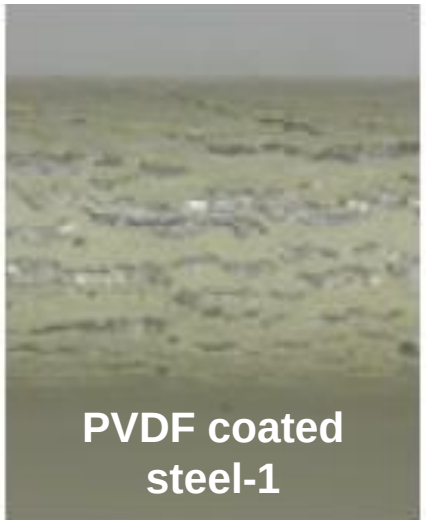
Salt spray 2,000hrs (0T bending)





0T bending test (magnification by 40 times)





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Superior Processability & Corrosion Resistance

Salt spray 2,000hrs (punched)

- There is no rusting on the punched steel sheet after 2000-hour salt spray test
- Allow complex sheet shape, with no discoloration at the bend
- Tedlar® film has an elongation of more than 100% and no cracks formed after 0T bending to protect metal sheet from corrosion.

Chemical Resistance Testing

While UV is a major concern, coil surface coverages need to protect metal from a variety of substances like salt spray in coastal regions, acidic rain in industrious areas, and overall dirt and grim in cities including animal feces. The following tests shows how a Tedlar® PVF Metal Laminates compare to commercial PVDF coatings.

All samples are tested by immersion with 5%HCl and 10%NaOH respectively. Four-edges are sealed using wax to prevent the metal underneath damaged by chemicals. Also immersed only half of the samples to observe the surface change.

After 1000 hours the Tedlar® PVF Film remains unchanged while the coating made with PVDF fails after 100-300 hours.

Superior Chemical Resistance

Acid and alkali immersion test

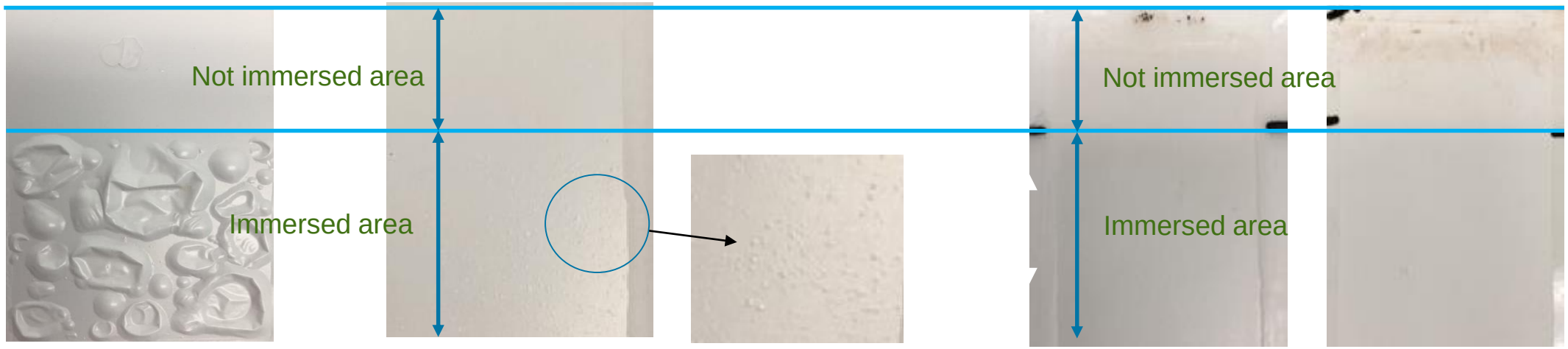
Top view

PVDF coated steel
(5% HCl, 168 hrs)

PVDF coated steel
(10% NaOH, 336 hrs)

