

An
Innovative
Bright
White
Pigment for
Cool Roof
Coatings

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The Science of Coatings Applications

Application Approach

- Identify an interesting application
 - Significant commercial growth
 - Impact on society
 - Need to solve technical hurdles
- Identify an industry partner
 - Industry leader in specialty minerals
 - Desire to improve / change market
 - Experience in rapid commercialization
- Levels of formulation testing
 - Make a formulation
 - Make a formulation that is equivalent
 - Make a formulation that is superior

This Presentation Research

- Society: Reduction of energy / environmental impact
- Application: Cool roof coatings
- Partner: Leading Specialty Mineral Company
- Testing: Exterior acrylic coatings with new silica-based white pigment

Research Focus:

Demonstrate efficacy of new white pigment in growth applications

Interesting Application: Liquid Applied Cool Roof Coatings

- Cool roof coatings are highly engineered formulations for flat or low slope roofs
- This application is regulated by the Cool Roof Rating Council (CRRC)
- The coating must meet rigorous performance criteria
- This presentation emphasizes Acrylic Elastomeric types of cool roof coatings



Cool Roof Coatings Standard Specifications

- Cool Roof Coatings are specified by ASTM D 6083 – 97a
- Specified properties are viscosity, volume solids, weight solids, elongation, tensile strength, accelerated weathering, permeance, water swelling, adhesion, fungi and tear resistance, and flexibility
- Unique focus on solar reflectance and thermal resistance
- THE ATTRIBUTES ARE QUITE COMPLEX



Interesting Application: Elastomeric Acrylic Cool Roof Market

Acrylic Resin Type Cool Roof	2019	2024	2029
Price \$/square	85	94	105
Area (million squares)	4.08	4.41	5.01
Pounds Total (MMlbs.)	58.6	63.7	72.5
Dollars Total (\$MM)	345	414	527

Key Takeaways:

- Large Market 5 million squares
- Three elements of growth
 - Social
 - Economic
 - Mandated
- Projected growth at 12% next five years

Source: 2020 Liquid-Applied Roof Coatings Report, The Freedonia Group

Interesting New Silica-Based White Pigment

- A highly refined silica-based white pigment that can be used in paint and surface coatings
- This pigment is durable, light weight (2.33 g/cc), bright white (HunterL >98) and inert
- State-of-the-art milling techniques yield multiple product grades
- Surface chemistry of the milled pigment is well suited for coatings
 - Isoelectric point ~2.2;
 - zeta potential at pH 8.5 ~[-45]
 - pH ~9.3

	NWM-5	NWM-10	NWM-15
d10 (μm)	1.3	1.5	1.6
d50 (μm)	2.3	3.8	5.4
d90 (μm)	4.6	10.2	15.9
HunterL	99.4	99.0	98.8

Key Finding: Our research has found that this new white pigment can improve cool roof coatings attributes while reducing cost

Properties Tested, Approach, and Key Findings

- Paint Manufacturing Process
 - Pigment load, wet-out and grind times
 - Energy requirements
 - Hegman

- Coatings Properties
 - In-can stability
 - Dry time
 - Dirt pick-up

- Variable Tested
 - Control- 0% Replacement
 - 12.5% Replacement
 - 25% Replacement
 - 50% Replacement



- Key Findings
 - 1) Viscosity Reduction
 - 2) Transparency Confirmed
 - 3) Abrasion Resistance Maintained
 - 4) Favorable Weathering

