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BASF Waterborne Direct-to-metal Technology: Optimizing the Balance between Sustainability, Cost and Performance

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Tony Neely, Ph.D., Technical Specialist – Waterborne Coating Technologies

Phil Robinson – Market Segment Manager
General Industrial Resins and Additives

- 8 years with BASF
  - Customer Care – Plastics
  - Supply Chain – Polyurethanes
  - Operations – Precious Metal Services
  - Marketing – Resins and Additives
- Bachelor's degree: 2007 Eastern Michigan University
  - Supply Chain Management and Manufacturing Engineering
- Master's of Business Administration: 2017 Northeastern University
  - Marketing and International Management

Tony Neely – Technical Specialist, Waterborne Coatings Resins and Additives

- 3 years with BASF
  - Research Scientist – Resins and Additives
  - Technical Specialist – Resins and Additives
- Previous Experience
  - 2 years industrial experience in organic/polymer synthesis and composites
- Bachelor's degree: 2006 Furman University
  - Chemistry: Research in Organic Chemistry and Polymer Films
- Ph.D.: 2015 University of South Carolina
  - Chemistry: Research in Surface Modification, Nanocomposites, and Controlled Radical Polymerization

Agenda

- Introduction to Industrial Market and Waterborne Coatings
- Developing Waterborne Resins for DTM Applications
- Formulating Corrosion-resistant Coatings
- 1K and 2K Waterborne Resins from BASF for DTM
- Conclusions

What are Focus Applications for Waterborne DTM Technologies?

C1-C2:
2-5 yrs. service in internal spaces w/ natural atmospheres & possible condensation or external spaces w/ limited environmental factors

C2-C3:
5-15 yrs. service in areas including external urban and industrial atmospheres w/ moderate SO2 pollution

****ISO 12944-2**

Gas cylinders

Tanks

Refineries, plants

Offshore

Radiator coatings

Container coatings

Infrastructure

- Air conditioned/ heated rooms with low humidity
- Very dry or very cold climate

- Non heated rooms, e.g. gymnasiums, storages
- Dry or cold climate with low pollution

- Rooms with occasional condensation, e.g. food production
- Moderate climate & moderate pollution

- Cities with high level of air pollution
- Frequent condensation, e.g. production facilities, swimming pools

- Coastal areas, cities with very high level of air pollution, marine areas
- Very frequent condensation, and high pollution, e.g. mines

Corrosiveness of atmosphere, increasing anticorrosion requirements

Source: DIN EN ISO 9223

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General Industrial Subsegment Details

Metal Packaging

- End uses – Beverage/food, general line, drum/pail and closures
- Drivers – Largely consumer driven: demographics, product safety, sustainability & branding/design
- **$558M total market size that is 12% WB technology @ 1% growth**
- Valspar (47%), PPG (25%) and Akzo Nobel (15%) are the major formulators

Coil

- End uses – Building products, transportation and business/home
- Drivers – Economic activity / GDP growth and commercial and retail property construction
- Legacy solventborne technology has a very strong foothold (polyester is the dominant technology)
- **$732M total market size that is 3% WB technology @ 0% growth**

General Metal

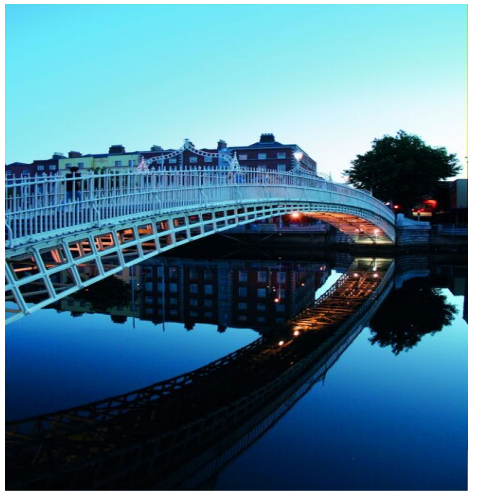
- OEM – Extremely fragmented market in technologies, applications and formulators
- Consumer drivers – Employment rate, disposable incomes and credit availability
- Commercial drivers – GDP growth & construction, business confidence and government funding
- **$1,082M total market size that is 9.2% WB technology @ 2% growth**

