Developments in Fluoropolymer Resins For Long Life Coatings

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Fluoropolymers in Coatings

- Characteristics of Fluoropolymers
  - Excellent weatherability
  - Good chemical resistance
  - Low surface energy
  - Poor solubility
  - Difficult to apply
- PVDF Coatings
  - Coil coating
- Market Needs
  - Ambient cure
  - Easy to apply
  - Physical properties close to familiar coatings

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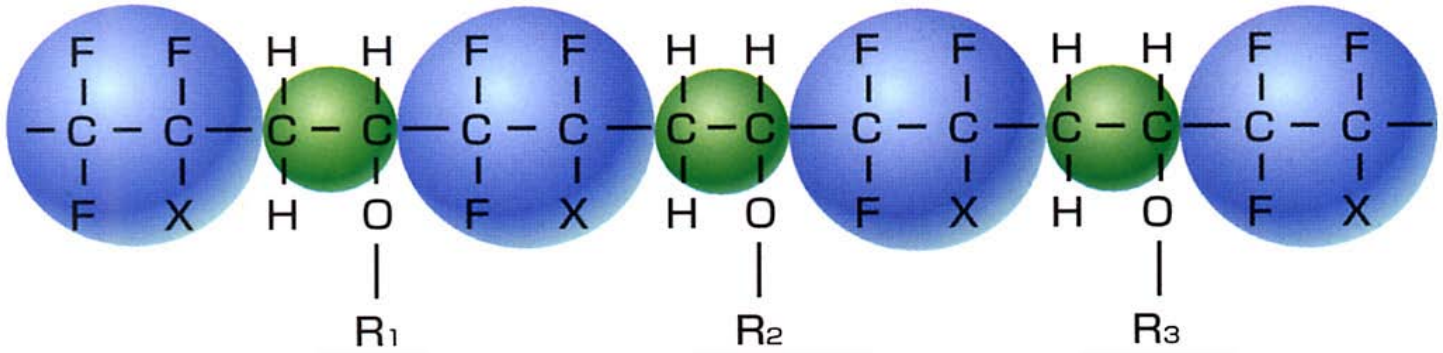
Fluoroethylene Vinyl Ether (FEVE) Resins

Fluoro Ethylene

Vinyl Ether



FLUORINATED SEGMENTS: Weatherability, durability, chemical resistance

VINYL ETHER SEGMENTS: Gloss, solubility, crosslinking

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Advantages of FEVE Based Coatings

- **Ambient Cure**
  - **Field applied coatings**
- **OH Functional**
  - **Fluorourethanes**
- **Solvent Soluble**
  - **Clean, crisp colors**
  - **Wide range of gloss**
- **Fluoropolymer Segments**
  - **Ultra-weatherable**
  - **Corrosion resistance**

