Powder Coating Preparation: Control of Surface Defects for FEVE Resin Systems

Connie Przeslawski

Powder Coating Summit, 03 September 2021

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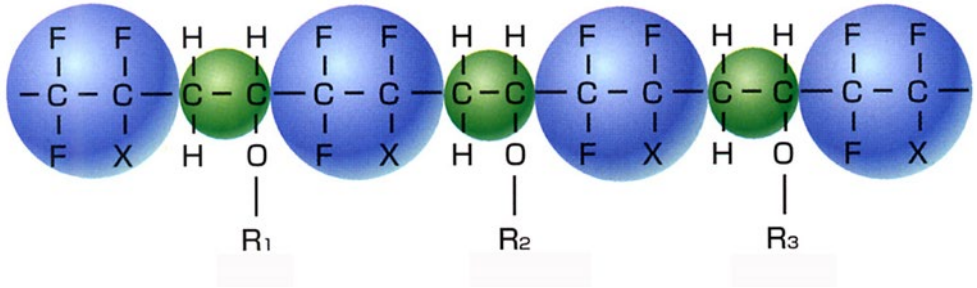
FEVE Chemistry

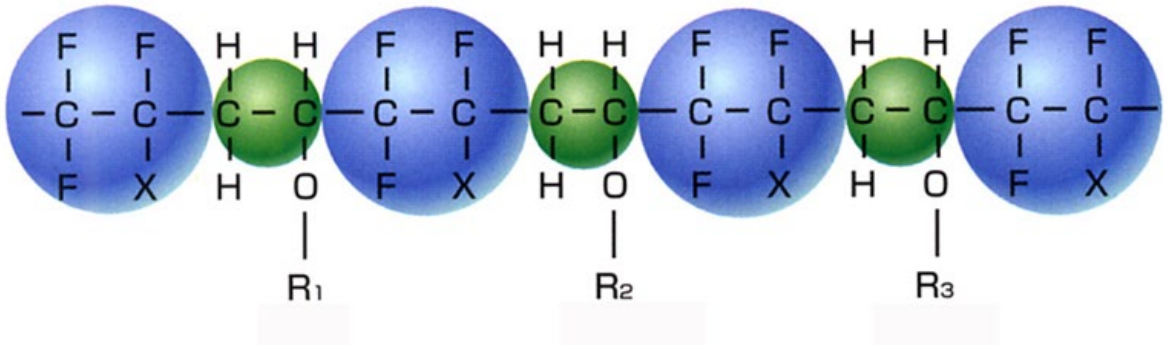
- Alternating copolymers synthesized via radical polymerization
- Amorphous structure
- FEVE resins are the ‘backbone’ or binder resins
- Hydroxyl groups scattered through the FEVE backbone



Fluoroethylene Vinyl Ether

FLUOROETHYLENE	VINYL ETHER
• Weatherability • Durability • Chemical Resistance	• Gloss • Solubility • Crosslinking

FEVE Chemistry: Bond Energy



Bond Energies

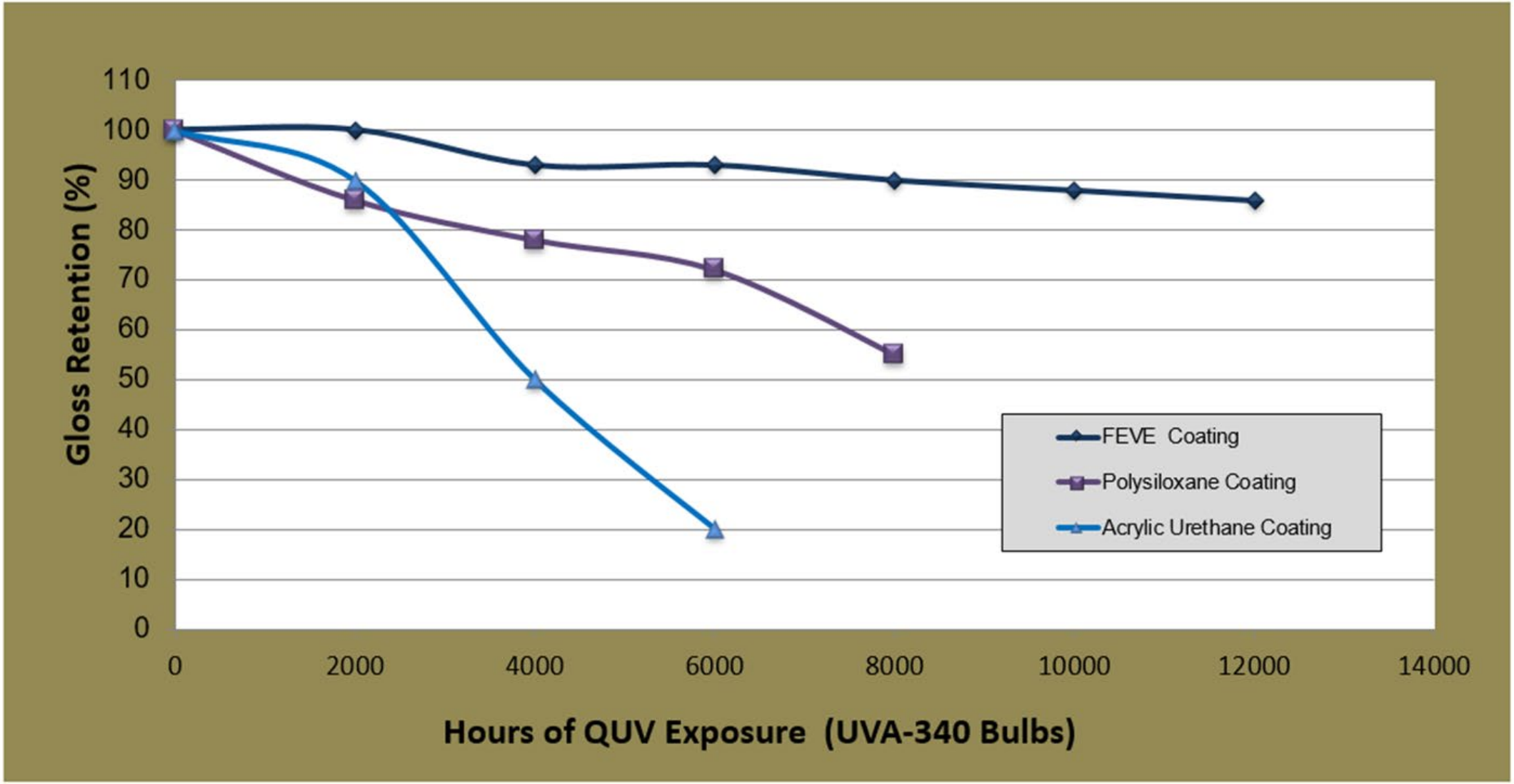
Bond Type	$\Delta H_{f,298K}$ (kJ/mol) [Indirect Bond Strength]
C-F	536
C-O	380