Industrial Maintenance

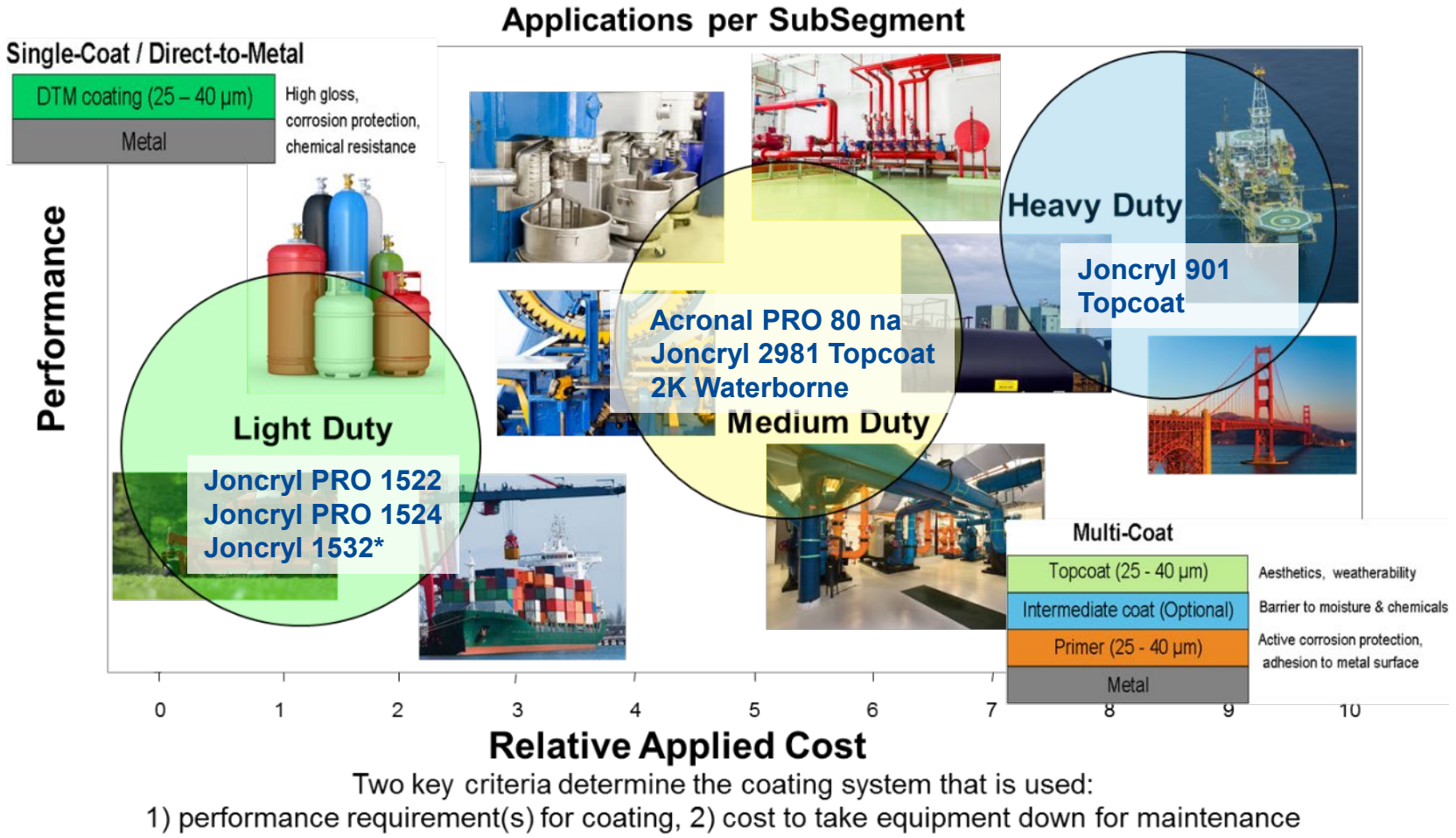
- Non-OEM – Extremely fragmented market in technologies, applications and formulators
- End uses – plant maintenance, airport terminals, schools and hospitals
- Drivers – Same as General Metal with less volatility
- **$1,619M total market size that is 30% WB technology @ 4% growth**