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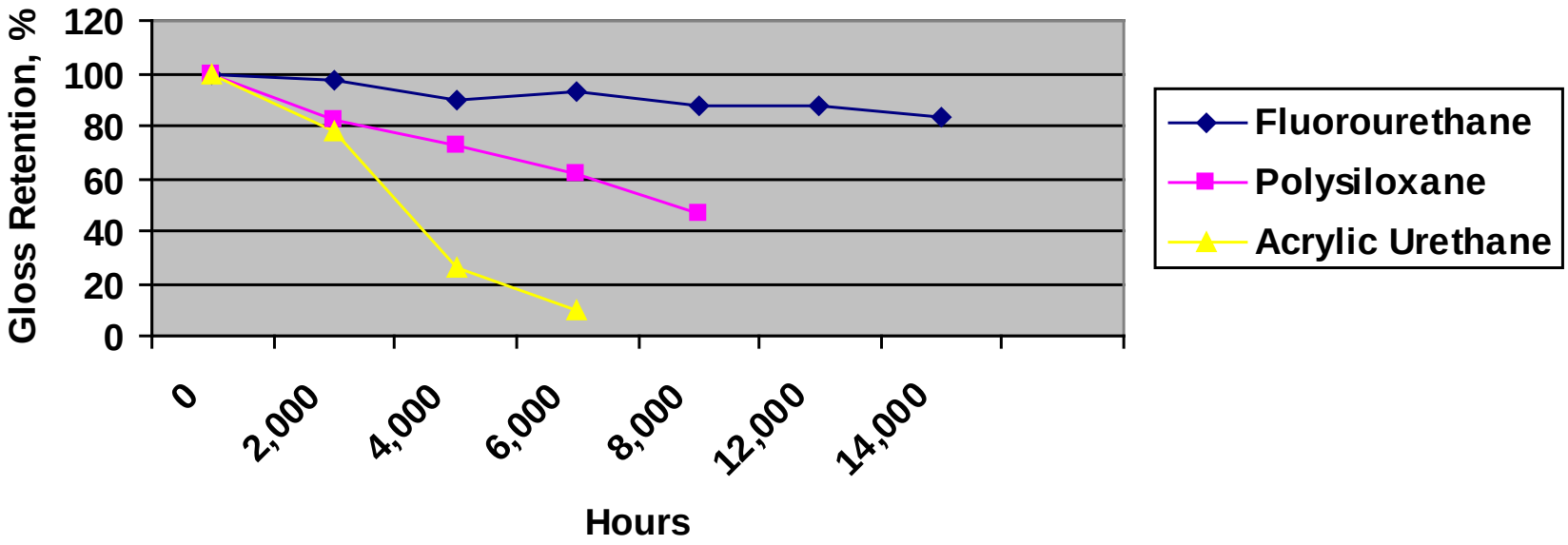
Weathering of FEVE Coatings

QUV-A Test (ASTM D4587)



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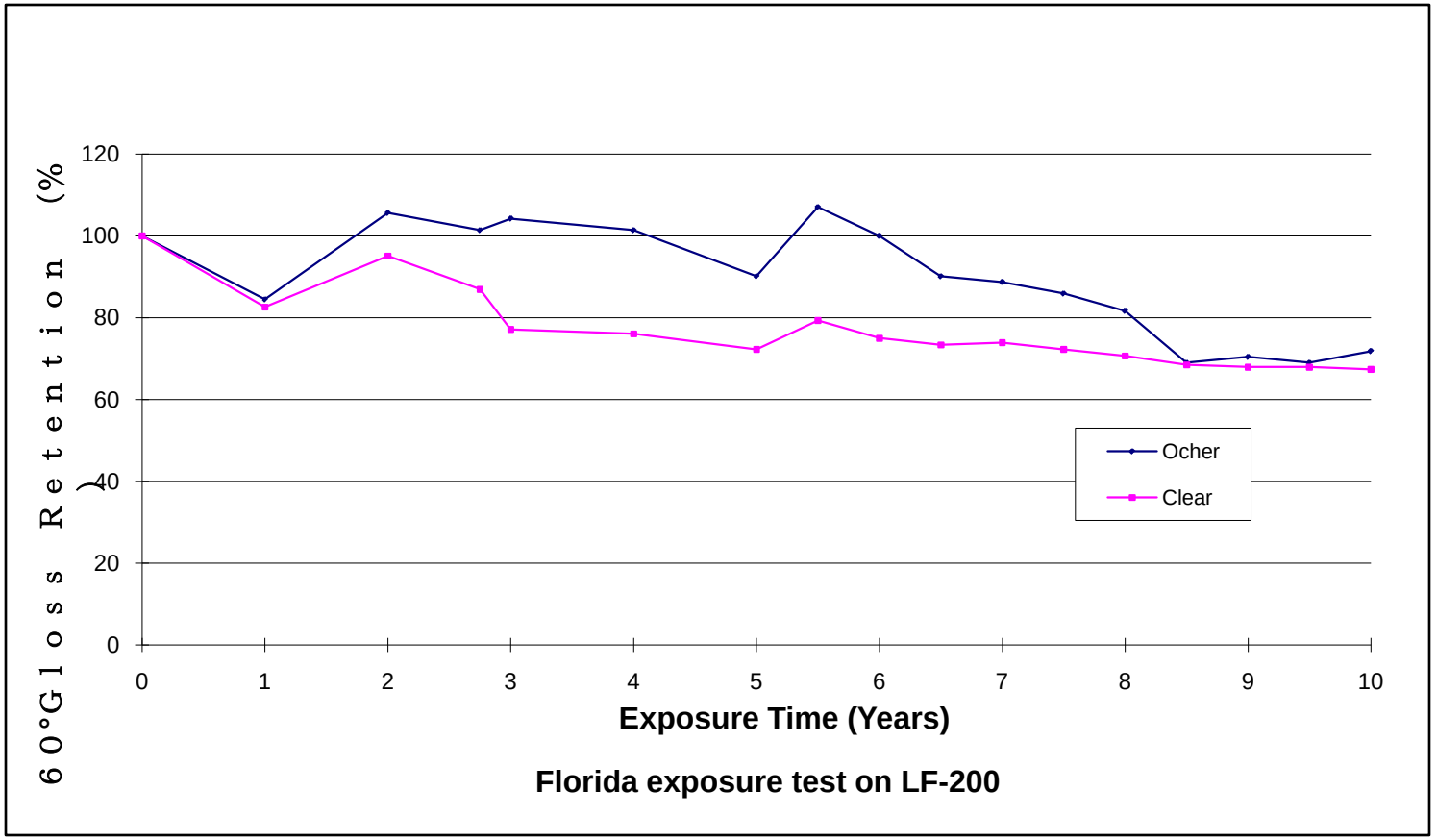
Weathering of FEVE Resin Topcoats