- UV radiation in sunlight contains enough energy to break chemical bonds
- C-F bond energy is stronger than UV radiation energy
- C-F bonds provide additional ‘protection’ for vinyl ethers

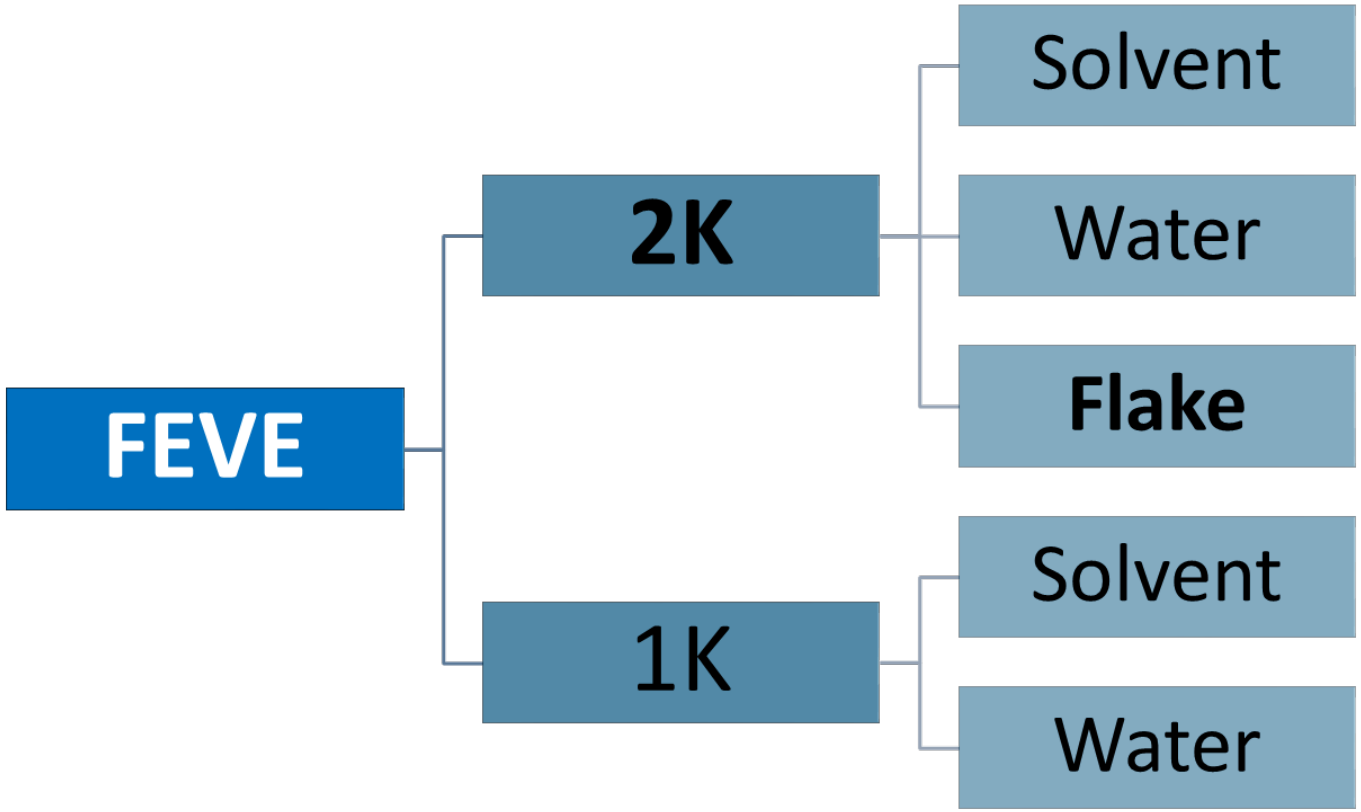
Solar Energies

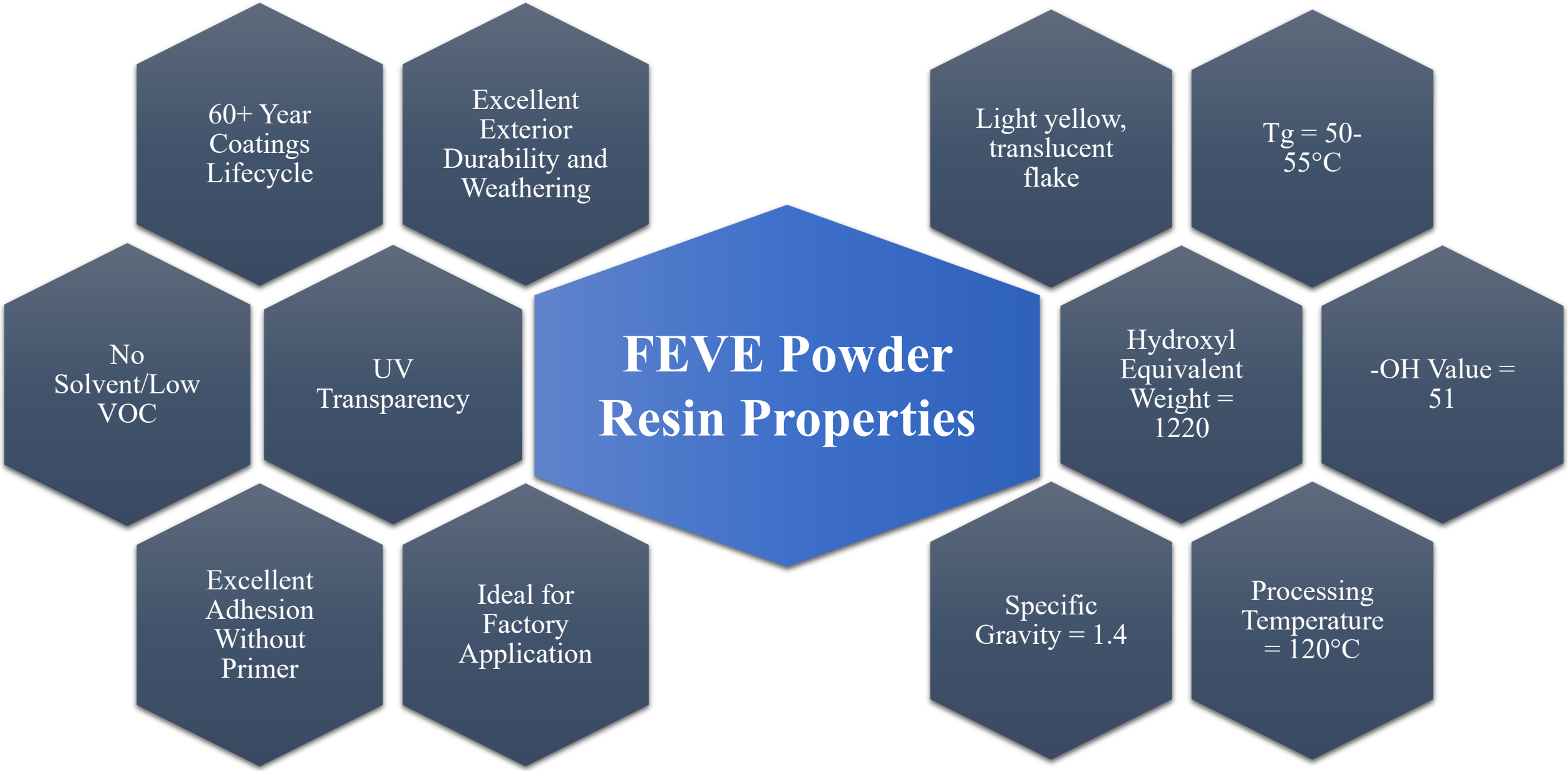
Group	λ (nm)	Energy (kJ/mol)
Vis	780-400	150-300
UVA	400-315	300-380
UVB	315-280	380-430

FEVE Coatings: Accelerated Weathering



FEVE Resin Grades




60+ Year Coatings Lifecycle
Excellent Exterior Durability and Weathering
Light yellow, translucent flake
Tg = 50-55°C
No Solvent/Low VOC
UV Transparency
FEVE Powder Resin Properties
Hydroxyl Equivalent Weight = 1220
-OH Value = 51
Excellent Adhesion Without Primer
Ideal for Factory Application
Specific Gravity = 1.4
Processing Temperature = 120°C

