Keeping White Roofs White

New Acrylic Latex for Reflective Roof Coatings with Improved Dirt Pickup Resistance

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Agenda

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- Cool Roofing introduction
- Cool Roofing Standards – ASTM D6083
- Solar Reflectivity Index
- Components of a roof coating and contribution to performance
- EPS® 2210 and benefits of formulating with EPS® 2210

Cool Roofs

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Roofs with reflective surfaces, or cool roofs, contribute to mitigating the "urban heat island" phenomenon. They bounce back the sun's intense rays, taking in **80% less heat** than conventional dark-colored roofs **and reducing indoor temperatures by as much as 30% during hot weather conditions.**

A cool roof diminishes the transfer of heat to a building, enabling it to remain cooler and use less energy for air conditioning. In residential buildings with air conditioning, the solar reflectance from a cool roof can **potentially decrease the peak demand for cooling by 11–27%.**

Cool roofs **reduce overall temperature and stress on the power grid.**

The U.S Department of Energy (DOE) advocates for cool roof coatings as an economical and minimally disruptive approach to boost the **energy efficiency of pre-existing buildings.** These buildings currently represent over 20 billion square feet of commercial roofing space that is available for retrofit in the United States.

Sources: NYC °CoolRoofs, U.S. Department of Energy, Cool Roof Fact Sheet, U.S. Environmental Protection Agency, Reducing Urban Heat Islands: Compendium of Strategies, Cool Roofs, pp. 1, 8.

What is a Roof Coating?

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- **RCMA (Roof Coatings Manufacturers Association)**
  - Roof Coating: A fluid-applied adhered coating used for roof maintenance, roof repair, or as a component of a roof covering system or roof assembly

- **Cool Roof Coatings**
  - A roof coating that has been designed to reflect more sunlight and absorb less heat than a standard roof – www.energy.gov

Typical Benefits of Cool Roof Coatings

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Extend the life of the roof

Protect the roof surface by providing a low-cost, sacrificial layer that absorbs the punishment of the elements

Reflective roof coatings **reduce surface temperatures**

Greater occupant comfort – in occupied buildings without A/C

Avoids building or occupant disruption and roof replacement

Save money

Repair and /or coat vs tear off and replace

Federal and local tax deductions

Less A/C required for cooling

Peak Energy Use Reduction

Roof Coating Needs

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ASTM D6083

Property	Test	ASTM	Spec
Toughness	Initial percent elongation	D 2370	100%
	Initial tensile strength	D 2370	200 psi
	Tear resistance	D 624	60 lbf/in
Water resistance Adhesion	Water vapor permeance	D 1653	< 50 perms
	Water swelling	D 471	< 20%
	Wet adhesion	D 903	> 2 pli
Fungi resistance	Fungi resistance	G 21	Zero rating
Durability	Accelerate weathering	D 4798	No cracking or checking
	Final percent elongation after 1000 h accelerated weathering	D 2370	100%
	Low temperature flexibility after 1000 h accelerated weathering	D 522	0.5” mandrel @ -10C
Reflectivity	High initial solar reflectance		
	Dirt pickup resistance	In-house method	
	Bleed-through resistance	In-house method	

ASTM D6083 Type I vs Type II

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TABLE 1 Liquid Physical Property Requirements

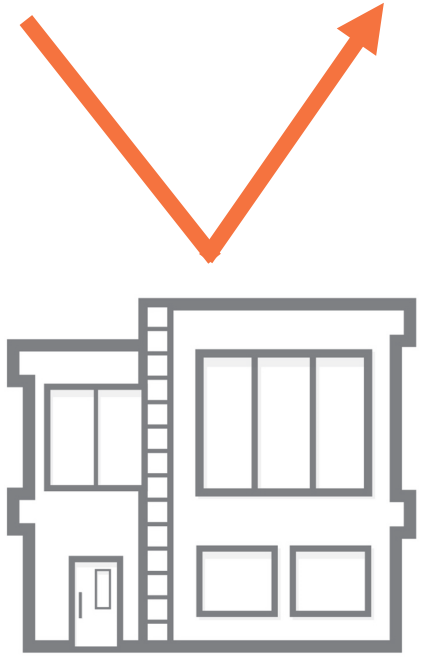
Physical Property	ASTM Designation	Requirements	
		Type I	Type II
Viscosity	D2196	12 to 85 Pa·s [12 000 to 85 000 cps]	0.2 to 100 Pa·s [200 to 100 000 cps]
Volume solids	D2697	≥50 %	≥45 %
Weight solids	D1644	≥60 %	≥50 %

