

Fluoropolymer Coatings for Plastics

**Presented at the 12th Annual Coatings for
Plastics Symposium**

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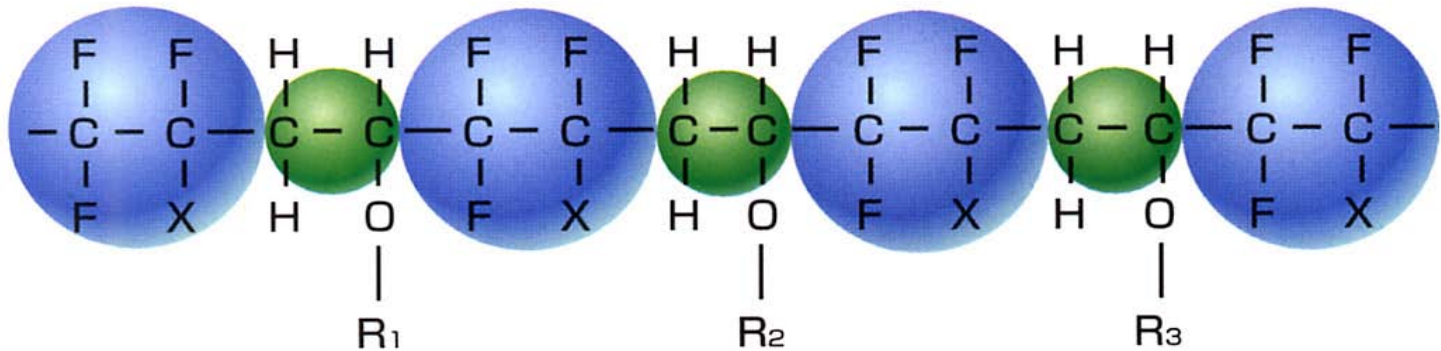
Properties of Fluoropolymers

- Excellent Weatherability
- Good Chemical Resistance
- Low Surface Energy
- Poor Solubility
- Difficult to Apply
 - Especially in the field
 - Especially on plastics

Fluoroethylene Vinyl Ether (FEVE) Resins

 Fluoro Ethylene

 Vinyl Ether



FLUORINATED SEGMENTS: Weatherability, durability, chemical resistance

VINYL ETHER SEGMENTS: Gloss, solubility, crosslinking (-OH groups), adhesion, flexibility, toughness

Advantages of FEVE Coatings

- OH Functional
 - Fluorourethanes
- Ambient or Elevated Temperature Cure
 - Field applied coatings
 - Shop applied coatings
 - Coatings for plastics
- Solvent Soluble
 - Clean, crisp colors
 - Wide range of gloss
- Fluoropolymer Segments
 - Ultra-weatherable

Types of FEVE Resins

- Solvent Based
 - Xylene
 - VOC/HAPS issues
- Solid Resins
 - Low VOC/HAPS free coatings
- Water Emulsions
 - Water resistance, weathering issues
- Water Dispersions
 - Excellent water resistance, weathering

