Coatings Trends & Technologies SUMMIT

ENHANCING WHITE PIGMENTS FOR INNOVATIVE COATINGS

US SILICA®
ENGINEERED PERFORMANCE MATERIALS®

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AGENDA

1. New White Pigment (NWP) for Coating Enhancements – An Introduction
2. NWP for Reduced TiO_2 Dependence in Coatings – Proof-of-Concept
3. Verifying and Extending Enhancements – Lubrizol Collaboration
4. Conclusions

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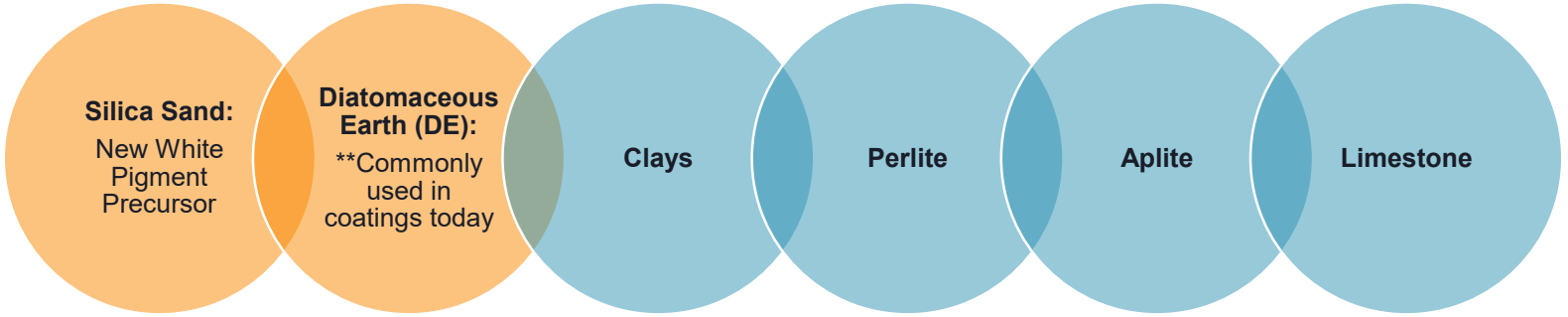
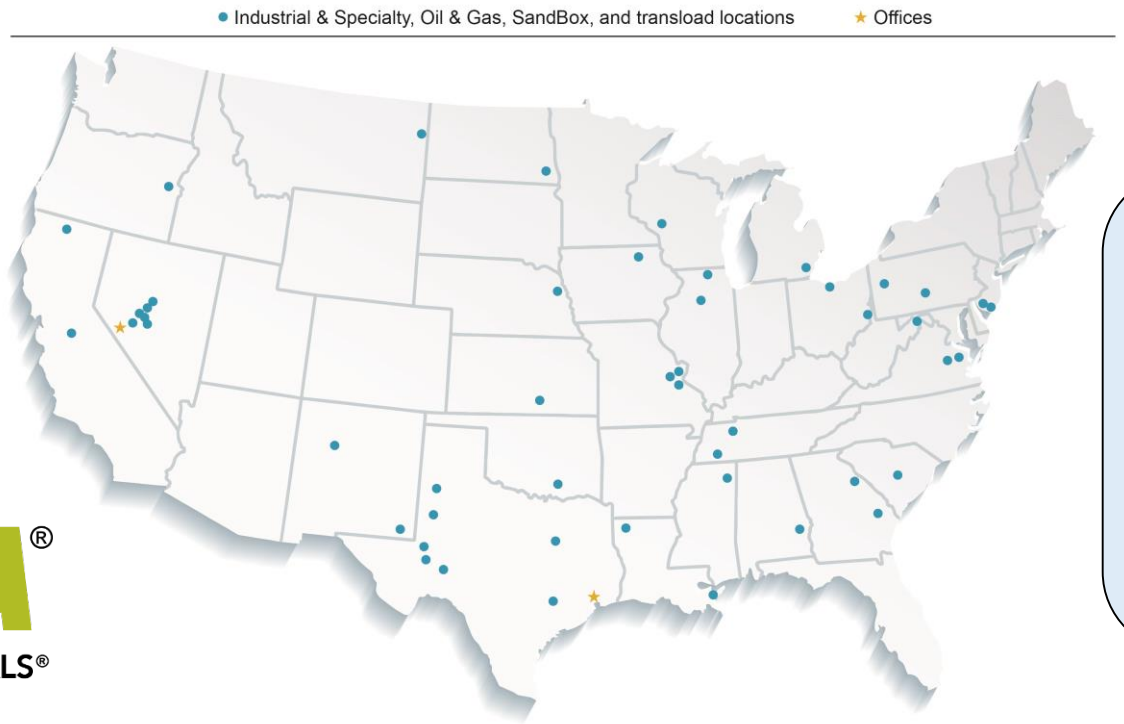
U.S. SILICA - WHAT WE MINE AND WHERE