Control Formulation: TiO_2 is in control formulation

Viscosity Reduction When Using New White Pigment

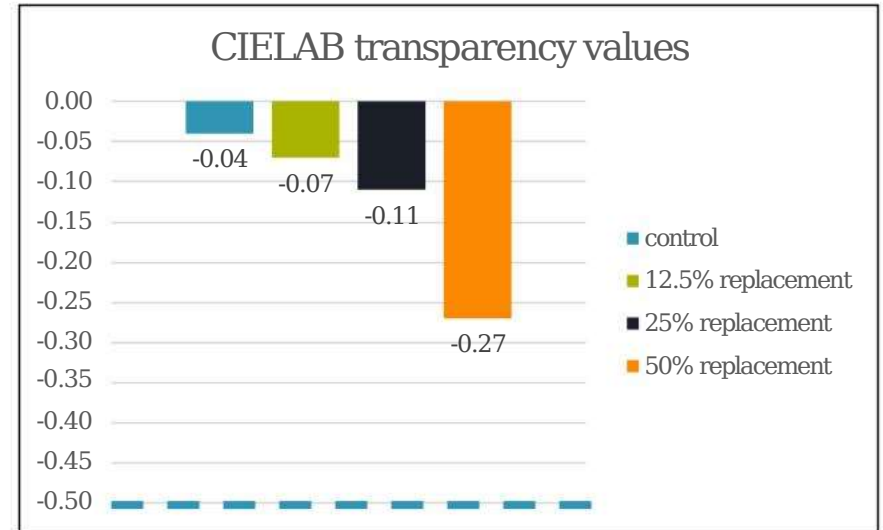
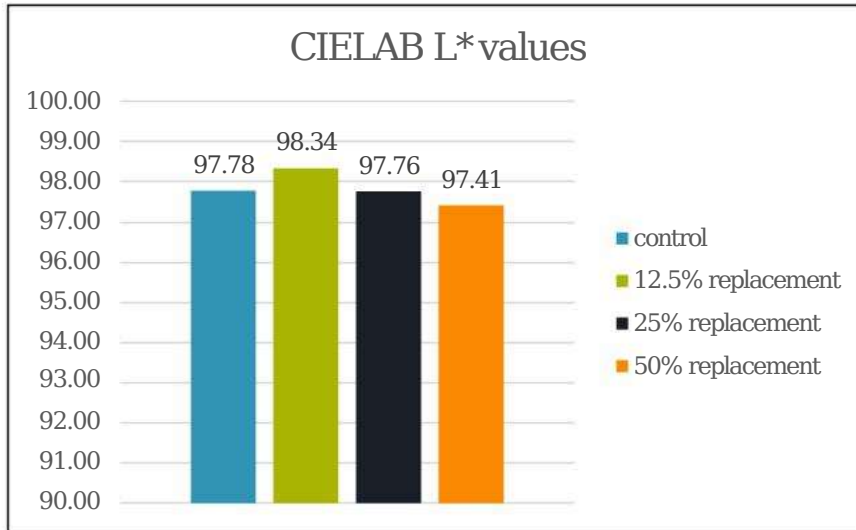


Brookfield Viscosity (cps @ rpm) #4 spindle			
RPM	10	20	50
0% new white pigment	4700	1640	290
12.5% new white pigment	1300	520	85
25% new white pigment	200	120	20

Brookfield Viscosity (cps @ rpm) #4 spindle			
RPM	10	20	50
0% new white pigment	4700	1640	290
12.5% new white pigment [-20% dispersant]	4000	1700	285
25% new white pigment [-35% dispersant]	5000	1700	320

Cost Reduction: The data illustrates viscosity reduction which can result in a surfactant reduction thus lowering formulation costs

Color & Transparency Impact with Increased Replacement



Improve /Maintain Brightness:

Data shows that there is no degradation of brightness

Impact on Transparency:

Values less than 0.5% are not visually detectable

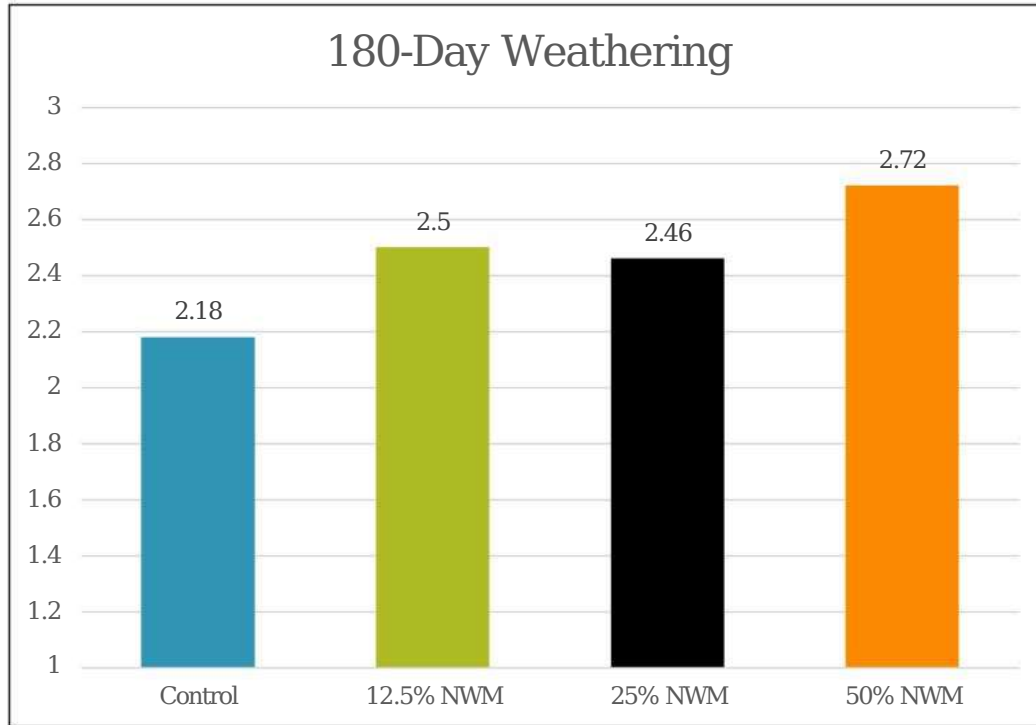
Cross Hatch Adhesion Test Show Favorable Results

ASTMD903 Cross Hatch Adhesion	
Description	5A=no delamination 0A=complete delamination
Control	5A
12.5% replacement	5A
25% replacement	5A
50% replacement	5A
Retail Brand A	5A
Retail Brand B	0A
Retail Brand C	1A



No Adhesion Issues:
Up to 50% replacement of TiO_2 has no impact on adhesion

Favorable Exterior Weathering Study

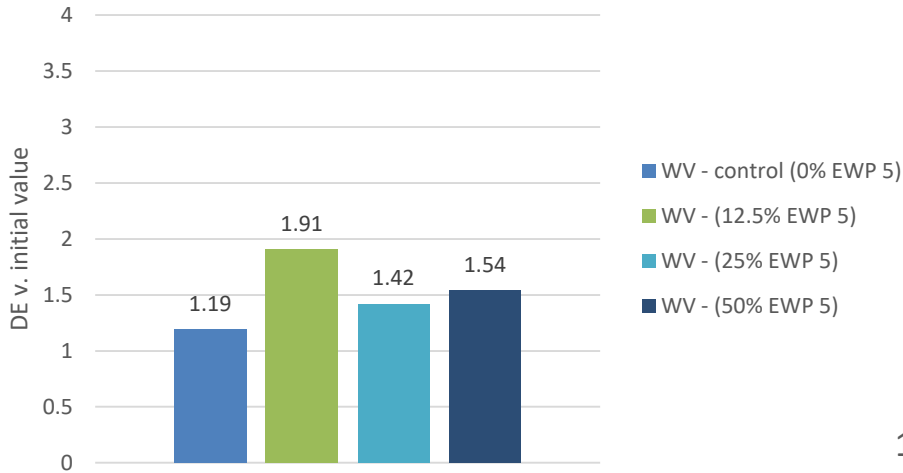


180 Day Similar Weathering:

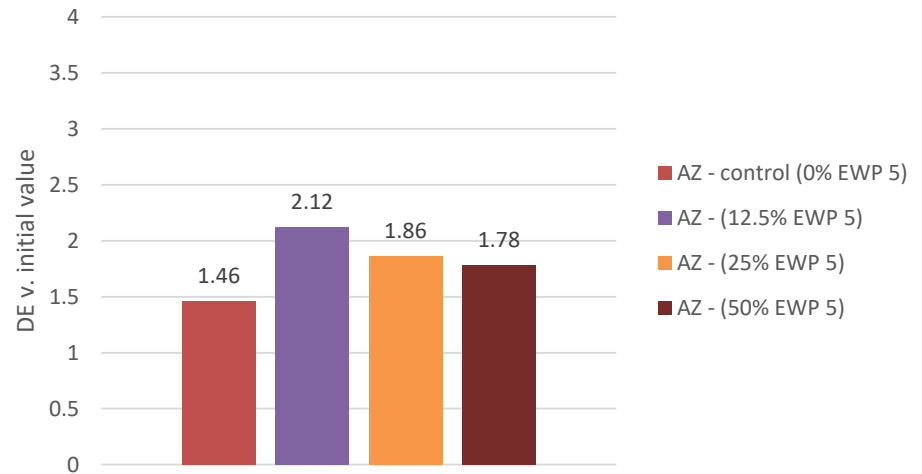
Addition of the new white pigment doesn't significantly impact the weathering