Tedlar® Film Laminate

5% HCl, 1,000 hrs **10% NaOH, 1,000 hrs**



Bubbling on the surface

Bubbling on the surface

- **Only Tedlar® PVF film provides superior protection to the steel!**

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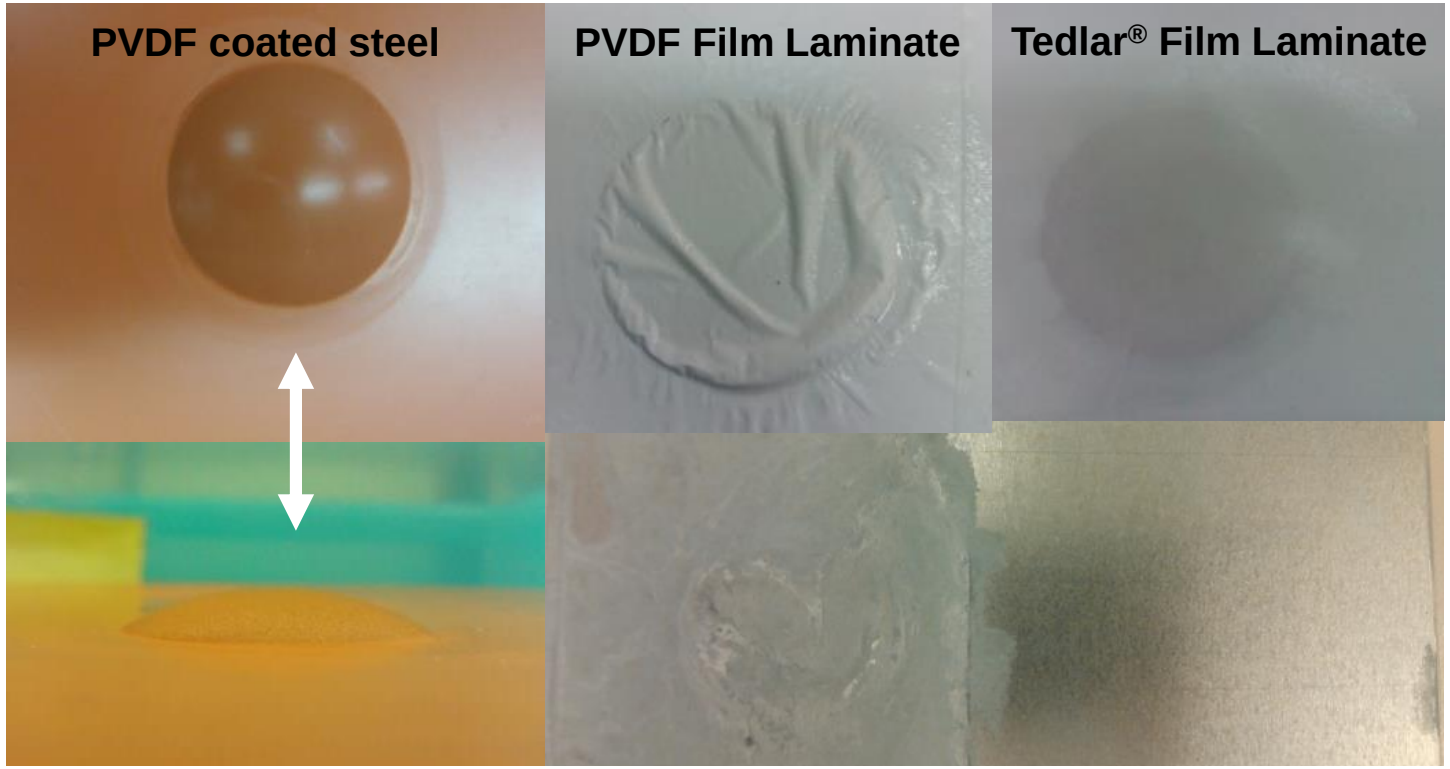
Superior Chemical Resistance

Acid and alkali resistance test

Top view



Bubbling on the surface	Bubbling on the surface, steel sheet is corroded	Surface is slightly discolored, steel sheet is intact

- Both PVDF coating and PVDF film have been attacked and severe bubbling can be found
- **Only Tedlar® PVF film provides superior protection to the steel!**