- 23 plants and mines
- > 1,800 employees
- Products sold in 100 countries
- Corporate HQ in Katy, TX
- Innovation Center in Rochelle, IL (Open Position: Sr. R&D Scientist)

US SILICA®
ENGINEERED PERFORMANCE MATERIALS®

NEW WHITE PIGMENT (NWP)

- **NWP** is a high-white pigment for thermoplastics, coatings, and building products
- NWP is part of **a product line** of white products from U.S. Silica: D90 nominal particle sizes include 10 um, 15 um, 20 um, 40 um and higher
- **In development since 2020**, it's been commercialized in coatings, countertops, and cementitious applications
- NWP is used to **complement** other pigments, like **titanium dioxide** or **colorants** across a wide variety of formulations
- By using NWP, manufacturers can reduce titanium dioxide and pigment use by up to 50%, which can **reduce pigment/filler costs by up to 30%**

NWP – ENHANCING COATINGS

Cost Optimization

- TiO_2 Reduction
- Colorant Reduction
- Price Stability

Product Differentiation

- Mechanical Properties
- Density
- Aesthetics
- Viscosity Reduction
- Solar Reflectivity
- Resilience

Reducing Business Risk

- Shipping & Logistics
- Health and Safety
- Regulatory
- Security of Supply

NWP

- **Reduced TiO_2 Dependence**
- **Notable Differentiation**
- **Reliable Pricing and Supply**

TYPICAL PROPERTIES OF NWP AND TiO_2

	Talc	Kaolin (Clay)	Calcium Carbonate	Barium Sulfate	Titanium Dioxide (Rutile)	NWP
Mohs Hardness	1	2 – 2.5	3	3 – 3.5	6 – 7	6-7
Typical Hunter L*a*b* Color Values	95 / 0.5 / 2	93 / 1 / 3	97 / 0.2 / 1	96 / 0.3 / 1.5	99 / 0.1 / 0.7	98 / 0.7 / 1.0

NWP TDS:

TYPICAL PARTICLE SIZE (LASER DIFFRACTION)		TYPICAL MEASURED PROPERTIES	
D-90 (µm)	5.8	Hunter L	> 98.0
D-50 (µm)	2.4	a	0.7
D-10 (µm)	1.3	b	1.0
GENERAL PROPERTIES			
Mohs Hardness	6-7	Refractive Index	1.49
pH	9-10	Specific Gravity	2.33

Other White Product Offerings	D-50 Particle Sizes
10*	4 microns
15	5 microns
20*	9 microns
40	12 microns
Granular materials available too	