Duplicate Exterior Weathering Sites





105-day Exterior Exposure Comparison



105-day Exterior Exposure Comparison



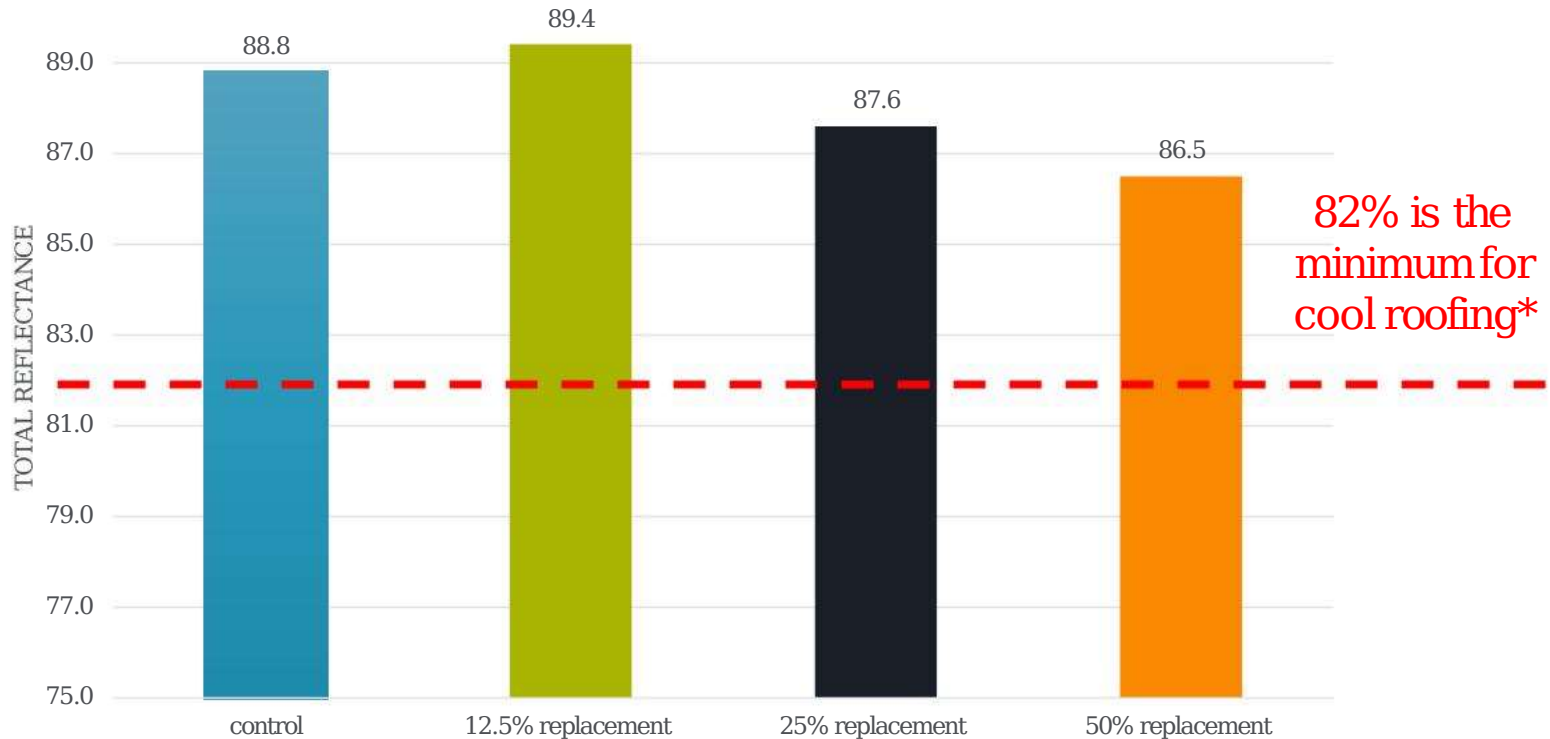
QUV Accelerated Weathering Study

Description	Elongation	Tensile Strength	Elongation 1000 hr. QUV	Abrasion
Standard – 100% R-960	415	249	278	0.95
12.5% replacement with EWP 5	482	239	236	1.10
25% replacement with EWP 5	475	230	260	1.60
Passing criteria	>100%	>200%	>100%	N/A
Outcome				