Trends Impacting Waterborne DTM Innovation

- Improved performance through corrosion resistance and UV degradation
- Thinner film builds or reduction of the number of coats
- Increased durability of coatings through improved gloss, chemical and UV/weather resistance
- Low / Zero VOC coatings
- Ease of maintenance (faster repair and return to service)
- Reduced cost, increased throughput and ease of application through better coverage with reduced paint usage, and elimination of coating layers
- Movement away from conventional crosslinking technology



Protective Coatings for Metal



Two key criteria determine the coating system that is used:
1) performance requirement(s) for coating, 2) cost to take equipment down for maintenance

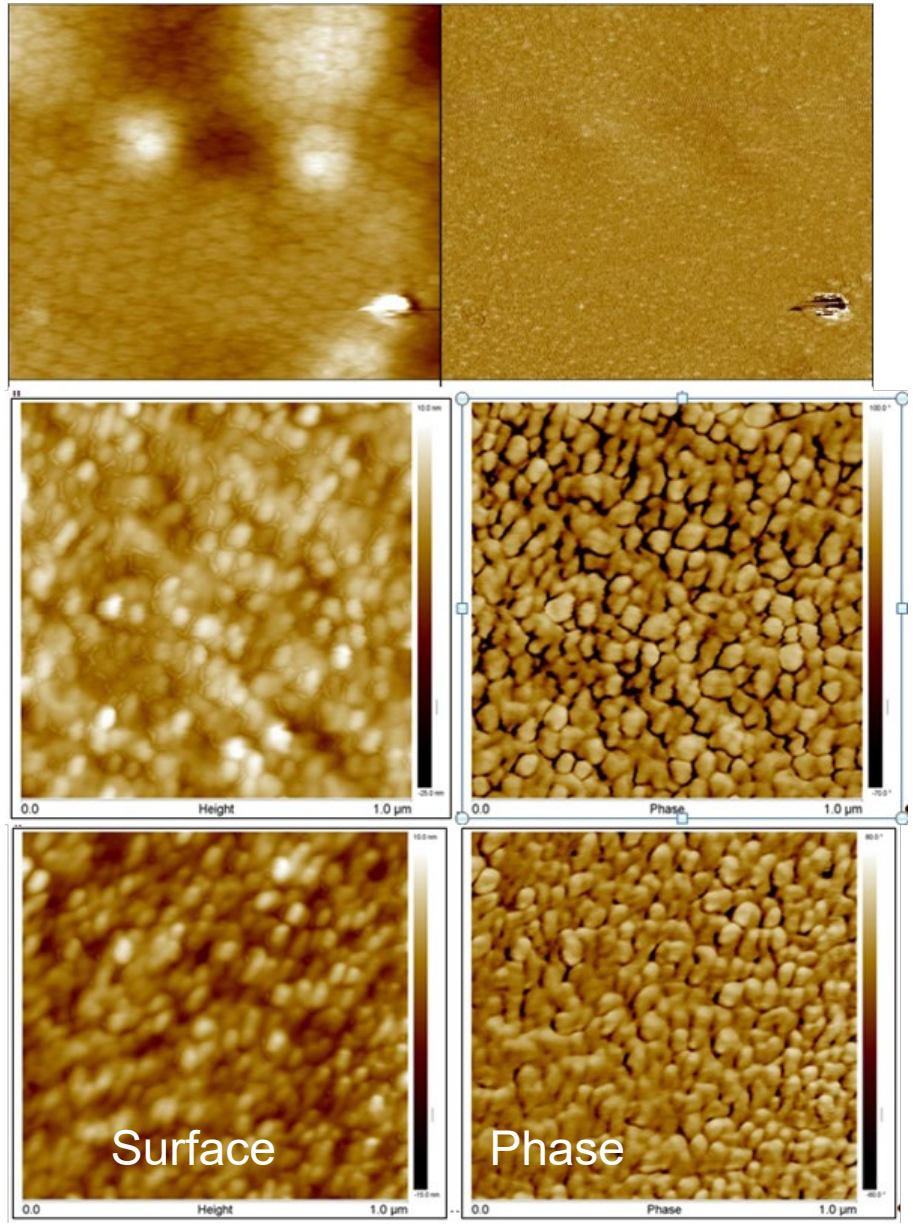
*Joncryl 1532 is not recommended for unprimed steel. Suitable for plastic, aluminum, galvanized steel and previously painted substrates.