Markets for FEVE Coatings

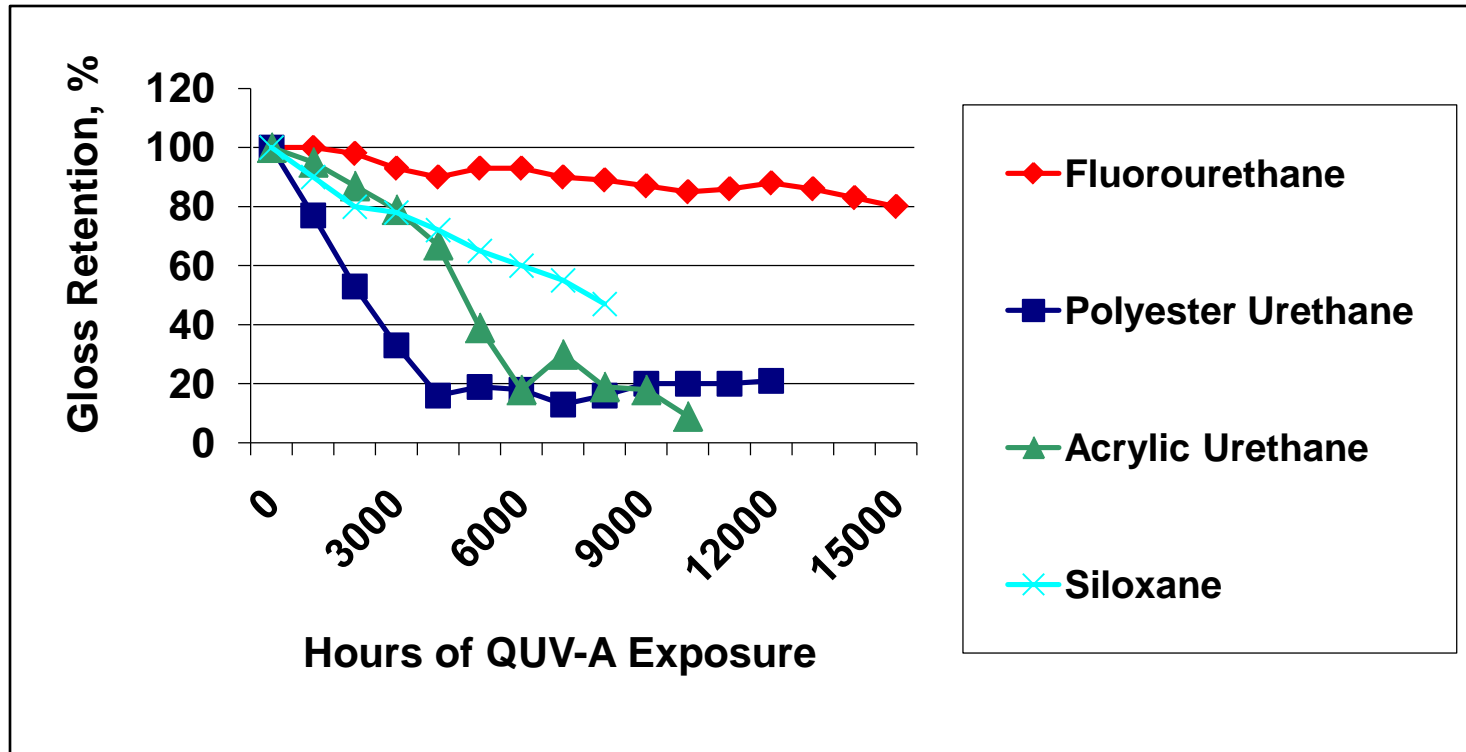
- Architectural
 - Monumental buildings
 - Aluminum extrusions-window frames
 - Aluminum panels
- Industrial Maintenance
 - Water towers
 - Bridges
- Aerospace
- Automotive