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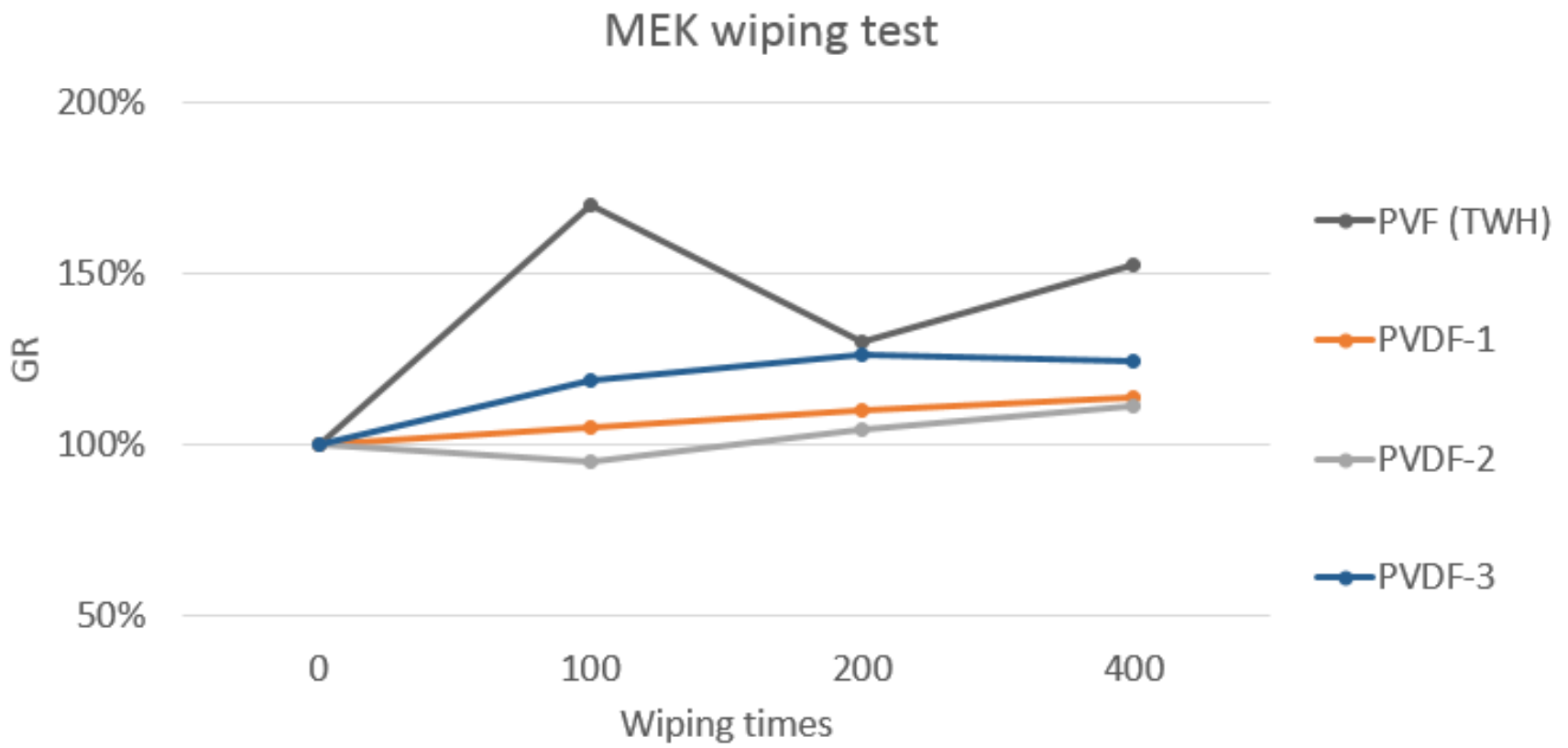
Chemical Resistance (MEK Wiping) and Gloss Retention



Tedlar® PVF film had excellent solvent resistance making allowing it to stand up to detergants and commercial grade cleaners.