**Available for evaluation*

NWP is most similar to TiO_2 than other minerals based on whiteness and hardness

NWP: DURABLE, WHITE, AND LIGHTWEIGHT

Durable

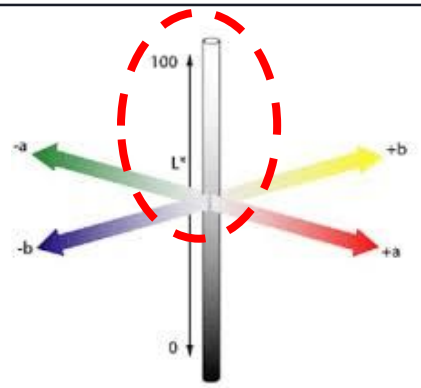
Mohs Hardness

Kaolin Clay	Calcium Carbonate
2 - 2.5	3

Mohs Hardness

Titanium Dioxide	New White Pigment
6 - 7	6 - 7

White



Color	Measure
L	> 98
a	0.7
b	1.0

Lightweight

Material	Specific Gravity
TiO_2	4.26
NWP	2.33

Domestically Produced

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POC: COOL ROOF COATINGS

- Cool roof coatings 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
- Focus on solar reflectance and thermal resistance

Two sets of data:

POC 1: Head-to-head higher loading white pigment.

POC 2: Lower pigment loading with comparisons looking at alternatives.

POC 1 – HIGH NWP LOADING: TESTING, APPROACH, KEY FINDINGS

Proof-of-Concept 1.A: High Pigment Loading

Demonstrated same processing

- Pigment load, wet-out, and grind times
- Energy requirements
- Hegman measurements

Different replacement levels with NWP

- Control – 0% replacement
- 12.5% TiO2 replacement
- 25% TiO2 replacement
- 50% TiO2 replacement

Demonstrated same performance

- In-can stability, dry time, and dirt pick-up

Demonstrated same adhesion

- No adhesion impact up to 50%, ASTM D903 “cross hatch”

Demonstrated similar weathering (accelerated and outdoor)