The resin must be all-acrylic for ASTM D6083

TABLE 2 Cured Film Physical Property Requirements

Physical Property	ASTM Designation	Requirement	
		Type I	Type II
Initial percent elongation (break)	D2370	minimum 100 % 23 °C [73 °F]	minimum 100 % 23 °C [73 °F]
Initial tensile strength (maximum stress)	D2370	minimum 1.4 MPa [200 psi] 23 °C [73 °F]	minimum 1.4 MPa [200 psi] 23 °C [73 °F]
Final percent elongation (break) after accelerated weathering 1000 h	D2370	minimum 100 % at 23 °C [73 °F]	minimum 100 % at 23 °C [73 °F]
Permeance	D1653	maximum 2875 ng [Pa·s·m^2] [50 perms]	maximum 2875 ng [Pa·s·m^2] [50 perms]
Water swelling	D471	maximum 20 % (mass)	maximum 20 % (mass)
Accelerated weathering 1000 h	D4798/D4798M	no cracking or checking	no cracking or checking
Adhesion	D903	minimum 350 N/m [2.0 pli] wet	minimum 350 N/m [2.0 pli] wet
Fungi resistance	G21	zero rating	zero rating
Tear resistance	D624	>10.5 kN/m [60 lbf/in.]	>10.5 kN/m [60 lbf/in.]
Low-temperature flexibility after 1000 h accelerated weathering	D522/D522M	minimum pass 13 mm [0.5 in.] mandrel –26 °C [–15 °F]	minimum pass 13 mm [0.5 in.] mandrel –10 °C [14 °F]

Roof Coating Needs - SRI



SOLAR REFLECTANCE
The solar energy that is reflected by the roof

THERMAL EMITTANCE
The relative ability of the roof surface to radiate heat

Acrylic roof coatings = ~0.9

Solar Reflectance Index (SRI)

Calculated value indicating the ability of a roof surface to return solar energy to the atmosphere.

Combines reflectance and emittance.

Typically reported as a value between 0 and 100.

Components of Acrylic Roof Coatings

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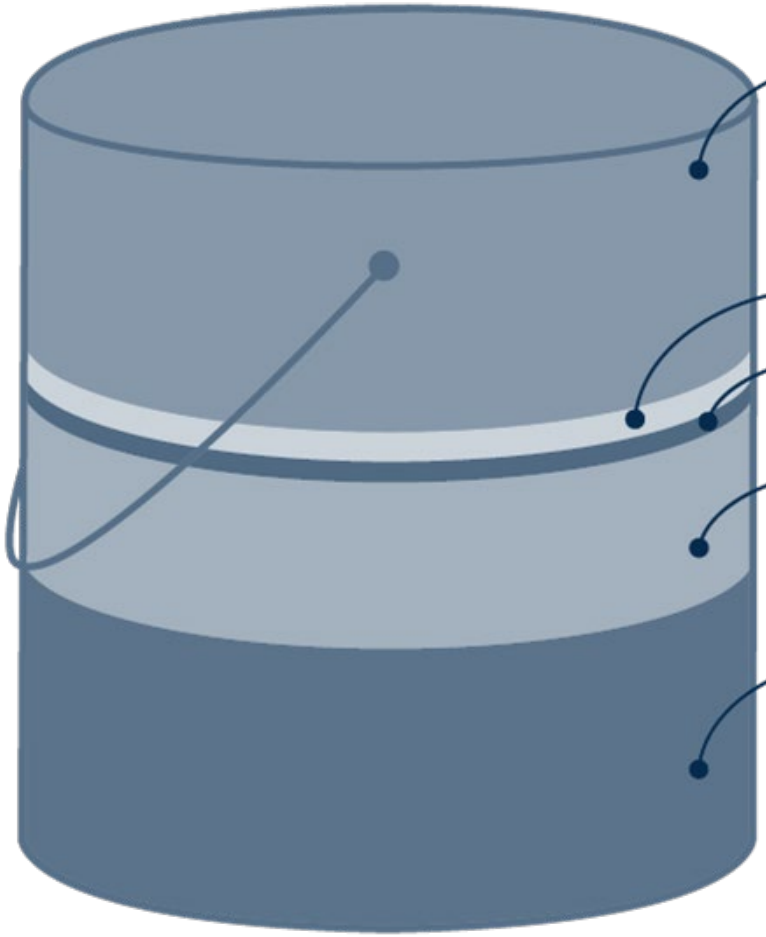
Raw Material	Pounds
Water	155
Dispersant	3
Ammonia	3
Defoamer	1
TiO2	90
Calcium Carbonate	370
Defoamer	2
Acrylic Latex (55% solids, 45% water)	450
Coalescent	7
Biocide/Fungicide	11
Glycol	11
Cellulose Thickener	3
Total	**1162**