South Florida Weathering



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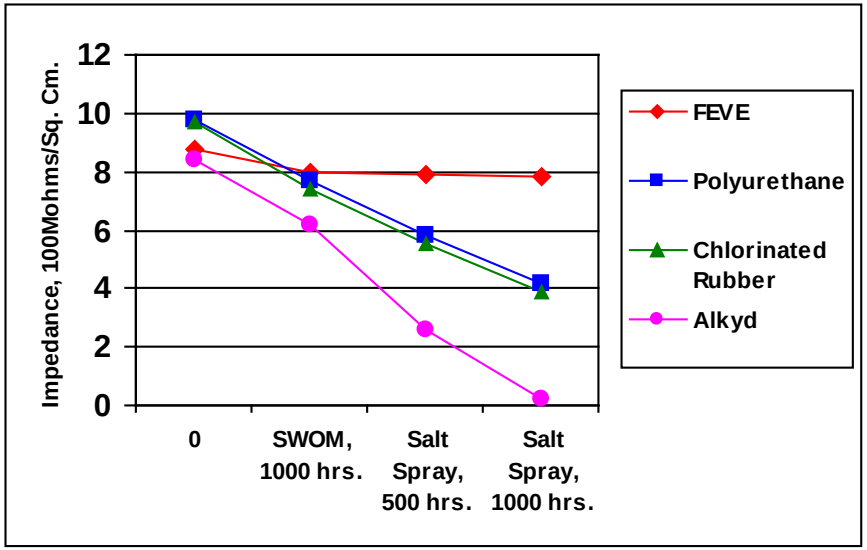
Comparative Weathering of Fluorourethane Topcoat

Test Site	Test Duration Years	Topcoat Type	Initial µm	Final µm
Suruga Bay	16	Acrylic Urethane	25	0 (13 yrs.)
Suruga Bay	16	Fluoro-Urethane	25	21

Prevention of Corrosion with FEVE Resin Topcoats

Electrochemical Impedance Spectroscopy

- Coating System Tested
  - Zinc rich primer/epoxy/topcoat
- Shows Effectiveness of Topcoat in Preventing Corrosion
- Accelerated Weathering Followed by Salt Fog Test
- Smaller Change, Better Corrosion Resistance