- Delta E (change of color) was similar for all weathered samples

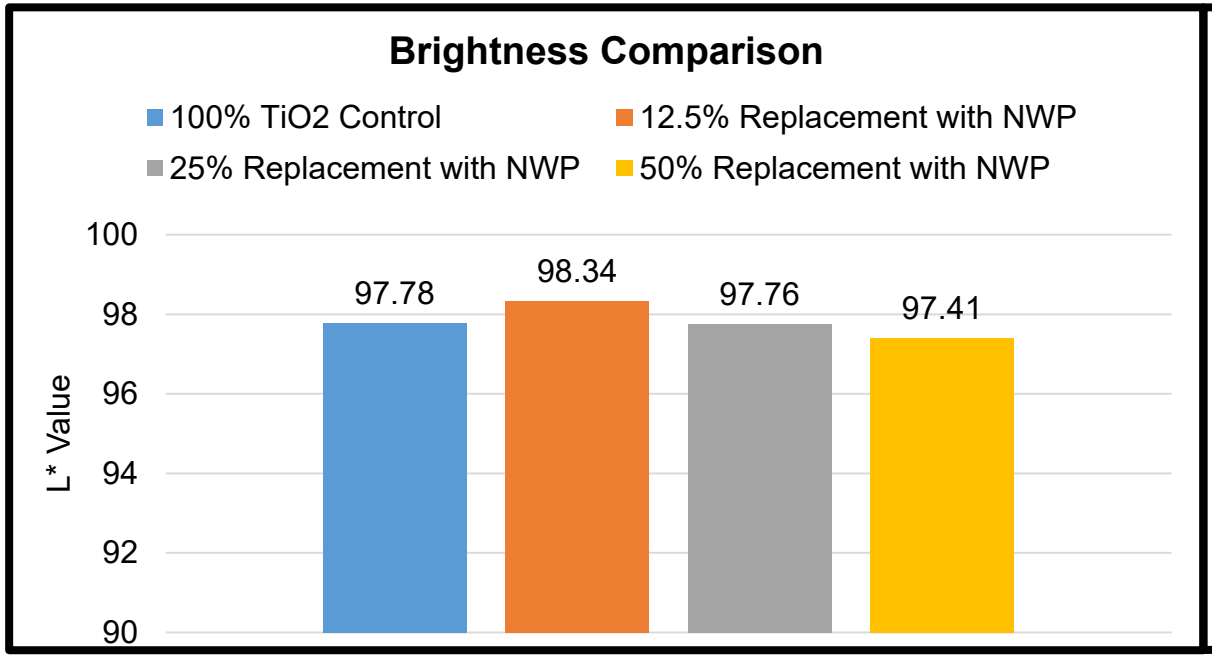
Key findings

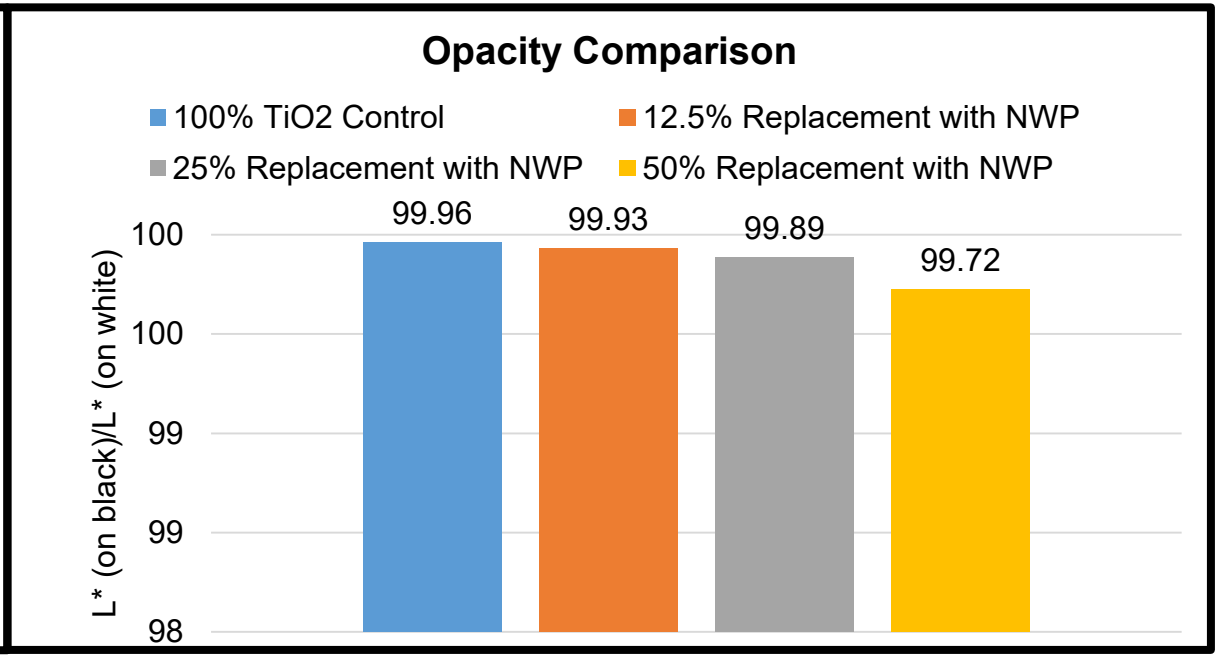
1) Negligible change in brightness
2) Minimal change in opacity