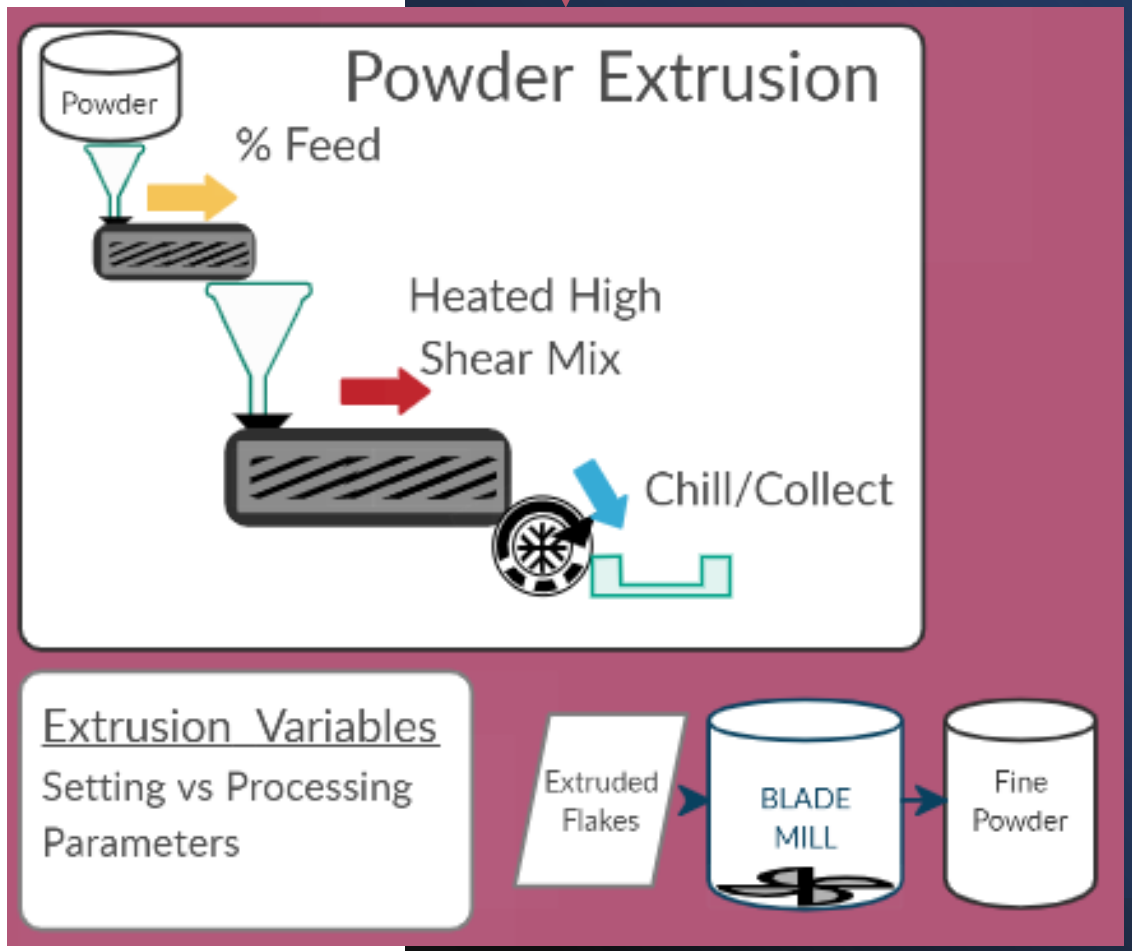
Extrusion Conditions

Setting Parameters (before extrusion)

- Throughput/feed rate (%)
- Screw speed (RPM)
- Screw profile
- Barrel zone temperatures
- Formulation chemistry

Process Parameters (during extrusion)

- Torque
- Pressure/filling degree profile
- Temperature profile
- Residence time
- Dispersion/distribution mixing quality