Parameter	Value
Wt% solids	65
Vol% solids	51
PVC	40
VOC, g /liter	41
wpg	11.6



Water: carrier – allows the coating to flow

Solvents: Assist in film formation, open time

Additives: adjust pH, stability, viscosity; biocides, defoamers

Latex: binder/film forming agent – primary component influencing physical properties

Pigment/fillers: reflectivity, reinforcement

EPS® 2210 Properties and Specs

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EPS® 2210 is an all-acrylic emulsion designed for use in elastomeric roof coatings. Coatings formulated with this polymer are capable of conforming to **ASTM D6083 Type II** standards while still providing excellent **dirt pickup resistance** and **resistance to asphalt bleed-through**.

MARKET SEGMENTS

- Elastomeric Roof Coatings
- Elastomeric Wall Coatings

PROPERTIES

- Excellent weatherability
- Exceptional dirt pickup resistance
- Asphalt bleed-through resistance
- Adhesion to typical roofing substrates
- Excellent balance of tensile and elongation properties

TYPICAL PROPERTIES	
Weight Solids	55.0 +/- 0.7%
Weight/Gallon	8.70 +/- 0.10
pH	7.5-8.5
Volume Solids	53.0 +/- 0.7%
Tg	-12° C
Volatile(s)	Water

Physical Properties in Coating Formulation (SR2210-1)

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Physical Property	Units	ASTM Method	EPS® 2210	ASTM Spec
Table 1 Liquid Physical Properties				
Viscosity	Pa·s	D2196	15	0.2 to 100
Volume Solids	%	Calculated	52.0	>45
Weight Solids	%	Calculated	65.7	>50
Table 2 Cured Film Physical Properties				
Initial elongation	%	D2370	267	>100
Initial tensile strength	PSI	D2370	306	>200
Aged elongation	%	G155, D2370	139	>100
Permeance	Perms	D1653 Method B inverted	27	<50
Water Swelling	%	D471	6.8	<20
Accelerated weathering	P/F	G155	Pass	No cracking, checking
Adhesion to Galvanized Steel	PLI	C794/D903	2.4	>2
Tear Resistance	LB_f/IN	D624	101	>60
LT Flex (-10°C)	P/F	D522	Pass	No cracking
DPUR	dE	EPS Method – ROX Slurry	2.0	N/A
Bleed through resistance	dE	EPS Method	14	N/A