Control formulation for “POC 1”: TiO_2 is in control formulation loading = 20%

POC 1 – HIGH NWP LOADING: COLOR AND OPACITY

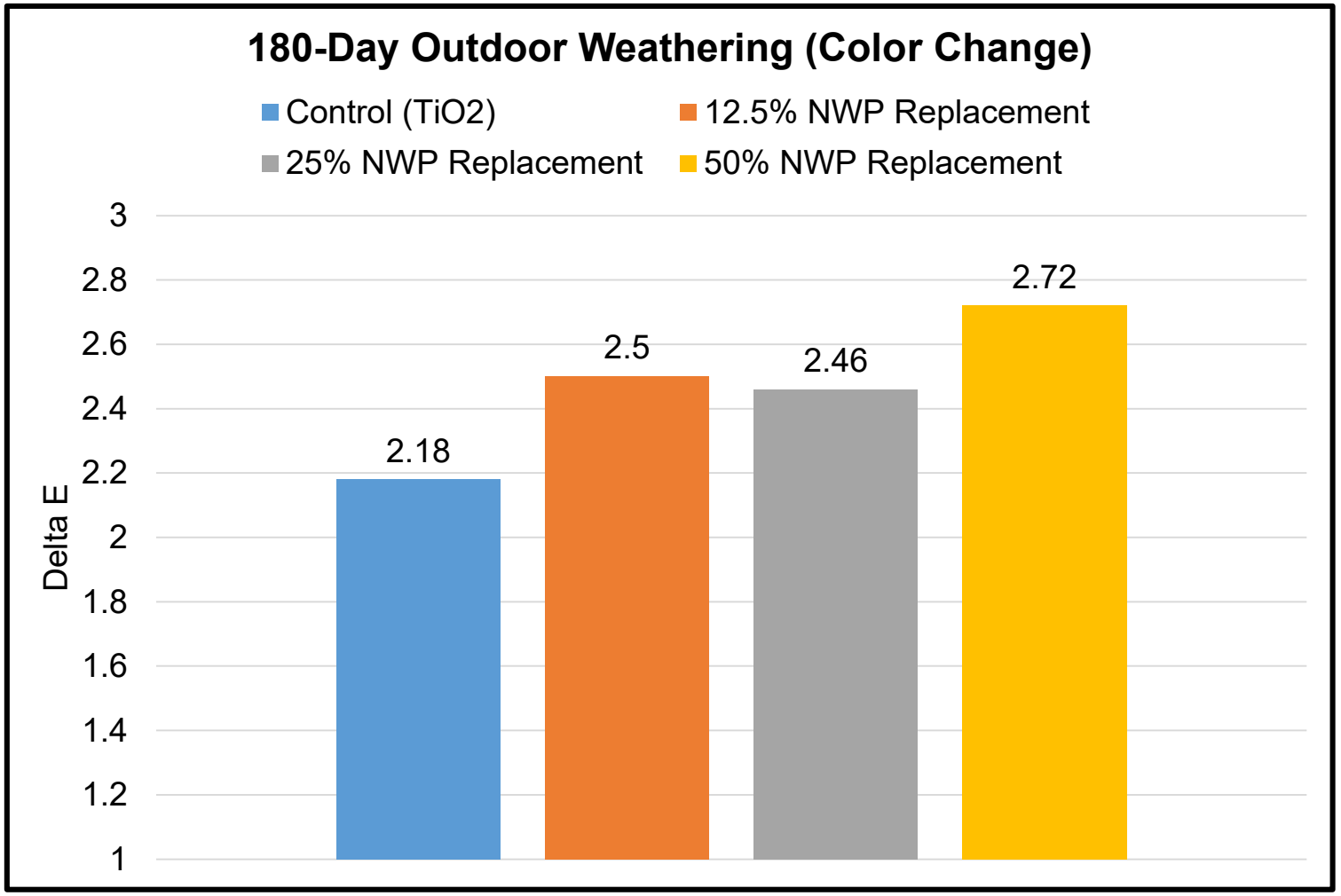
Dry thickness 10 mil





NWP-samples show no significant change in brightness and minimal decrease in opacity.