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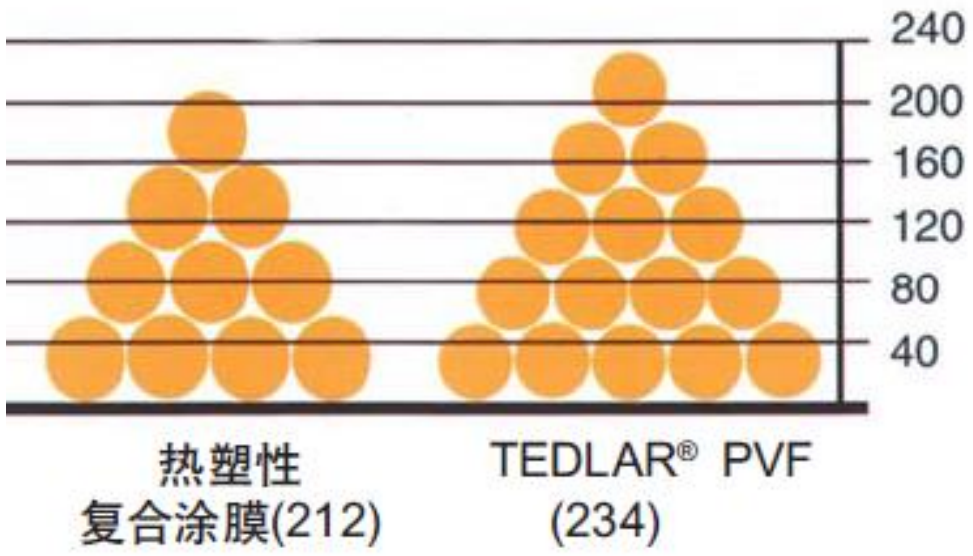
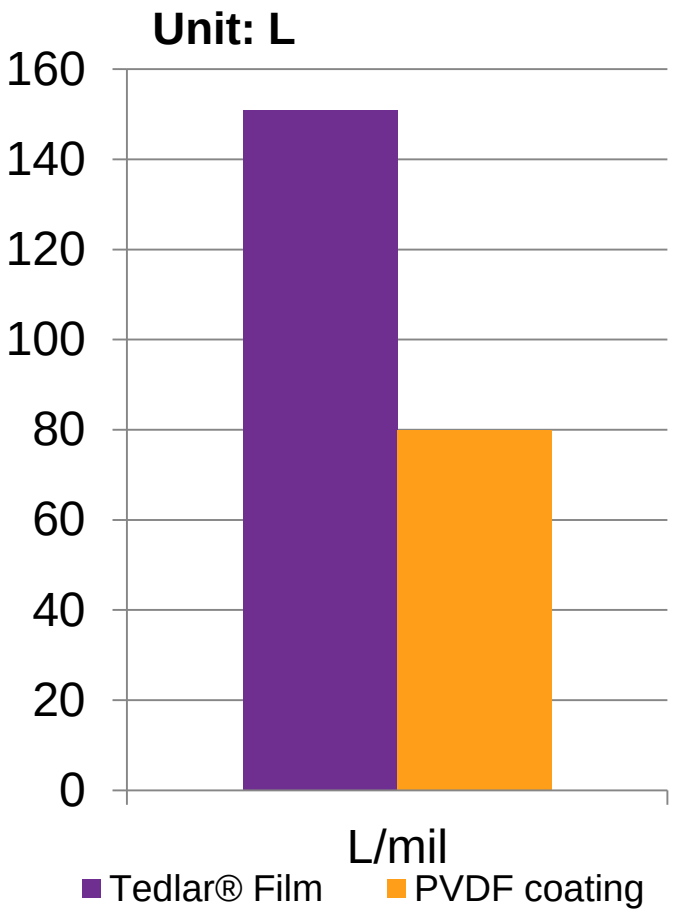
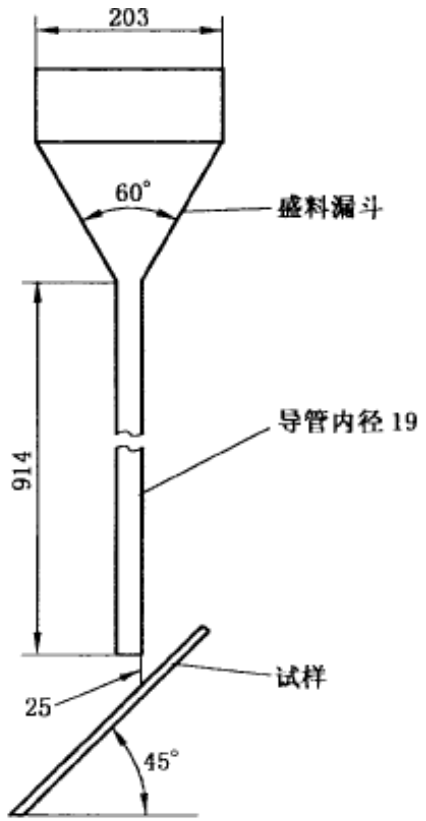
Abrasion Resistance

Tedlar® PVF Film shows good scratch resistance which will help prevent against erosion.