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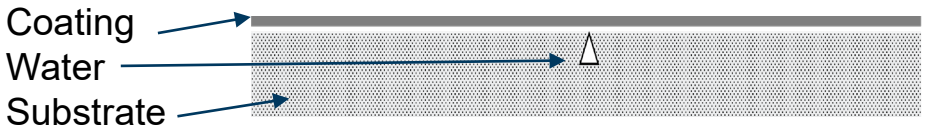
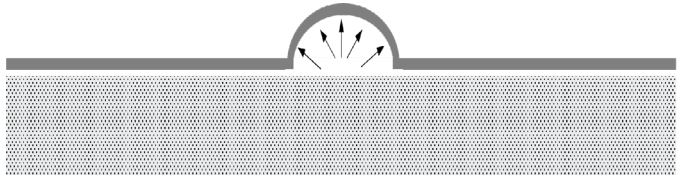
Water Vapor Permeance

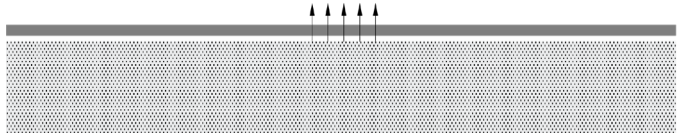
- All roof coatings are permeable to water to some extent
- Water or water vapor gets trapped under the roof coating and needs to escape when it warms up
- Blisters form when it expands faster than it can escape
- Water Vapor Permeance (WVP, WVTR, MVTR, permeability)
  - Ability of film to transport water vapor
  - Perms = mass/area/time/pressure
  - <~10 perms can cause blistering
  - Higher is better up to ~50 perms
- **EPS® 2210 Permeance is 20-30 Perms**



Low permeability coating
Trapped water forms a blister



High permeability Coating
Trapped water can escape



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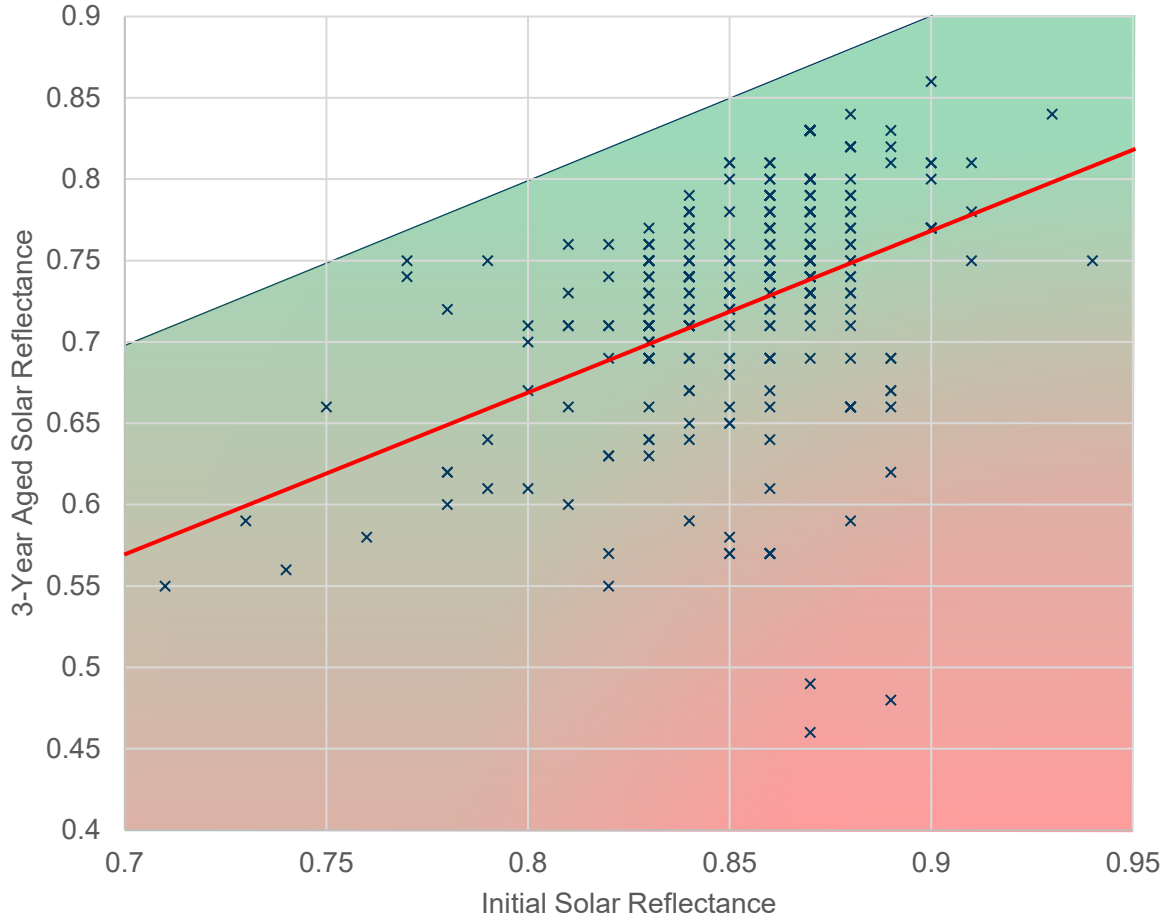
Dirt Pickup Resistance