WEATHERABILITY



Weathering Station

POC 2 – REDUCED NWP LOADING: TESTING, APPROACH, KEY FINDINGS

POC 2: Reduced Pigment Loading

Demonstrated Same Processing

- Pigment load, wet-out, and grind times
- Energy requirements
- Hegman measurements

Demonstrated Same Performance

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

Control formulation for "POC 2": TiO_2 is in control formulation loading = 8%

Different Replacement Levels

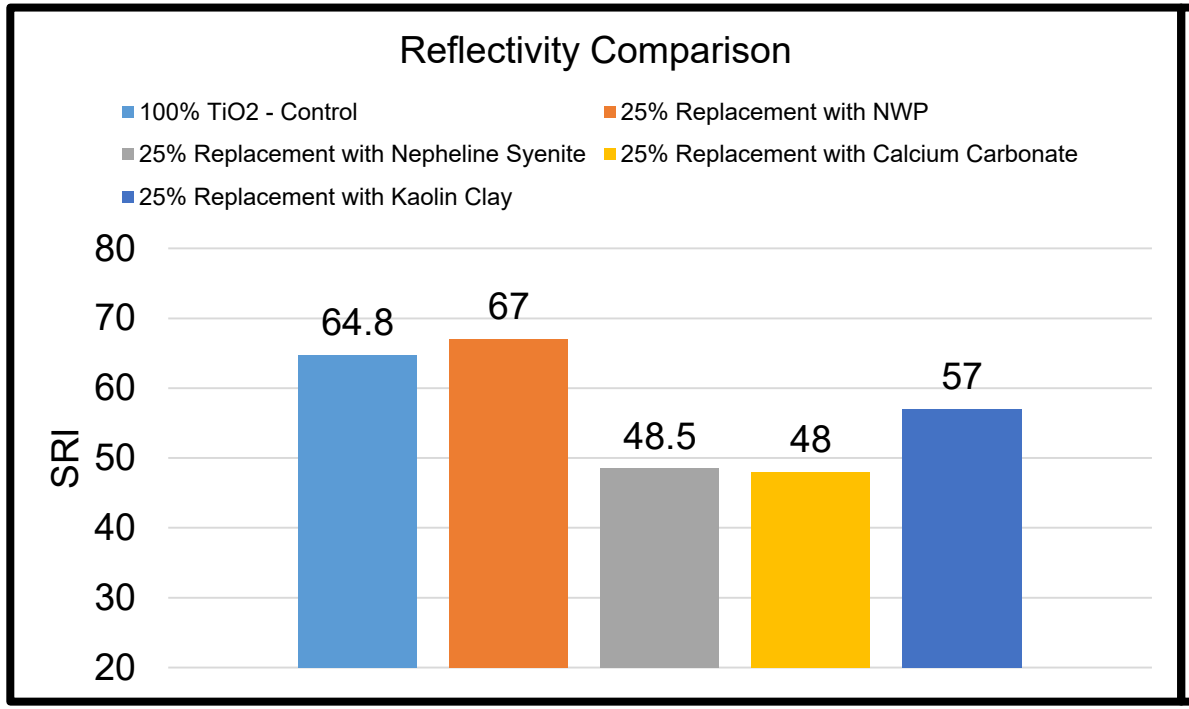
- Control – 0% TiO_2 Replacement
- 25% TiO_2 Replacement
  - NWP
  - Calcium Carbonate
  - Nepheline Syenite
  - Kaolin clay