Key Result: Replacing R-960 TiO₂ with EWP 5 does not affect QUV weatherometry

Favorable Cool Roof Attributes

Solar Reflectance Graph



Solar Reflectance Impact:

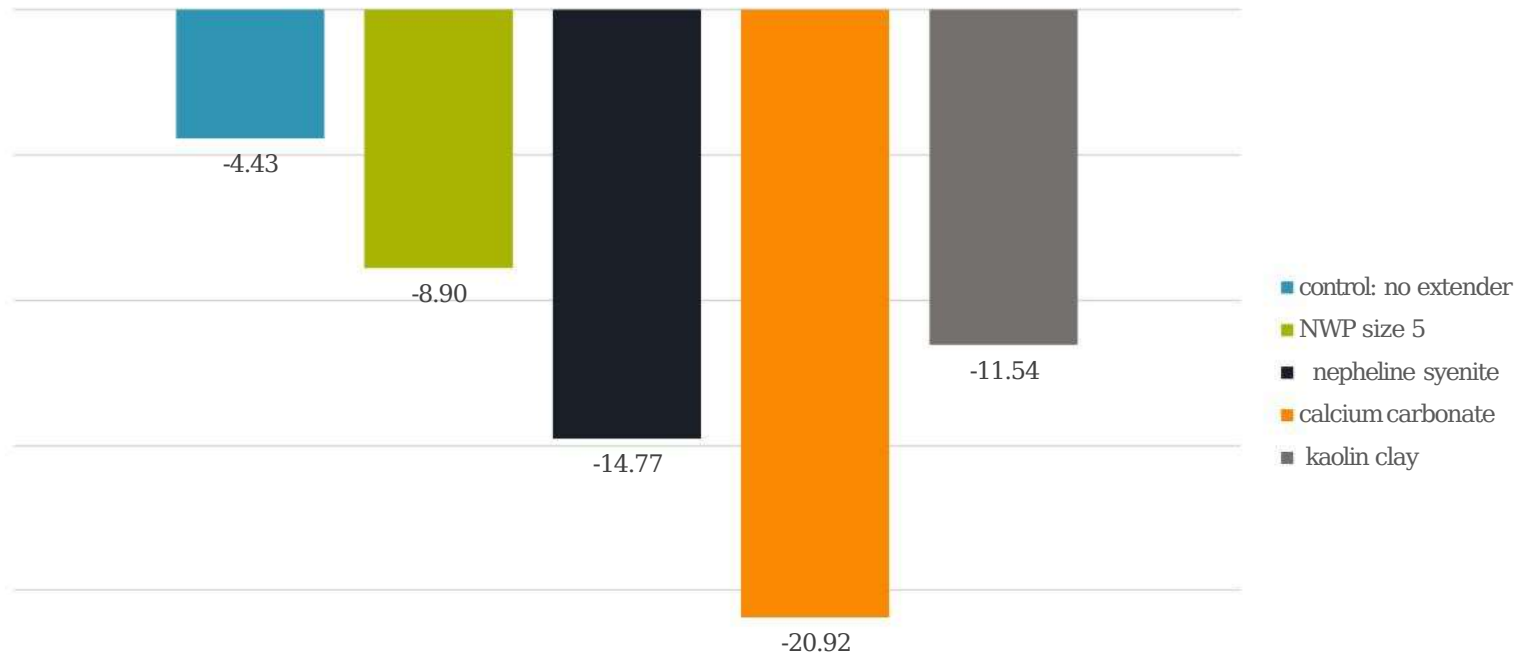
12.5% substitution is a favorable improvement on solar reflectance. Higher substitution levels still exceed cool roofing requirements.