The Falling sand Test shows that abrasion resistance of 38um PVF film is equivalent to 100um thick thermal plastic multi-layer coating and has much better performance compare to PVDF coating







Falling sand abrasion resistant Test

Properties of Tedlar® PVF Film versus PVDF Coating

			Results	
Property	How to Test and Measure	Standard	PVF Film*	PVDF
Adhesion	2 hour boiling water	ASTM D3359	100%	100%
Chemical resistance	5% HCl immersion test		800 hours	168 hours
	10% NaOH immersion test		1000 hours	336 hours
	Nitric acid exposure		Delta E <3	Delta E <5
Coating flexibility	T bend	ASTM D4145	0T	2T
Hardness	Pencil hardness	ASTM D 3363	2H**	H
Specular Gloss	60 degree	ASTM D523	~40	~40
Corrosion resistance	Salt spray	ASTM B117	1500 hours***	1500 hours***
Accelerated exposure	QUV UVA, 4000 hours, gloss retention		Delta E <4	Delta E <4
			~80%	~80%
Humidity resistance		ASTM D2247	4000 hours	4000 hours

*Type of TWH15BL3 ** Gouge hardness *** Field area

*Type of TWH15BL3 ** Gouge hardness *** Field area

Tedlar® PVF Film – Successful Cases in WW

Tedlar® PVF Film – Successful Cases in WW

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PVDF Failure on the Bent Areas

PVDF T Bending Area Failure – Taiwan, 3 years after installation

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Tedlar® PVF Film Exposure

Corrosion damage seen at bends for PVC – Comparative installations in Utsunomiya Japan

PVC Coating
(Installed 1999)

Tedlar® Film Lamination
(Installed 1983)

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DuPont Offering

1. Tedlar® PVF Films - Clear & pigmented

2. Adhesive system For Tedlar® PVF Film Laminates - type of acrylic adhesives

Tedlar® PVF Film

Item	
Clear Film (TAP15BX3)	A clear PVF film to provide superior protections to patterned, graphic architectural materials
Pigmented Film –	
Choice	Choice Colors typically have shorter lead times and lower minimum order quantity requirements
Cool	Inspired by nature, the cool hues and understated bright tones in this collection bring to mind sea, sky and lush foliage.
Neutral	Minimalistic and serene, this collection includes soothing tones and natural, soft hues.
Warm	Taking cues from the sun and sandy beaches, the creamy hues in this collection evoke feelings of comfort and warmth.

Adhesive system

Item
Acrylic adhesive 68080
a liquid that can be pre-applied to facilitate lamination of products for interiors, such as vinyl wall coverings, and for exteriors, such as architectural siding, awnings, signage and fabrics.
Acrylic adhesive 68070
a liquid that is used with resin solution *Epon™ 828 to bond Tedlar® to aluminum and galvanized steel of various gauges.

**Epon™ is a trademark of Momentive Performance Materials Holdings LLC.*

DuPont will share technical know-how to help the convertors to laminate PVF film with proper processing conditions

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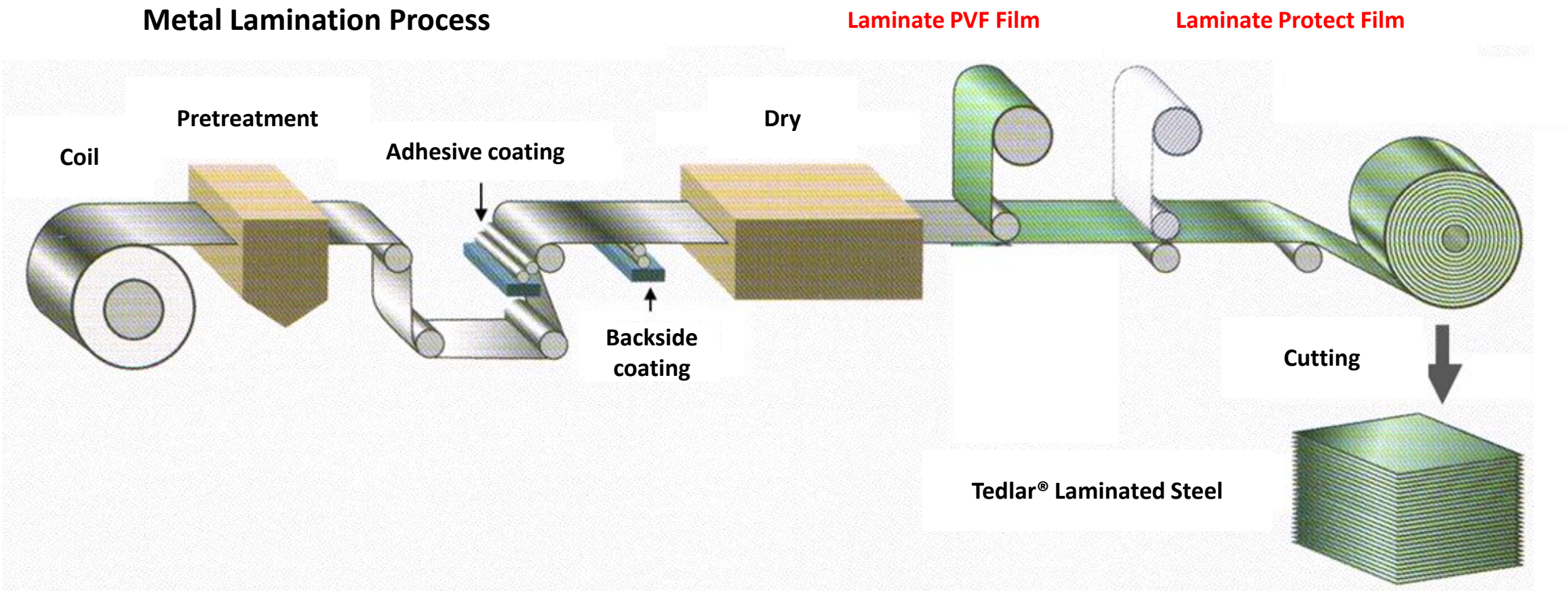
Metal Lamination Process