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Types of FEVE Resins

- Solvent-Based
  - Dissolved in xylene
  - Difficult to meet VOC/HAPS regulations
- Develop New Resin Forms For New Standards
- Solid Resins
  - Powder coatings
- Water Emulsions
- New Water-Based Resin

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FEVE Solid Resins

- **Same Performance as Solvent Based Resins**
  - **Weatherability**
  - **Corrosion resistance**
- **Soluble in Exempt Solvents**
  - **Oxsol 100**
  - **T-butyl acetate**
  - **Acetone**
- **Soluble in: Propylene Glycol Ethers, Esters, Ketones**
- **Meet 100 g/l California Standard for Industrial Maintenance Coatings**

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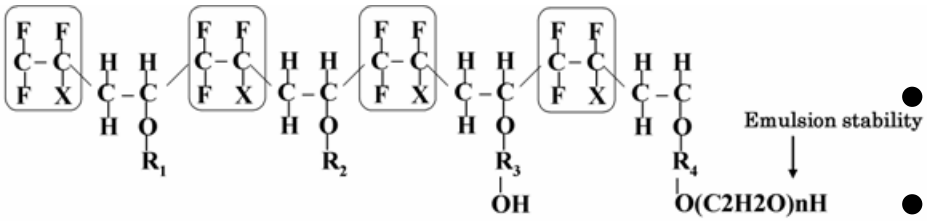
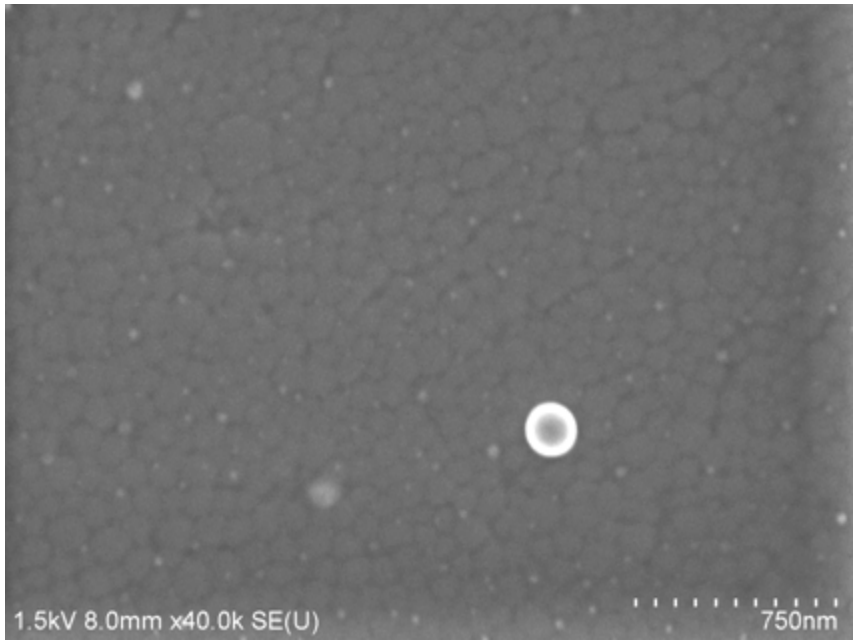
FEVE Water Emulsions





- Modified structure for emulsion stability
- High molecular weight
- Film forming via coalescence
- Affects film properties
  - Water resistance
  - Weathering
  - Adhesion
  - Permeability
- Problems at 50 g/l VOC?