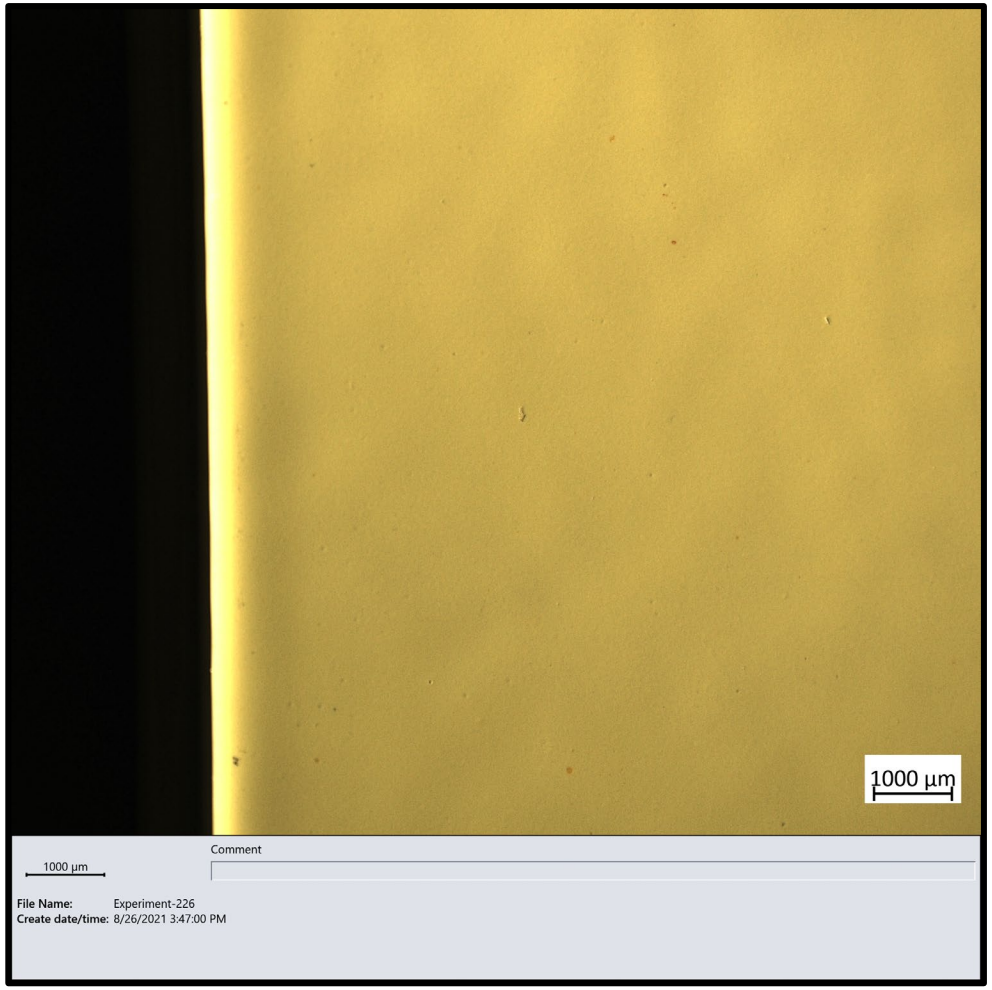


Types of Paint Coating Testing

- Natural Weathering
- Accelerated Weathering
- Chemical/ Physical Testing
- Surface Appearance
- Electrochemical Measurements