Laminate PVF film with appropriate adhesive onto steels thru heat lamination process to create similar construction but superior performance of painted steels



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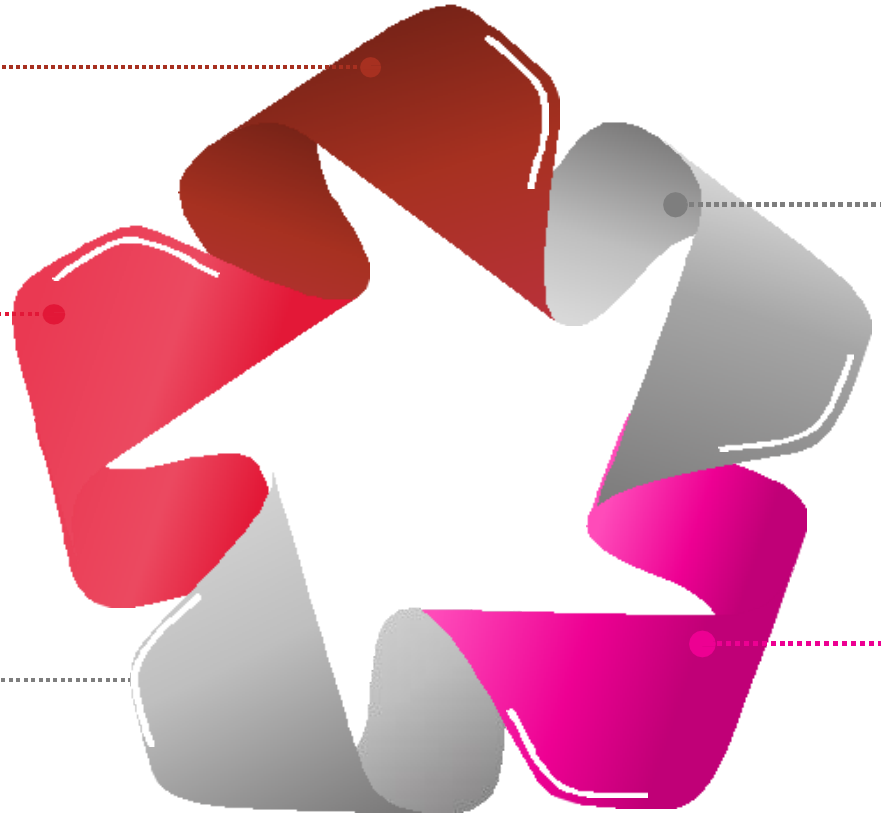
Materials Matter™

Ensuring to remain your building without aging by the right choice of materials

Sustainability is the industrial trend

The reliability and sustainability of Tedlar® PVF film laminated steel is related to the good processing, right selection of adhesive… etc.

It requires more reliable solutions for the severe environment conditions



There's risk under current specification to ensure sustainability of buildings

Higher maintenance cost is expected without right choice of materials

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