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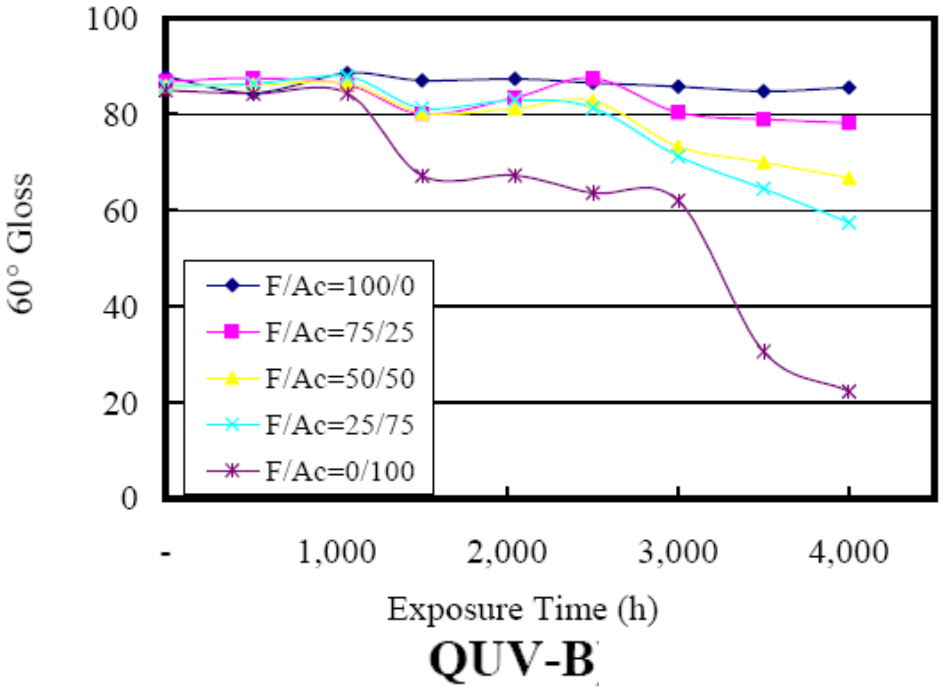
FEVE Water Emulsions

- **Used in Blends With Standard Resins**
  - **Improved weatherability**
  - **Improve gloss and color retention**



Blend of Single Component FEVE Water Emulsion with Primal® PR-1042 (Rohm & Haas)

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FEVE Water Based Resins

- **Need for Water-Based Resin With Properties Matching Solvent-Based Resins**
  - **Water resistance**
  - **Weatherability**
- **Minimize Changes to FEVE Polymer**
  - **Less modification, better properties**
- **FEVE Water Dispersion**

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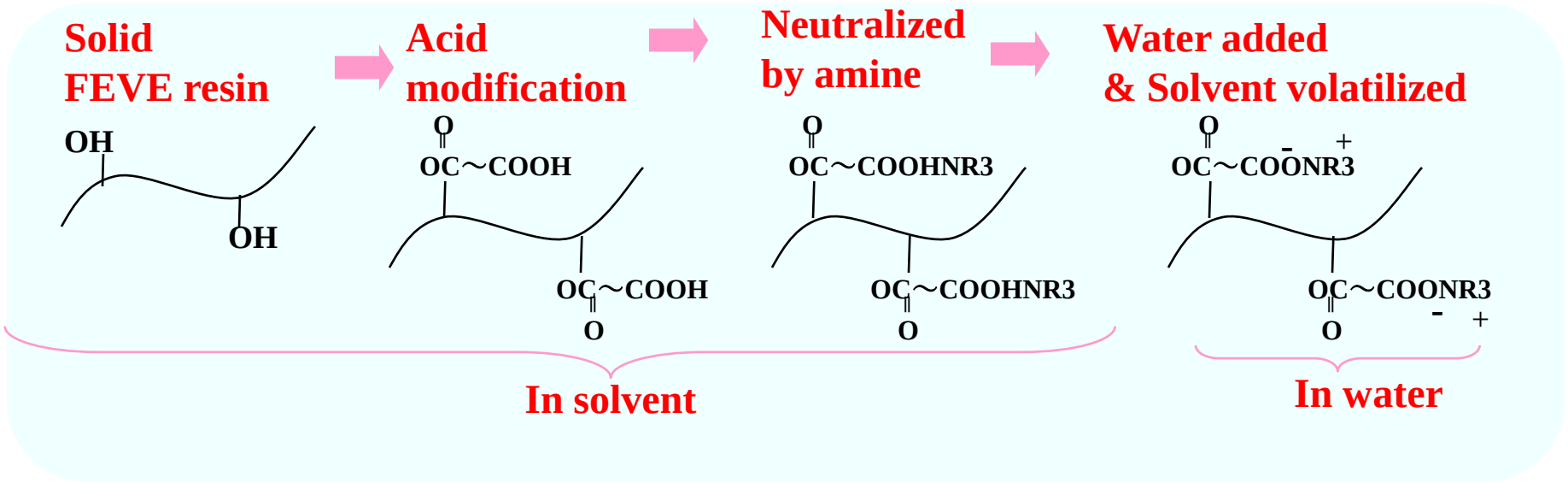
FEVE Water Dispersions