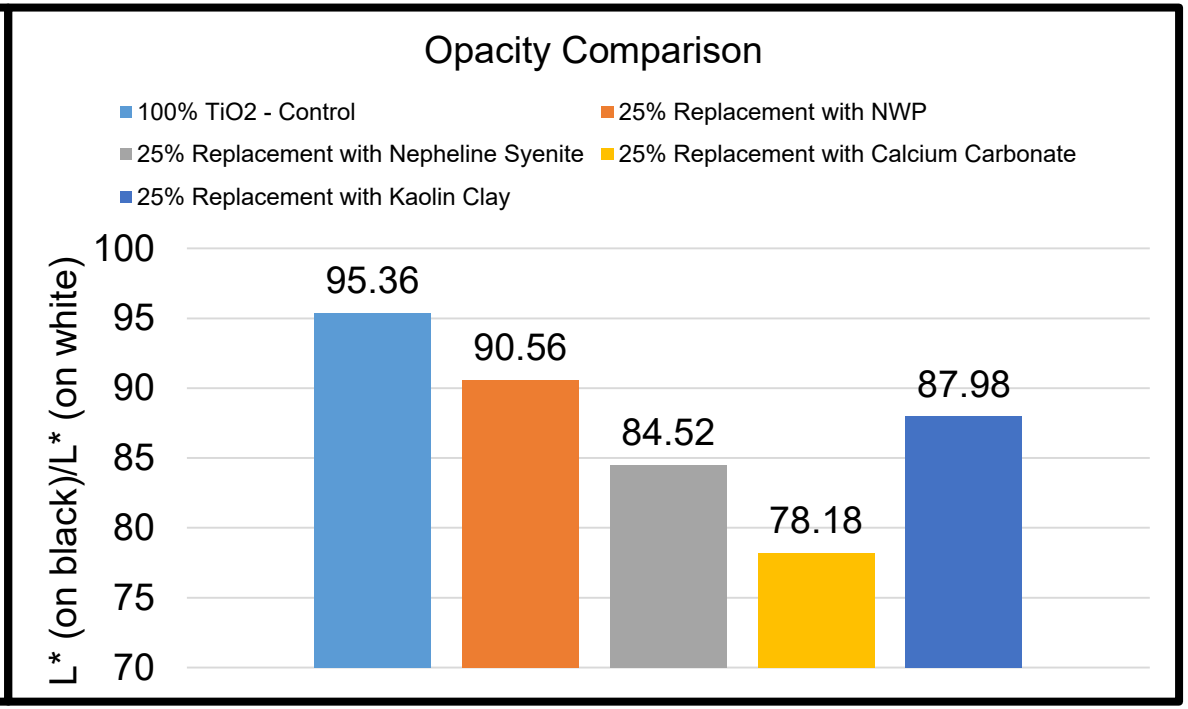
Key Findings

1) Enhancement in solar reflective index
2) Opacity closer to TiO_2 than other white alternatives

POC 2 – REDUCED NWP LOADING: SOLAR REFLECTIVE INDEX (SRI) and OPACITY

Dry thickness 10 mil





NWP Showing Enhanced SRI and Improved Opacity:

- The type of mineral has an impact on performance
- NWP improves solar reflectivity (Orange Bar, Left) versus other white pigments
- NWP (Orange Bar, Right) provides more opacity than other white fillers

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LUBRIZOL COLLABORATION: ROOF COATINGS – FORMULATION, PERFORMANCE, KEY FINDINGS

Formulation

- Acrylic resin specifically designed for elastomeric roof coatings; 10% TiO_2; 30% $CaCO_3$
- Dispersant

Similar Performance

- Processing
- Opacity and Color
- Tensile Strength and Low-Temp Flexibility

Different Replacement Levels

- Control – 0% TiO_2 Replacement
- 25% TiO_2 Replacement
- 50% TiO_2 Replacement

Key Findings

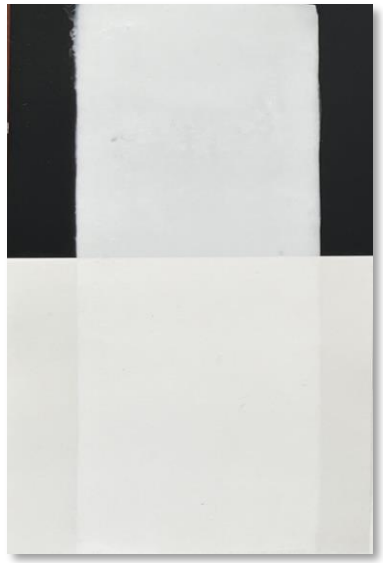
1) Opacity and color close to TiO_2 control sample
2) Small enhancements in water absorption and impermeability