Microscope Imaging of FEVE Systems

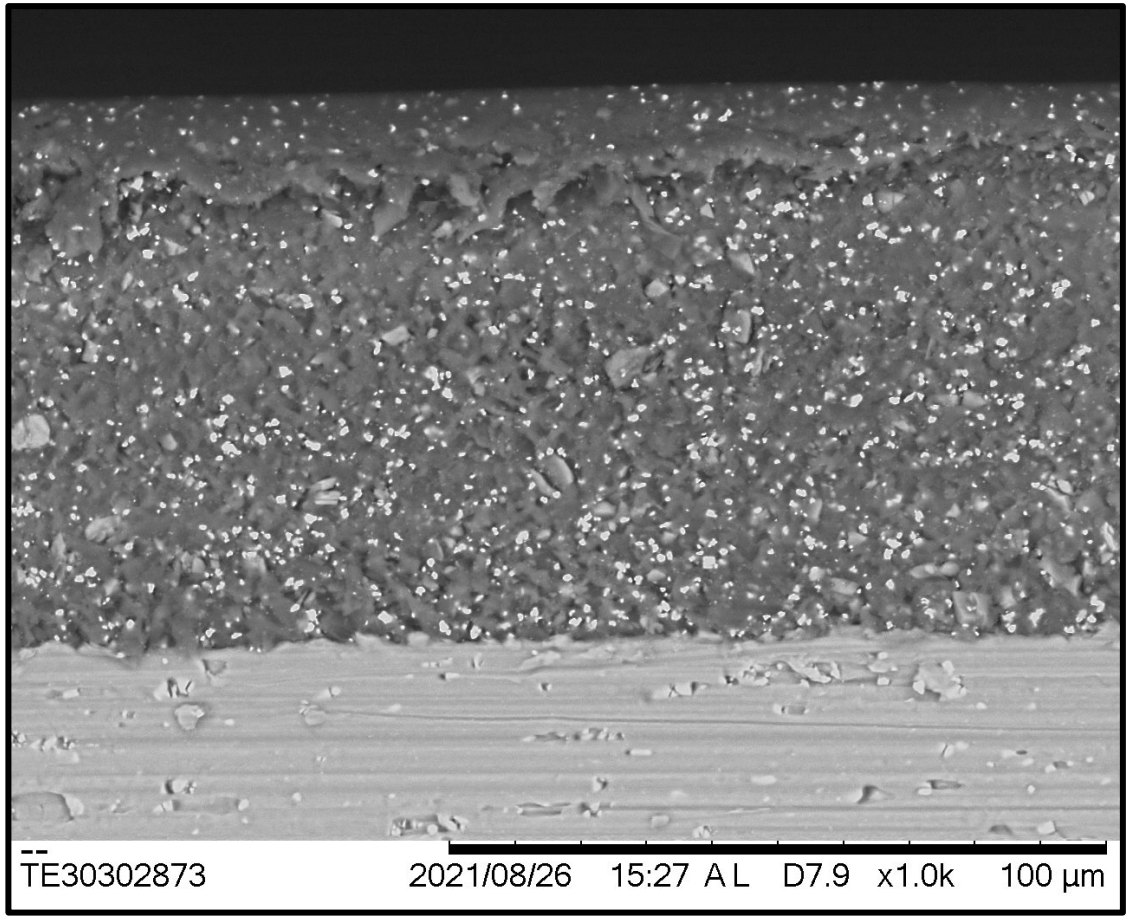
Maximum throughput/barrel feed



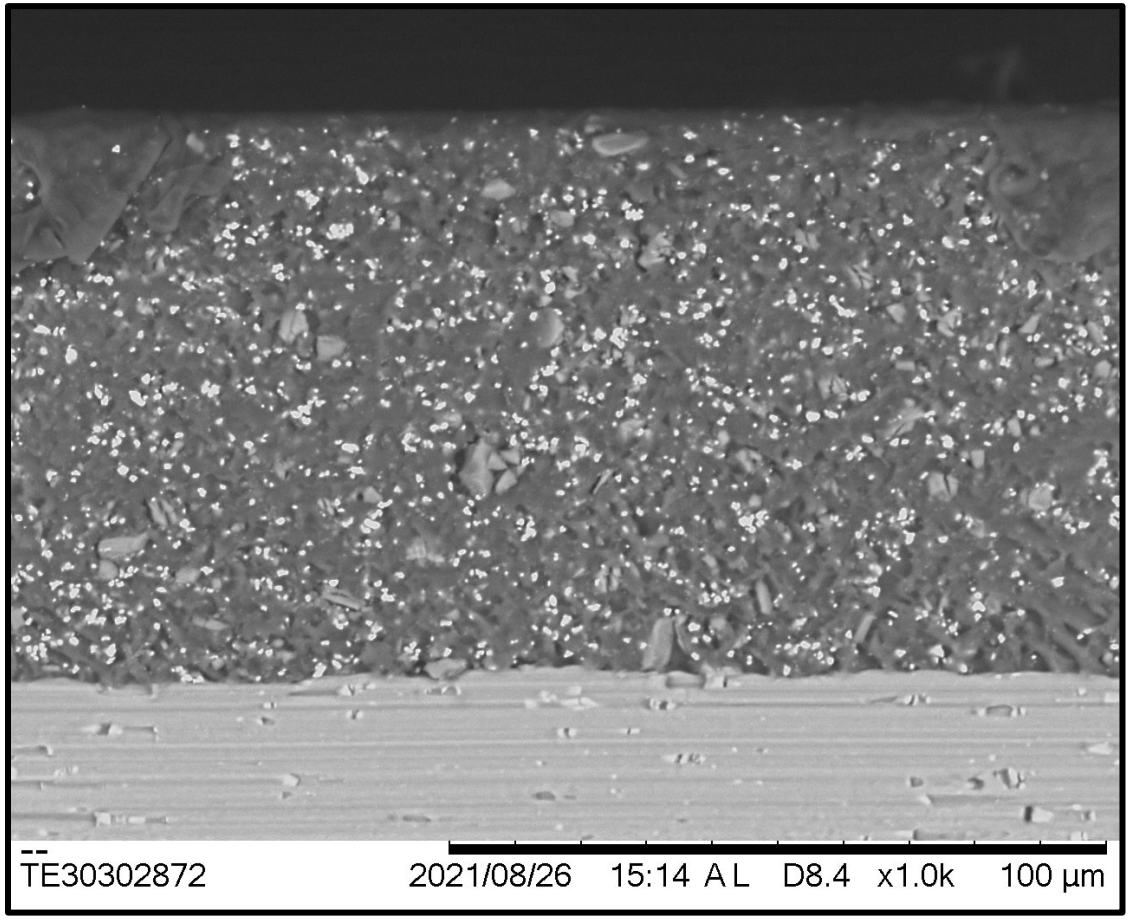
50% throughput/barrel feed

SEM Cross Section of FEVE Systems

Lower RPM, lower dispersive mixing



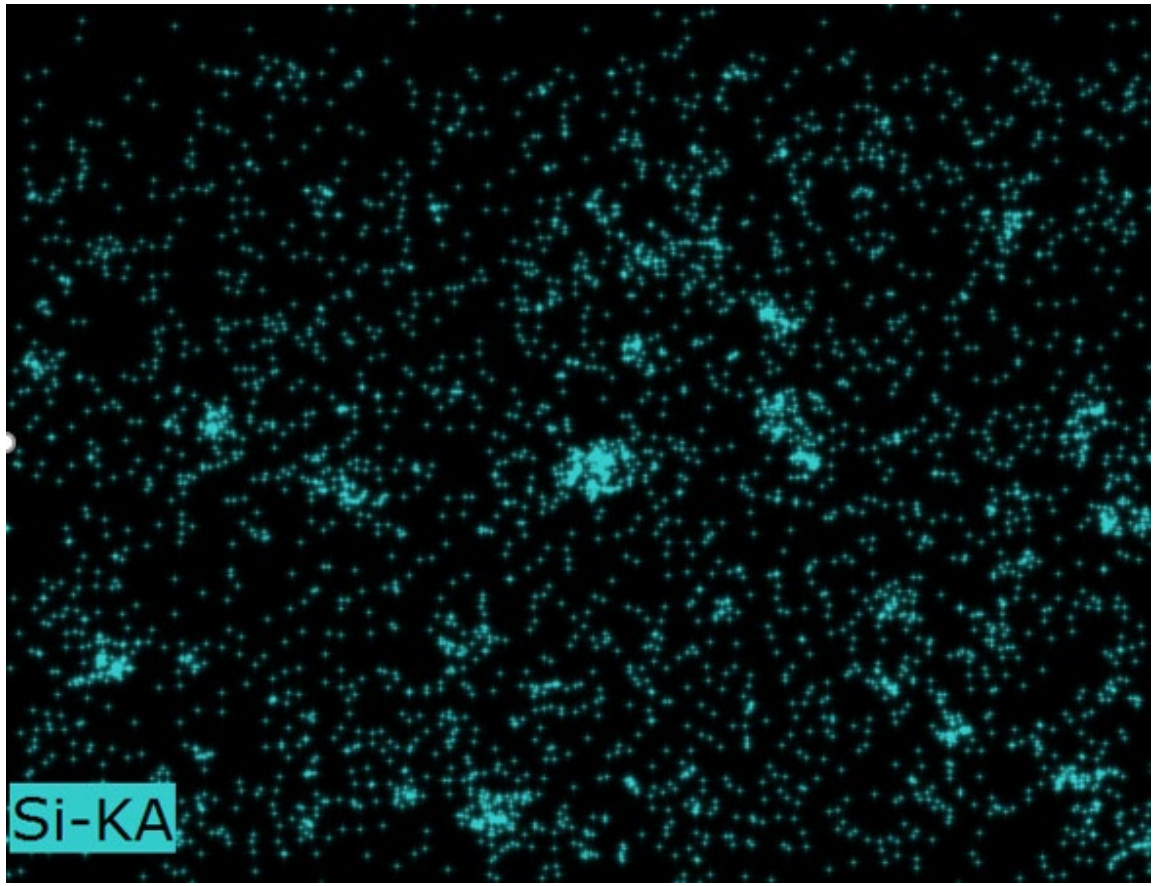
Higher RPM, higher dispersive mixing



SEM-EDX Cross Section of FEVE Systems

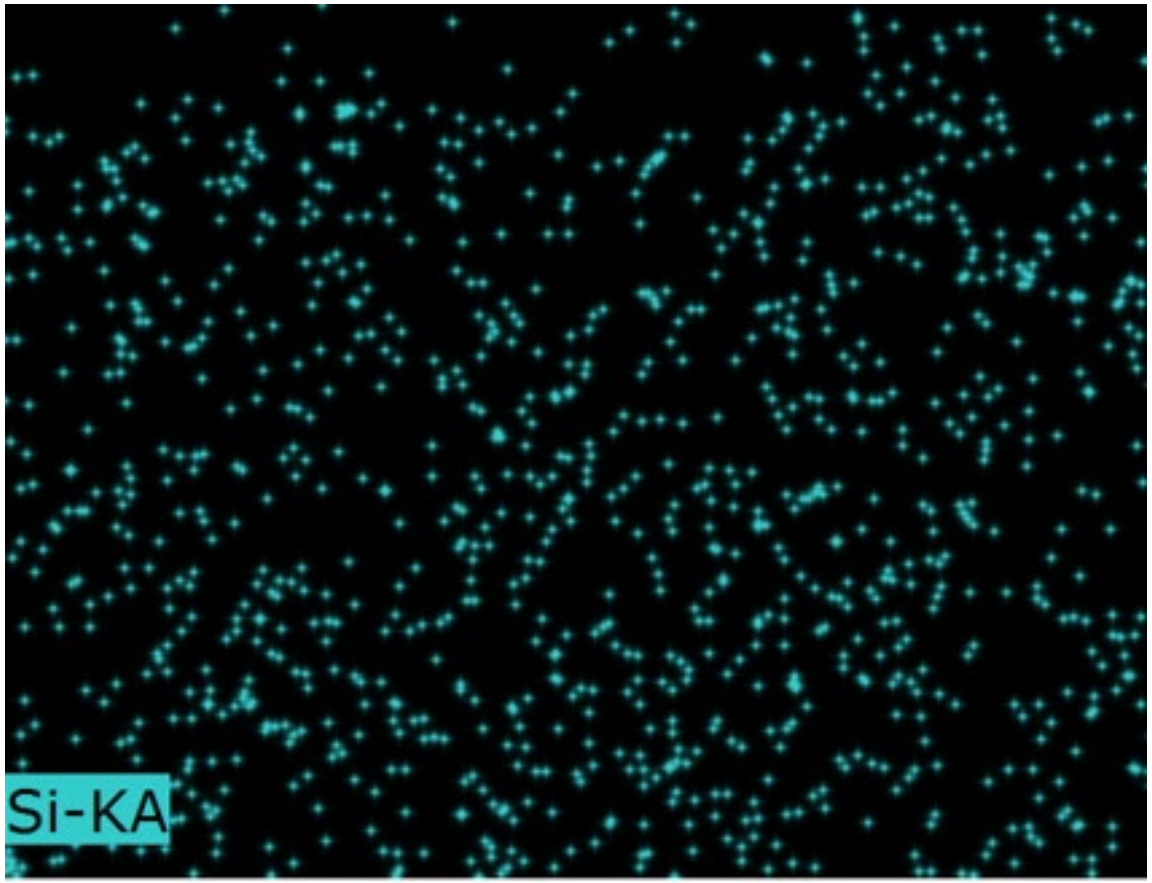
Lower RPM, lower dispersive mixing

1000x Magnification



Higher RPM, higher dispersive mixing

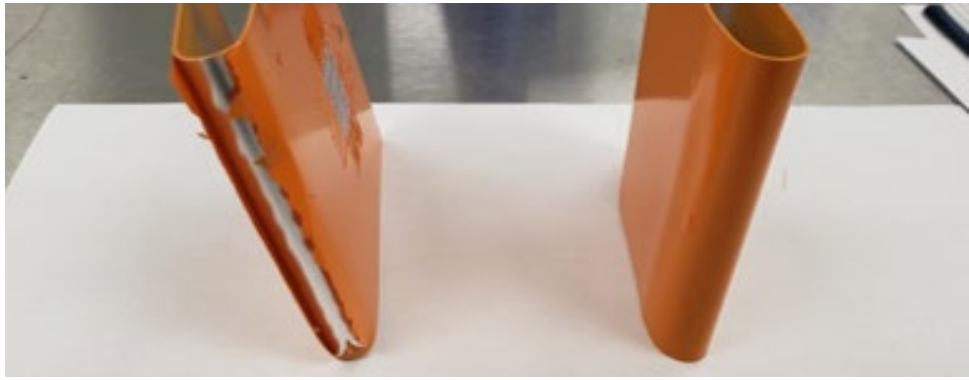
1000x Magnification



Processing Conditions: Physical Properties