Producing Dispersions



FEVE Water Dispersions
Typical Physical Properties

Physical Property	Value
Appearance	Milky White Liquid
Solids, wt. %	40%
pH	7.4
Particle Diameter, µm	145
Minimum Film Forming Temperature, °C	27
Acid Value, mg KOH/g-polymer	15
Hydroxyl Value, mg KOH/g-polymer	85

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Properties of FEVE Dispersion Coatings

Property	Test Method		FEVE Dispersion, 2K	FEVE Emulsion, 2K	FEVE Solvent, 2K
Gloss, 60°	ISO 2813		88	78	90
Pencil Hardness	ASTM D 3363	Gouge	4H	4H	3H
Pendulum Hardness	ASTM D 4366		79	75	80
Impact Resistance	ASTM D 2794 Diameter=0.5”	Intrusion 0.5 kg Extrusion 0.5 kg	>1.0 >1.0	1.0 1.0	>1.0 >1.0
Cross Cut Adhesion	ASTM D 3359		5B	5B	5B
Water Resistance	ISO 2812, 40 C, 24 h Cross Cut Adhesion Blistering		4B No blistering	3B Medium blisters	5B No blistering

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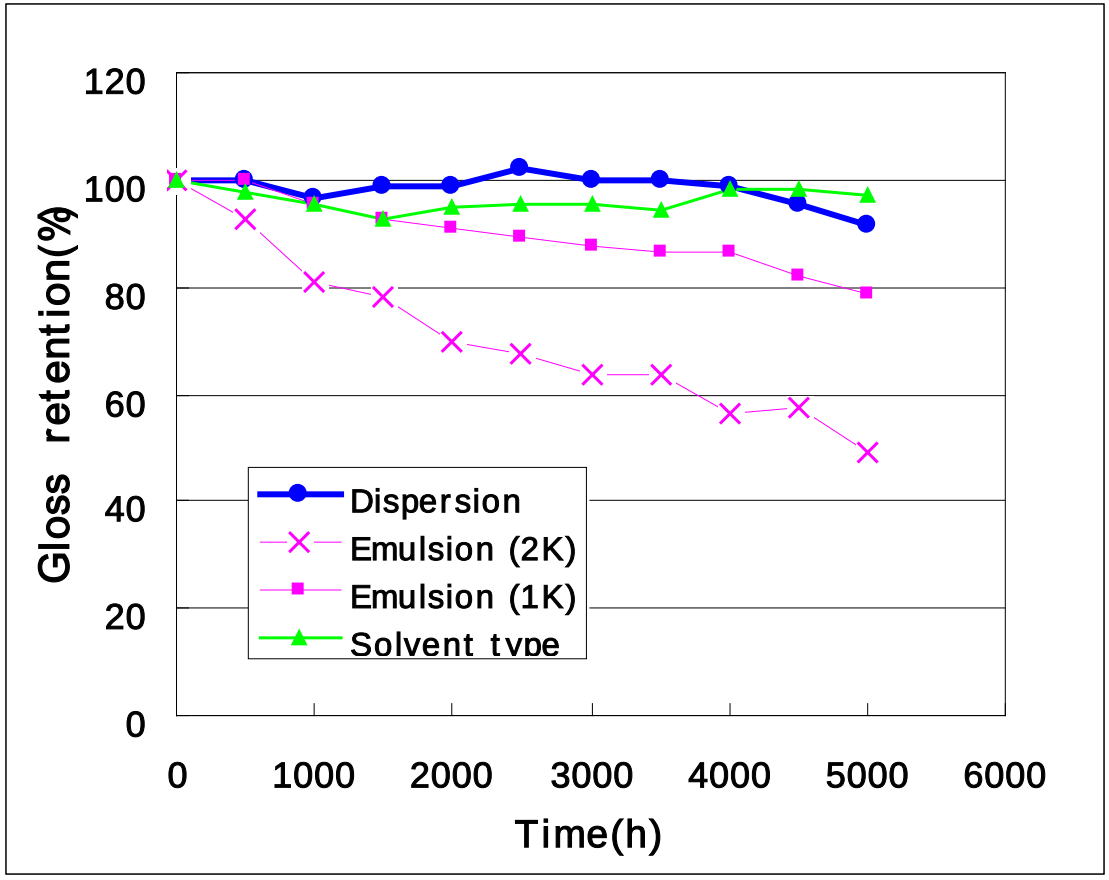
Comparative Weathering of FEVE Water Dispersions (QUV-B)