The keys to keeping white roofs white are bleed-blocking and **dirt pickup resistance**

- **Dirt pickup resistance** (DPUR) is a crucial requirement for roof coatings
- Accumulated dirt reduces reflectivity
- DPUR can significantly affect **building energy costs** in roof coating applications
- Does not significantly affect thermal emittance

Influence of DPUR on Solar Reflectance

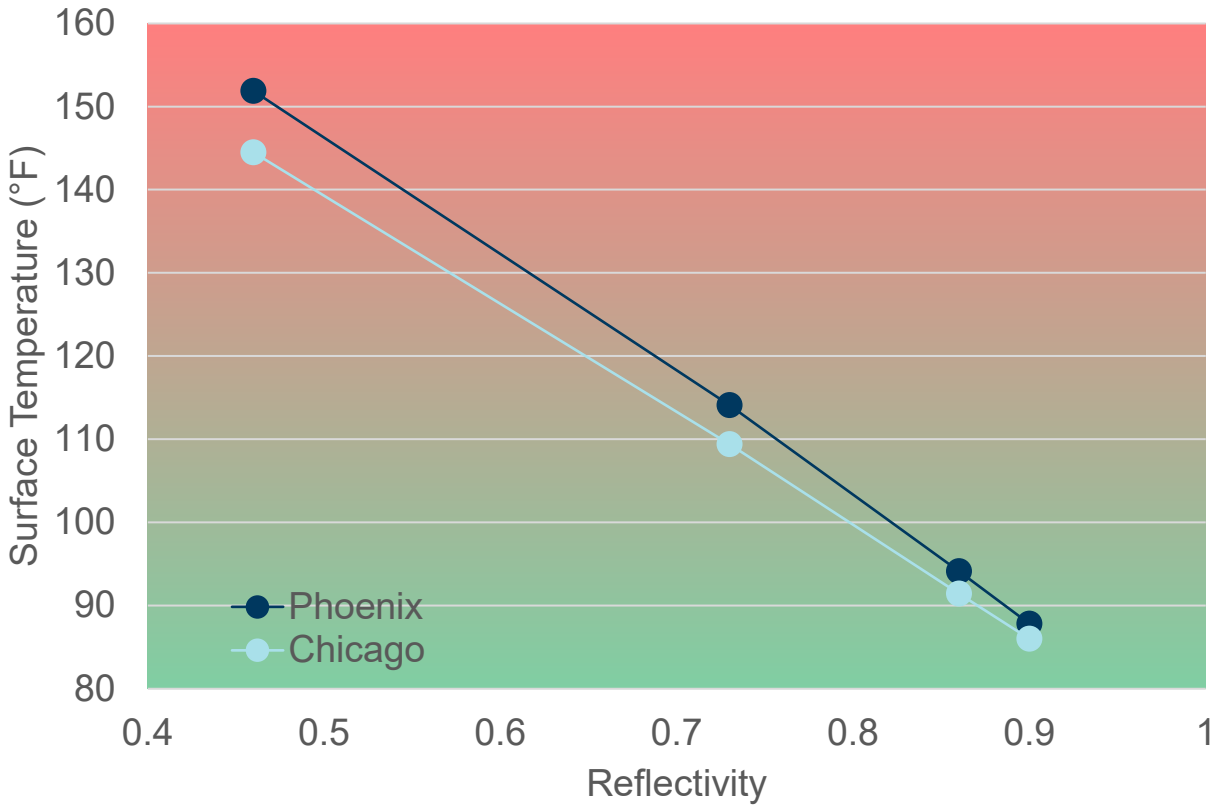
- Cool Roof Rating Council records initial and 3-year aged reflectance
- Decrease in reflectance ranges from 0.02 to 0.4
- Average decrease is 0.13 ± 0.05
- How does this translate to temperature?