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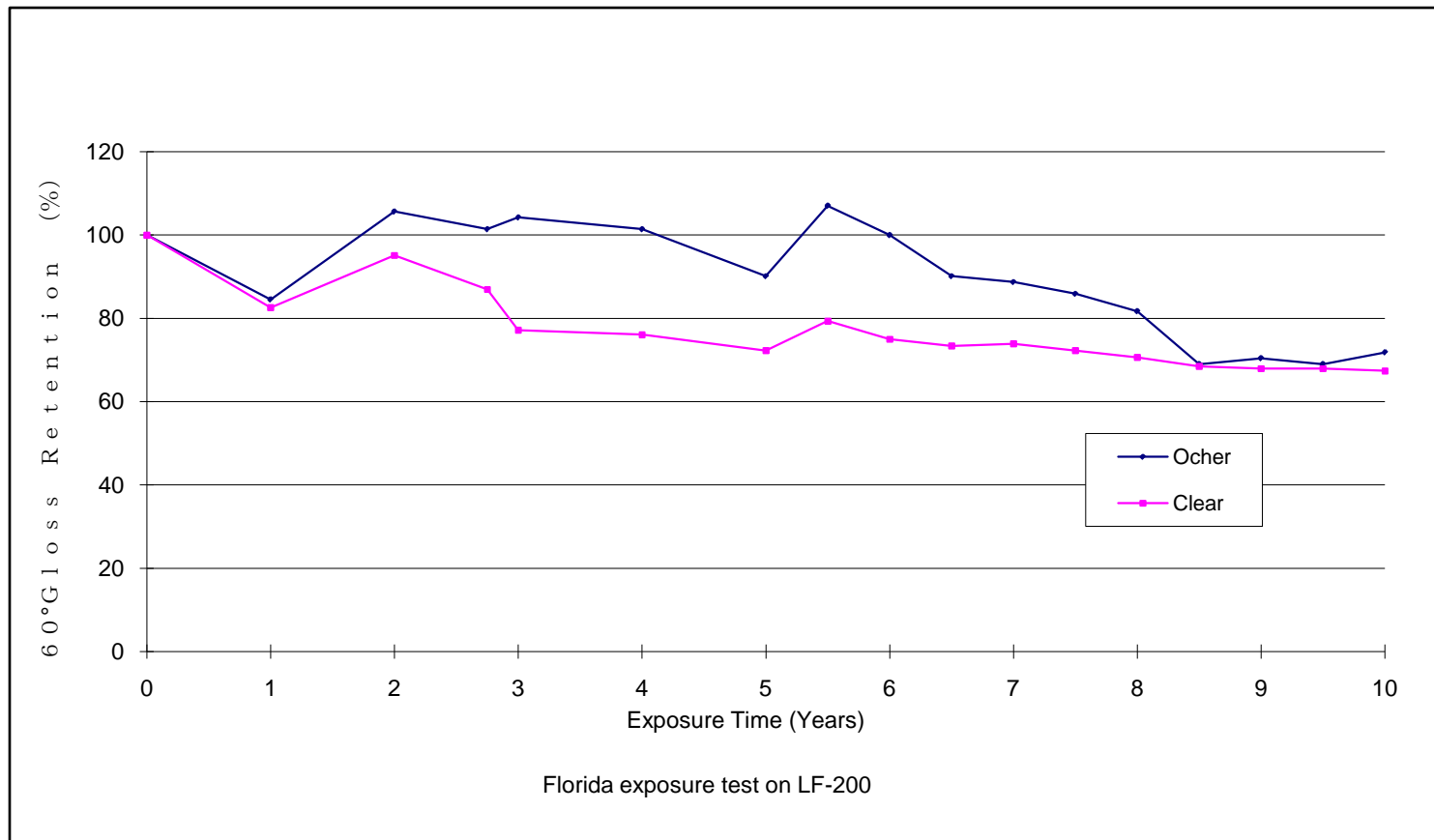
Weatherability of FEVE Coatings