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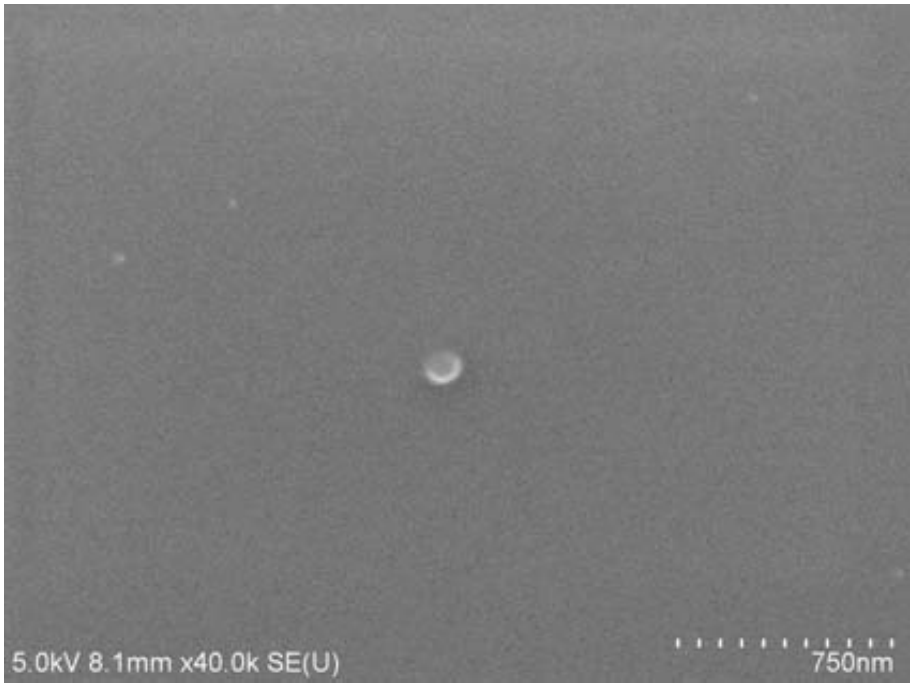
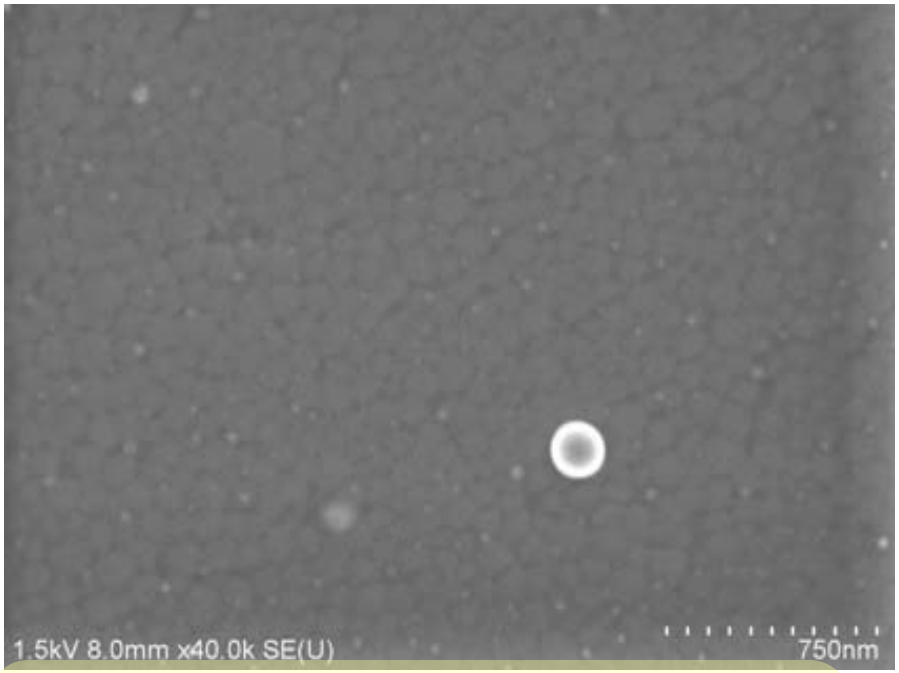
SEM: FEVE Dispersion vs. Emulsion