- Adjustments in processing can eliminate surface defects and improve physical performance
- Processing parameters are essential to final performance of coating
- Formulation chemistry is critical

Left: Maximum throughput/barrel feed
Right: 50% throughput/barrel feed



Left: Lower RPM/lower dispersive mixing
Right: Higher RPM/higher dispersive mixing

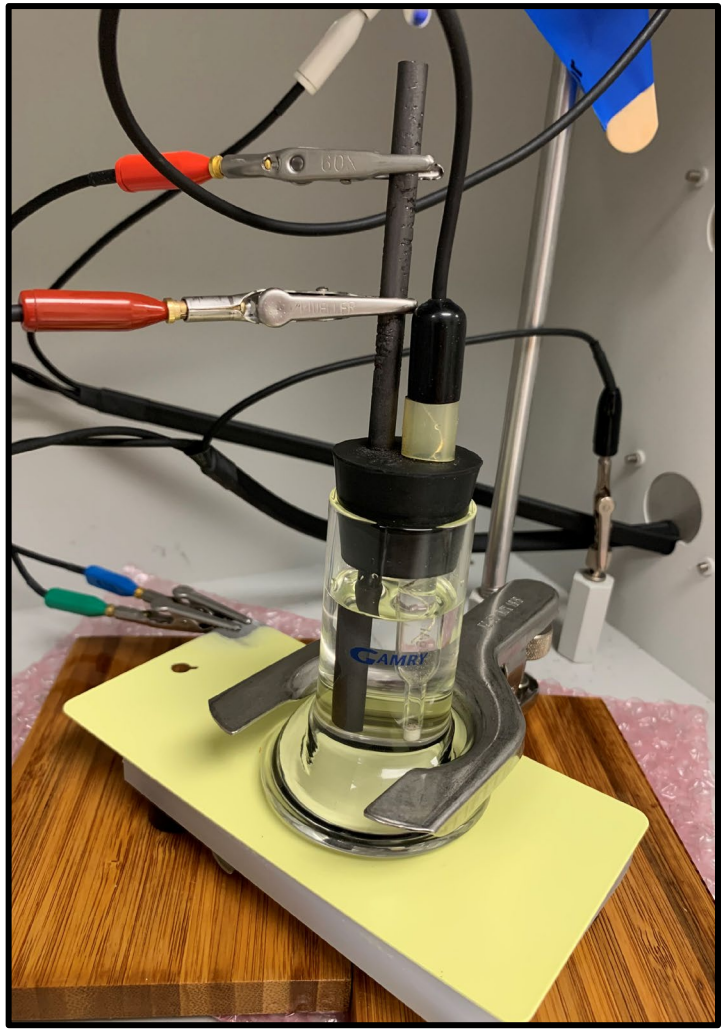
EIS: Coating Capacitance & Water Uptake

- Rapid Electrochemical Assessment of Paint (REAP)
- Water volume uptake via coating capacitance determination

$$\%\ \text{volume} = 100\ \log(Cct_0/\ Cc_{t24})/\log(80)^*$$

- Cc_{t0} = Coating capacitance (initial time)
- Cc_{t24} = Coating capacitance (after 24-hour soak)

- Highly controlled testing environment
- One of many electrochemical test methods used to quickly evaluate coating properties



* Brasher, Kingsbury

Lower RPM/lower dispersive mixing	Higher RPM/higher dispersive mixing
1.97% Water Uptake	**1.52%** Water Uptake
5% % Impedance Change	**2%** % Impedance Change

➢Extrusion processing parameters affect surface appearance and physical properties of the film coating

1. Higher RPM/Shorter Residence Time
2. Maximum Throughput/Barrel Fill

-Improved extrusion mixing
-Smoother surface appearance
-Improved physical properties
-Lower water uptake
-Faster material extrusion

1. Lower RPM/Longer Residence Time
2. Lower Throughput/Partial Barrel Fill

-Poor extrusion mixing
-Rough surface appearance
-Poor physical properties
-Higher water uptake
-Slower material extrusion

Future Work

- Formulation chemistry
- Processing conditions
- Screw profiles
- Thermal analysis and physical testing
- Additional EIS evaluations
- Accelerated weathering and natural weathering

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