QUV-A Accelerated Weathering

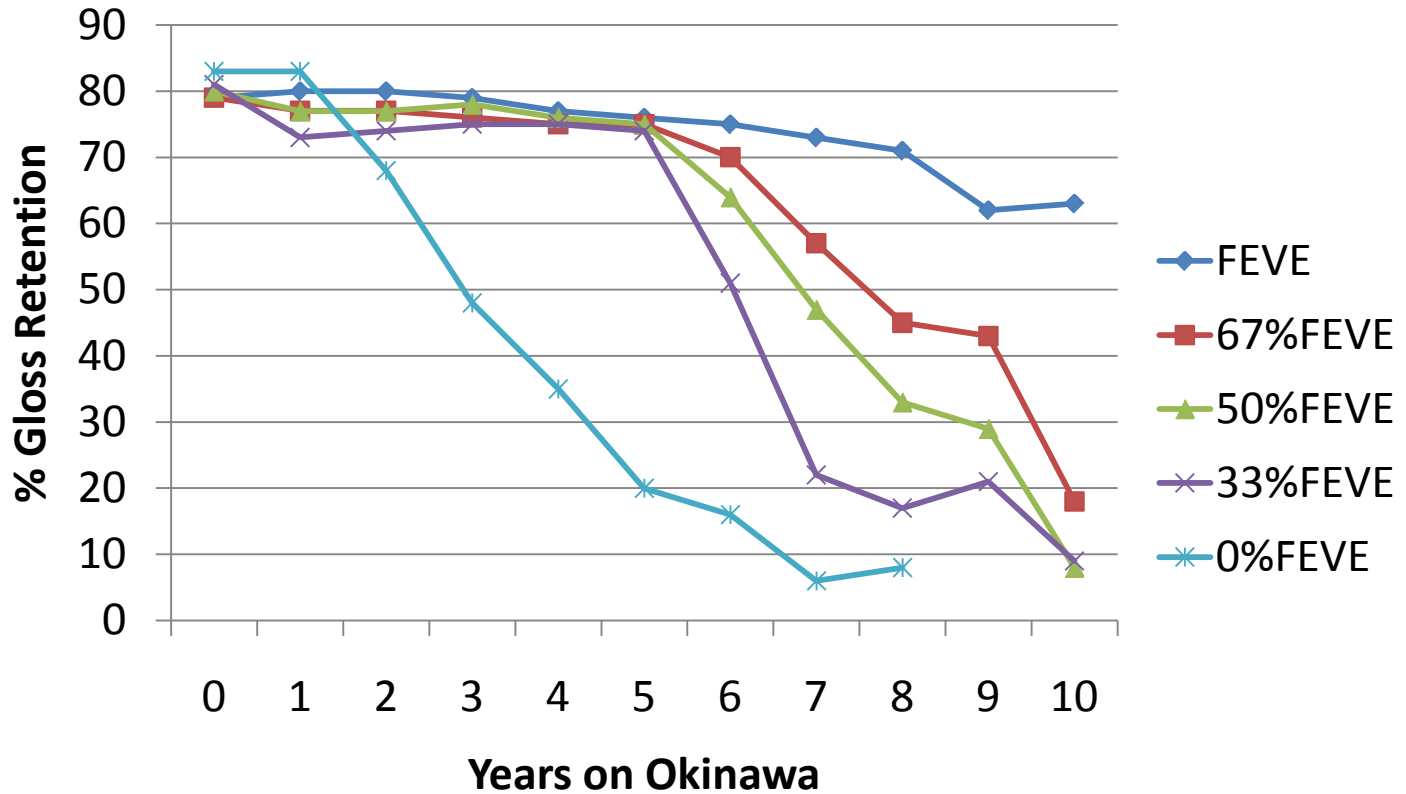


Weatherability of FEVE Coatings

South Florida Testing



Weatherability of FEVE Resins: Blends With Acrylic Resins



FEVE Coatings on Plastics

Dew Cycle Weatherometer Accelerated Weathering

Plastic Substrate	FEVE Coated?	Tensile Strength Retention, %		Elongation Retention, %	
		Irradiation in Dew Cycle Weatherometer, Hours			
		200	400	200	400
Polycarbonate	No	71%	62%	63%	55%
	Yes	118%	106%	123%	121%
Nylon 6	No	38%	44%	13%	3%
	Yes	97%	86%	89%	90%
Polypropylene	No	14%	12%	19%	9%
	Yes	103%	105%	102%	95%



Applications for FEVE Coatings on Plastics

- Architectural Components
 - Skylights
 - Wall and curtain wall systems
 - Stadium components
 - Awnings and canopies
 - Synthetic shingles
- Commercial Applications
 - Traffic signs
 - Exterior automotive plastics
 - Exterior graphics