Source: Cool Roof Rating Council

Influence of Reflectivity on Surface Temperature

- Calculate surface temperature from solar reflectance and thermal emissivity according to ASTM E1980
- Change in reflectance from 0.85 to 0.73 equates to an increase in roof temperature of ~20°F



Parameters for Calculations	
Ambient Air	80°F
Wind	Low (5 $W \cdot m^{-2} \cdot K^{-1}$)
Solar flux Phoenix	960 W/m^2
Solar flux Chicago	860 W/m^2

Source: https://coolcolors.lbl.gov/assets/docs/SRI%20Calculator/SRI-calc10.xls

Methods for Improving DPUR

CONCEPT

- Use of higher Tg resins
- Incorporation of specialty additives
- Utilize resins containing benzophenone
- **EPS Dirt Pickup Technology**

Red Iron Oxide Slurry Testing

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- Standard accelerated testing for **Dirt Pickup Resistance**
- Cure samples
    - Room temperature curing (3 days)
    - QUV for 7 days
- Apply a red iron oxide slurry
- Allow to dry
- Lightly rinse with water and wipe with cheesecloth

T_g Ladder with polymers

Higher Tg polymers tend to perform better for dirt pickup resistance

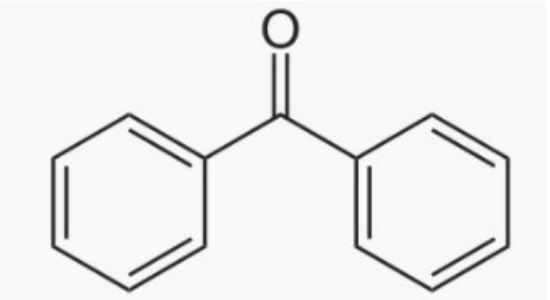
- The need for low-temperature flexibility in roof coatings
  - ASTM D-6083 Type I (-26 °C low temperature flexibility)
  - ASTM D-6083 Type II (-10° C low temperature flexibility)

Specialty Additives

Wax additives and fluorosurfactants have minimal to no impact on DPUR

Benzophenone

- Known in the art to add to resins and coating formulations to improve dirt pickup resistance
- Benzophenone is activated by UV light and abstracts a hydrogen from the acrylic resin
- Crosslinking occurs between radicals at surface of coating
- Benzophenone may trigger Prop 65 labeling requirements
- Benzophenone is a VOC according to ASTM D-6886 (methyl palmitate GC method)
- Benzophenone is frequently disclosed on an SDS
- Solid at room temperature, not trivial to add to a coating formulation



Benzophenone
(Diphenyl ketone)