Encouraging Results: Save Money / Enhance Performance

- Our initial theory based on experiments from other R&D projects
 - The new white mineral pigment can reduce product cost
 - This product line will reduce solar energy adsorption into the substrate
- We discovered that the new white mineral pigment enhances coating performance based on particle dispersion and separation
- This effect is measurable both in the liquid and cured (applied) coating
- Based on particle size, surface chemistry and dispersion quality, the new white mineral pigments will reduce cost AND... provide new benefits versus other more costly pigments.

New White Pigment is Different Then Traditional White Fillers

Transparency with TiO_2 replacement

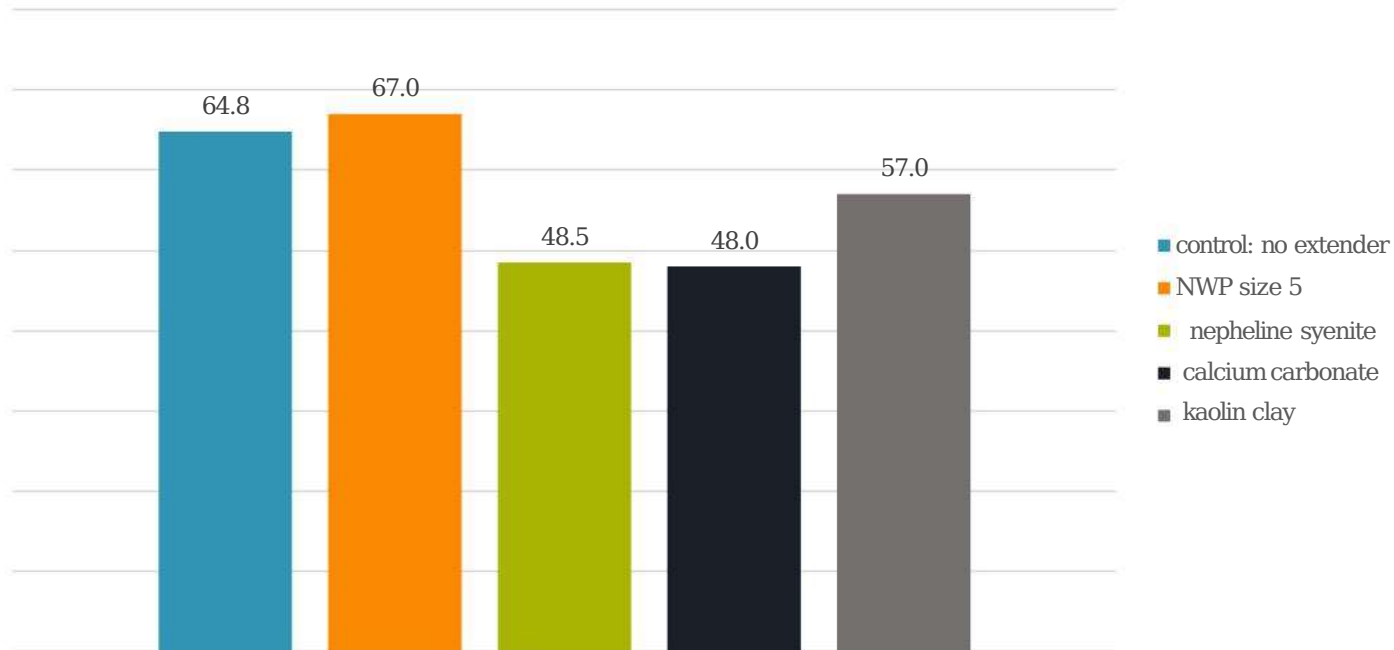


Not all white pigments perform the same:

The type of mineral has an impact on performance
This new white pigment performs better than other white fillers

New White Pigment Improves Solar Reflectivity

Solar Reflective Index with TiO₂ replacement



Enhanced Solar Reflectivity:

This data confirms that new white pigment improves solar reflectivity versus traditional white fillers

Conclusions and Next Research

- Silica-based white pigments can reduce cost and improve Cool Roof Coatings
- These white pigments are available in several particle size distributions
- We have on-going experimentation with other coatings properties for this project
- Evaluations in other polymeric systems are in progress e.g., epoxies, polyesters, rubber, cementitious, polyvinyl acetate and other polymers, etc.
- Encouraging applications include quartz countertops, inks, flooring, roofing, walls and other exterior coating applications, etc.
- We are looking for developmental partners

QUESTIONS?