Life Cycle Costs of FEVE Resins For Bridges

Coating Type	Process	Process Cost, \$/m ²	Initial Cost Ratio	Coating Life, Years	Cost/Year, \$/m ²
Chlorinated Rubber	Surface Preparation /Site Costs	\$37.56	2.4		
	Coating Cost	\$15.53	1.0		
	Total Cost	\$53.09	3.4	8	\$6.64
FEVE Urethane	Surface Preparation /Site Costs	\$43.06	2.8		
	Coating Cost	\$35.08	2.3		
	Total Cost	\$78.14	5.1	>21	\$3.72
Life Cycle Cost Ratio					0.56

FEVE Coatings on FRP

- Characteristics of FRP
 - Strength/weight
 - Clarity to light
 - Yellowing, cracking, hazing over time
- FEVE Clear Coats for Protection of FRP
- Case Study: FEVE Coating on FRP
 - Weathering
 - Adhesion after weathering
 - Other effects on coating performance

FEVE Coatings on FRP

- FEVE Coatings
 - Transparent to UV light
 - UVA stabilizers required
- Coating Properties Required
 - About 10 phr benzophenone derivative
 - Better UV absorption and bleed out characteristics
 - At least 25 μ thickness
 - Ensure complete surface coverage
 - Adequate light path for stabilizers