Dirt Pickup Resistance

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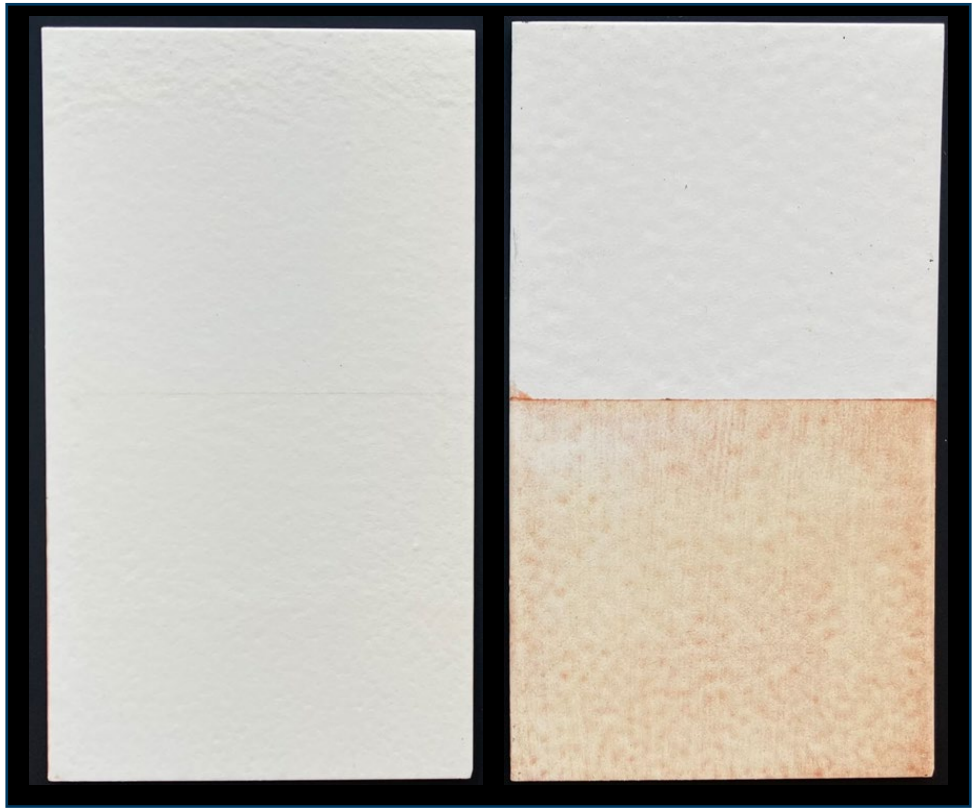
- **EPS DPUR technology** shows a significant improvement over competitive resin using benzophenone
- Incorporated directly into the resin chemistry
  - No special additives needed
  - No added VOC

EPS® 2210
EPS DPUR

Comp Resin
Benzophenone



Summary

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Cool roof coatings can protect your roof, provide **increased occupant comfort, and save building owners money.**

ASTM D6083 Standard Specification for Liquid Applied Acrylic Coating Used in Roofing provides testing requirements to ensure a **quality acrylic roof coating.**

SRI is a measure of the ability of a roof surface to return solar energy to the atmosphere and includes both reflectance and emittance. Specified by local government agencies.

Typical methods to improve DPUR result in an average 3-year drop in reflectivity of 0.13 which results in significant increases in roof temperature compared to freshly applied coatings.

EPS® 2210-based roof coatings can be formulated to exceed ASTM D6083 Type II specifications.

Proprietary DPUR technology in EPS® 2210 enables cool roofs to stay cool.

EPS Roof Coatings Portfolio

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Product	Chemistry	Solids (%)	pH	MFFT (˚C)	Description
EPS® 2210	**All-Acrylic**	**55.0**	**7.5-8.5**	**-12 (Tg)**	• **ASTM D6083 Type II roof coatings** • **Basecoat, topcoat**
EPS® 2224	All-Acrylic	58.0	3.5-5.5	-11 (Tg)	• Adhesion, flexibility • Sloped roof, topcoats
EPS® 2252	All-Acrylic	60.0	8.0-9.0	-32 (Tg)	• Adhesion to TPO and EPDM • Primers, basecoats
EPS® 2719	All-Acrylic	55.0	8.0-8.5	+4 (Tg)	• Asphalt bleed-through resistance, adhesion • Primer, basecoat, topcoat
RayFlex® 765	Styrenated Acrylic	50.0	7.2-7.7	-26 (Tg)	• Elongation and tensile strength • Topcoat

QUESTIONS

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EPS® 2210 samples available at epscca.com

https://www.linkedin.com/company/eps-materials

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