Control Formulation for "Lubrizol Collaboration": TiO_2 loading of 10%

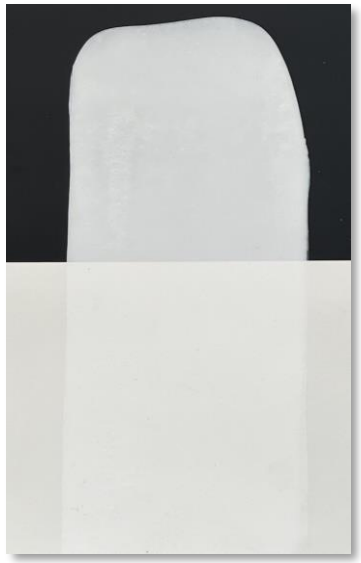
LUBRIZOL COLLABORATION: COLOR ANALYSIS AND OPACITY

Dry thickness 3 mil

Control – 10% TiO_2



25% TiO_2 replaced with NWP



50% TiO_2 replaced with NWP

Replacing TiO_2 with NWP – Aesthetic Changes:

- 25% TiO_2 replacement causes very little change in color and opacity
- Even 50% TiO_2 replacement only increases dE to 0.97 units and reduces opacity by 6.18 units

	L*	a*	b*	ΔL*	ΔE	Opacity
Control - 10% TiO2	95.99	-0.60	1.72	-	-	87.63
25% TiO2 replaced with NWP	94.77	-0.76	1.57	-1.22	1.24	86.66
50% TiO2 replaced with NWP	94.23	-0.80	1.92	-1.76	1.78	81.45

LUBRIZOL COLLABORATION: MECH. PROPERTIES (ASTM D6083)

Tensile Testing:

	Tensile Peak Stress (psi)	% Elongation Strain at break	Tear Resistance (lbs./f)
Control formulation	610.86	108.11	144.28
25% TiO2 replaced with NWP	593.10	129.79	145.87
50% TiO2 replaced with NWP	622.90	120.93	156.42

Tensile, Elongation & Tear resistance was performed on 20 mil dry film, prepared as 2x10 mil layers and allowed to cure for 14 days. Tear resistance was tested using the Die C method.

Low Temperature Flexibility:

	13 mm Cylinder	8 mm Cylinder	6 mm Cylinder
Control formulation	slight cracking	moderate	moderate
25% TiO2 replaced with NWP	slight cracking	slight cracking	moderate
50% TiO2 replaced with NWP	slight cracking	slight cracking	moderate

Low Temp Flexibility / Mandrel bend was tested using cylindrical test apparatus. Testing was done on a 12-mil film, coated onto aluminum, and was tested at -22°C.

LUBRIZOL COLLABORATION: WATER ABSORPTION AND IMPERMEABILITY

Water Absorption:

	1-Day Gain (%)	7-Day Gain (%)
Control formulation	13.78	13.61
25% TiO2 replaced with NWP	12.94	13.35
50% TiO2 replaced with NWP	12.56	13.05

Water Swelling was conducted on 20 mil films, dried for 7 days before testing and then submerged in water at 72°F for 7 days.

Water Permeability:

	Permeability of film	Permeability per mil (perms)
Control formulation	8.54	0.39
25% TiO2 replaced with NWP	7.60	0.32
50% TiO2 replaced with NWP	7.52	0.34

Moisture Vapor Transmission was tested using the wet cup method, (described in the ASTM as Test Method B). Testing was done on a 20-mil film, cured for 7 days before testing.

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COOL ROOF COATINGS SUMMARY: REFORMULATING WITH NEW WHITE PIGMENT

	Processing	Weathering	Opacity	Color	Solar Reflectivity	Water Permeability & Absorption	Mechanicals	Cost
Control	✓	✓	✓	✓	✓	✓	✓	-
NWP - 25% replacement of TiO_2	✓	✓	✓	✓	+	+	✓	+
NWP - 50% replacement of TiO_2	✓	✓	✓	✓	✓	+	✓	++
Alternative White Pigments	✓	In Testing	-	✓	-	TBD	TBD	++




QUESTIONS?

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