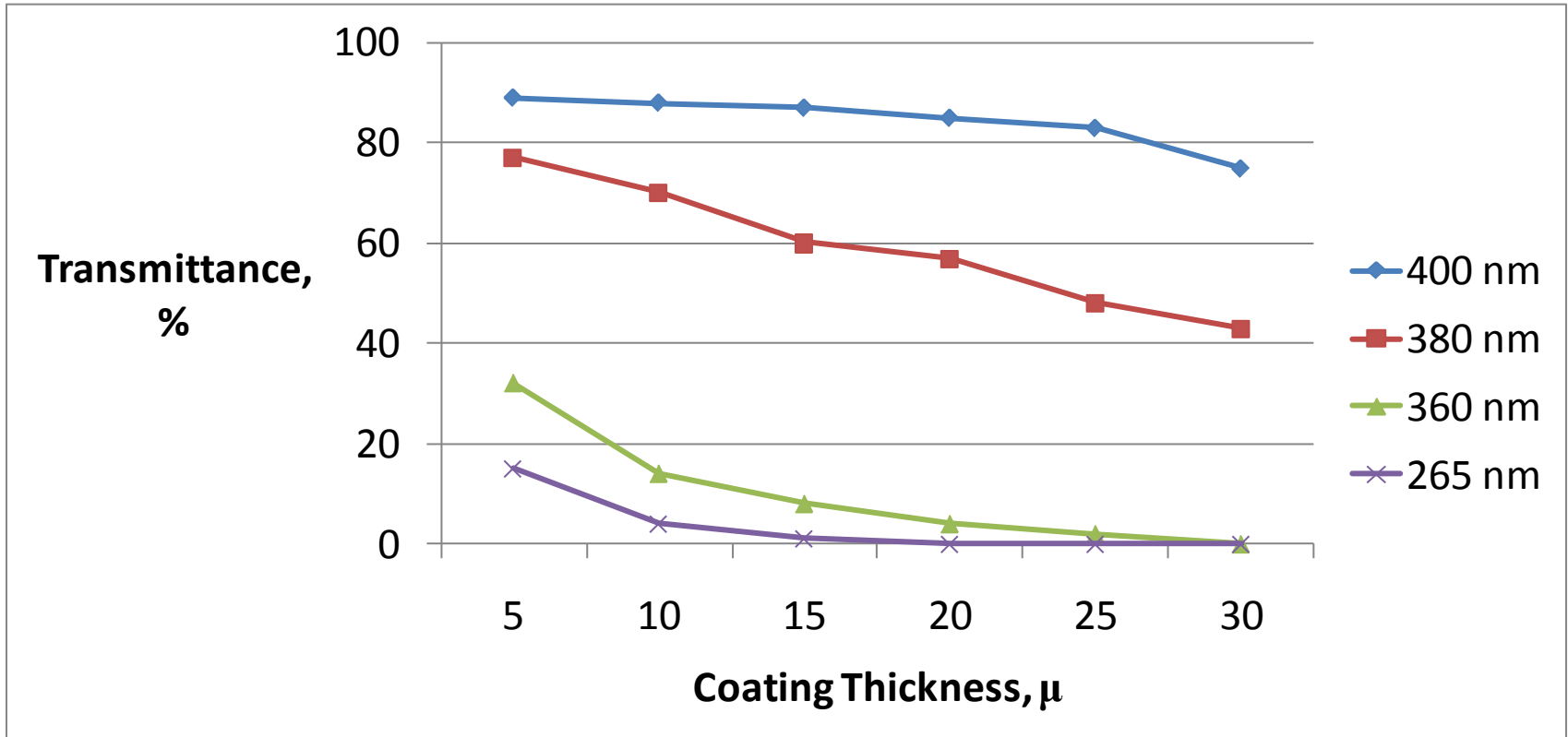
FEVE Coatings on FRP

Effect of Coating Thickness

Table: Weatherometer Testing of FEVE Coatings of Different Thickness

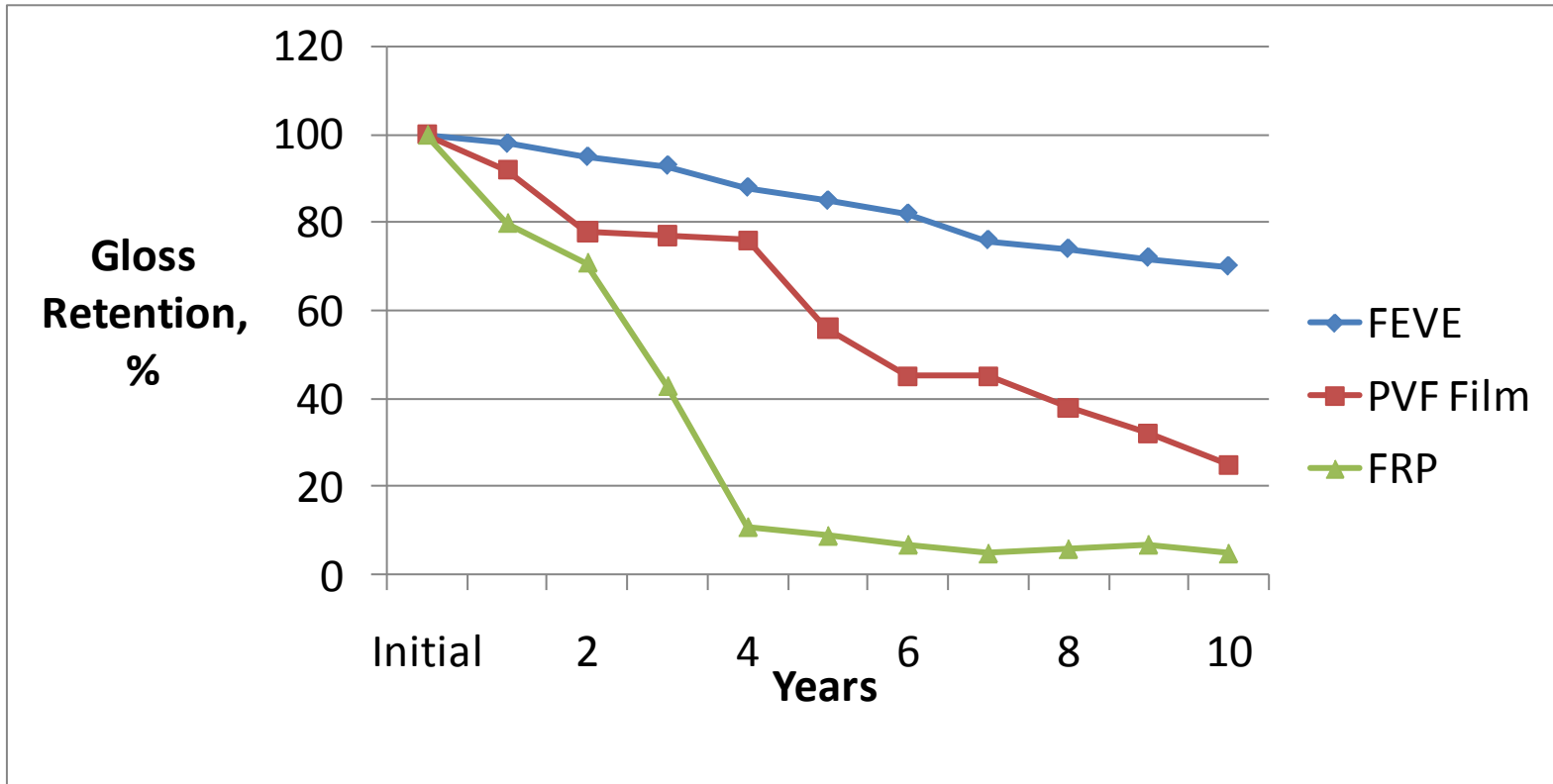
Exposure Time	2000 hrs.		5000 hrs.	
	Appearance	Adhesion* (Cross Cut)	Appearance	Adhesion*
FEVE Coating, 25 μ	Excellent	100/100	Excellent	100/100
FEVE Coating, 13 μ	Fair (slight yellowing)	100/100	Poor (yellowing)	0/100