Dispersion



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Markets for Fluorourethane Coatings

- Architectural Markets
  - Monumental buildings
  - Aluminum extrusions
  - Coil coatings
- Aerospace Coatings
  - Military: C-17, C-5
  - Commercial and general aviation
- Industrial Maintenance Coatings
  - Difficult to paint structures: bridges, water towers
- Automotive
- Specialty Markets
  - Solar panels
  - Wind towers

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Applications for FEVE Coatings

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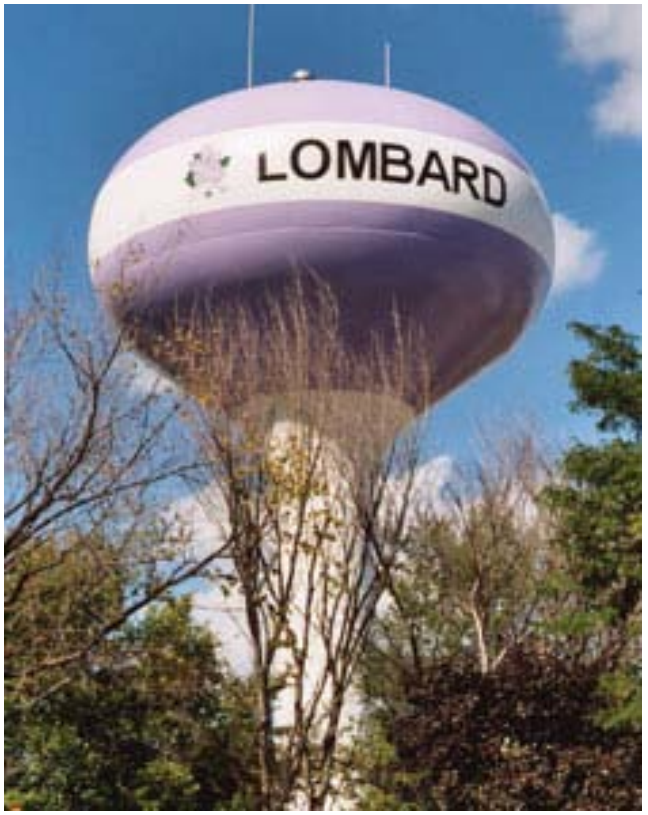
Applications for FEVE Coatings



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Conclusions

- Fluorourethanes Impart
  - Fluoropolymer characteristics
  - Excellent weatherability
  - Corrosion resistance
- FEVE Resins in Use for More Than 25 Years
  - Required for bridge topcoats in Japan
  - Estimated life of 60 years
  - Lower life cycle costs
- New Resins Meet Changing Environmental Regulations
- FEVE Coating Life Matches Infrastructure Life

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