Light Transmittance of FEVE Clear Coat



Weathering of FEVE Coating on FRP

Itoman City, Okinawa, Japan



Weathering of FEVE Coated FRP

Sunshine Weatherometer Test

Coated FRP

Uncoated FRP



Performance of FEVE Coated FRP

20 Years, Tokyo, Japan



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The logo for LUMIFLON, featuring three overlapping circles in red, yellow, and blue, with the word "LUMIFLON" written below them.

Performance of FEVE Coated FRP

15 Years, Marine Environment



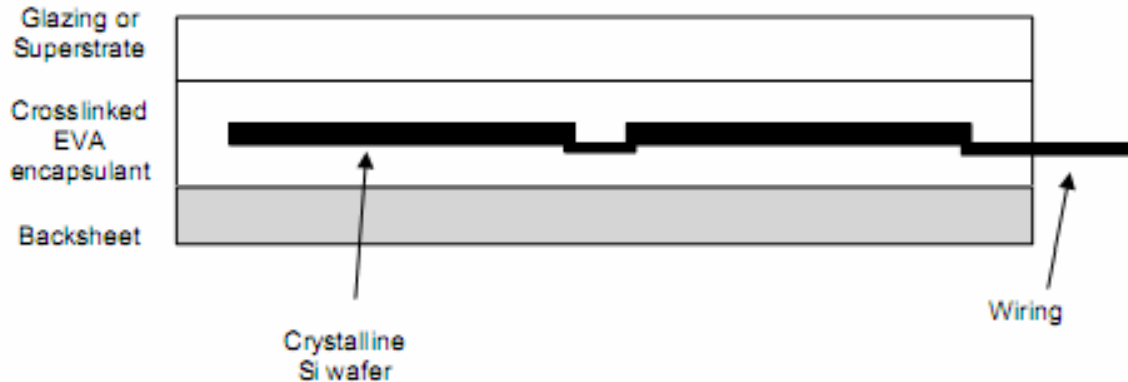
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The logo for LUMIFLON, featuring three overlapping circles in red, yellow, and blue, with the word "LUMIFLON" in black text below them.

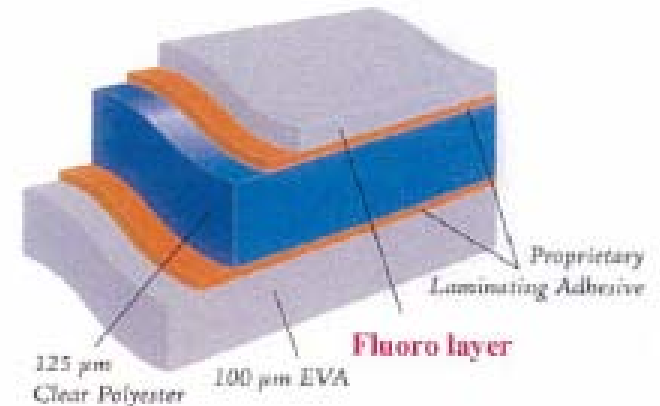
FEVE Coatings on PET Film

- PET Subject to Degradation by UV
 - Hydrolysis followed by delamination
- Application: Solar Cell Back Panels
- Solar Cell Back Panel
 - Physical protection for circuits and cell
 - Moisture protection
 - Electrical insulation
 - Color to blend into environment
 - Improved cell efficiency
 - Long life required
 - Ease of fabrication
 - Cost effective

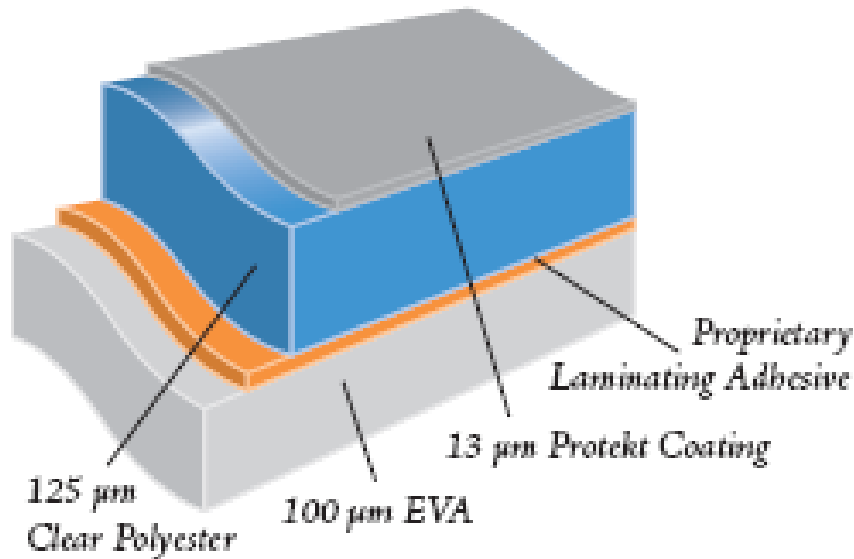
FEVE Coatings on PET Film



- Laminate Configuration
 - PVF/PET/PVF (TPT)
 - PVF/PET/EVA (TPE)
 - Laminated films
 - Supply limitations for PVF
 - Performance limitations



FEVE Coatings on PET Film



- Use FEVE Coating to Replace PVF in the Laminate
- Applied to PET from Coating Bath
- Technology Leap

Advantages of FEVE Coatings in Solar Backpanels

- Meet Performance Requirements for Backpanels
 - Tensile strength
 - Dimensional stability
 - Damp heat aging
 - Weatherability
 - Dielectric properties
 - Flame spread
- Substantial Cost Reduction
 - 13 μ vs. 37.5 μ for PVF
- Manufacturing Flexibility
 - Panel width
 - Custom colors
- Power Boost of 5%



Conclusions

- FEVE Coatings In Use for 25 Years
- Offer Excellent UV Stability
- Successful Use on Plastics
- Life Cycle Cost Advantages
- Useful in Blends to Improve Weathering

References

1. M. Temchenko, D. Avison, F. Mannarino, S. Lim, L. Campbell, M. Sullivan, J. Pratt, “Madico Backing Sheets,” Presented at 1st International Photovoltaic Power Generation Expo, Tokyo, Japan, Feb. 2008.
2. Madico, Inc. Product Literature, “Photo-Mark Protekt® HD,” 2007.
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5. L. Capino, “Fluorourethane Coatings with Extreme Exterior Durability,” Presented at the Paint & Coatings Expo Technical Program, Dallas, TX, 2007.