Formulating Corrosion-resistant Waterborne Coatings

Developing Waterborne DTM Binders

- New developments for waterborne DTM binders continue to improve resin performance at reduced VOC

- A DTM binder is expected to provide corrosion protection without the aid of anti-corrosive pigments
  - Waterborne acrylic binders provide corrosion resistance by forming a barrier
  - Good continuous film formation is critical



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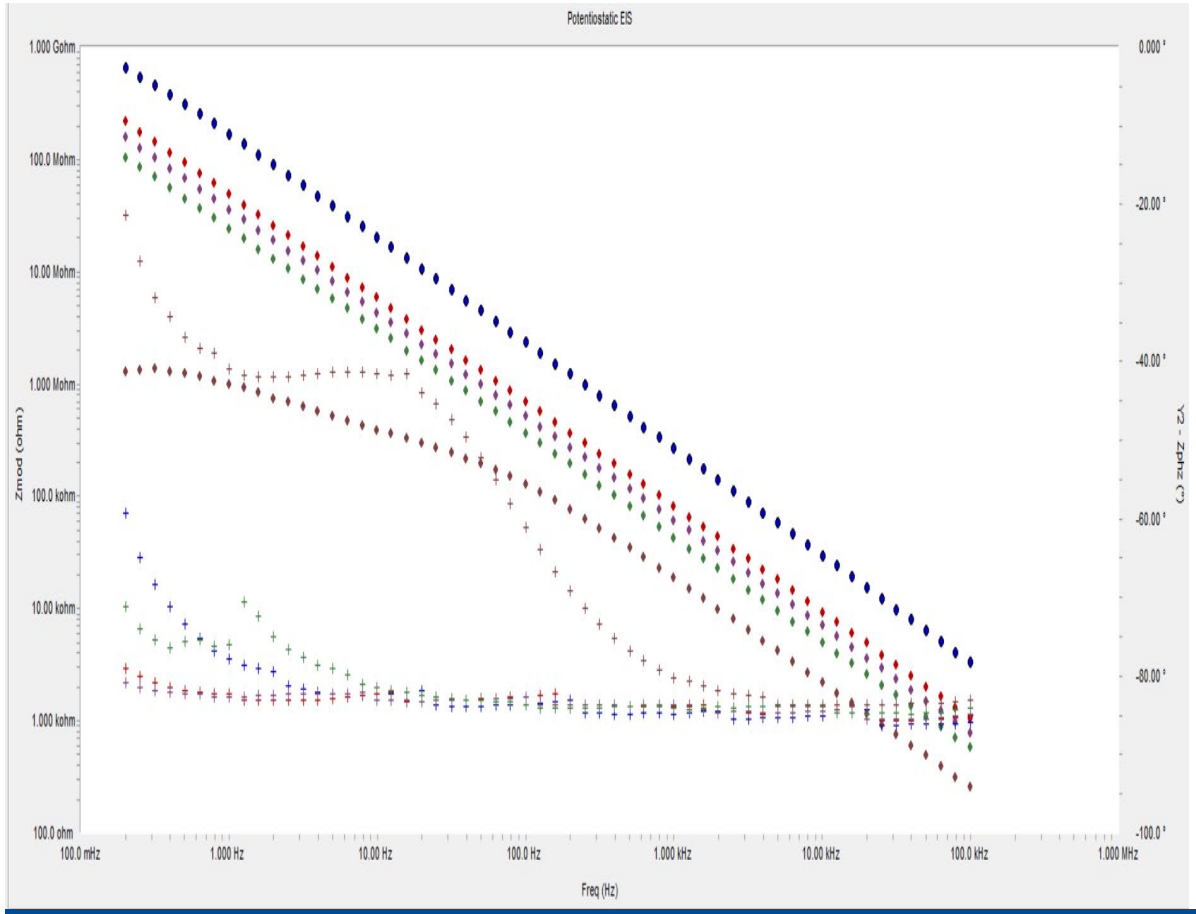
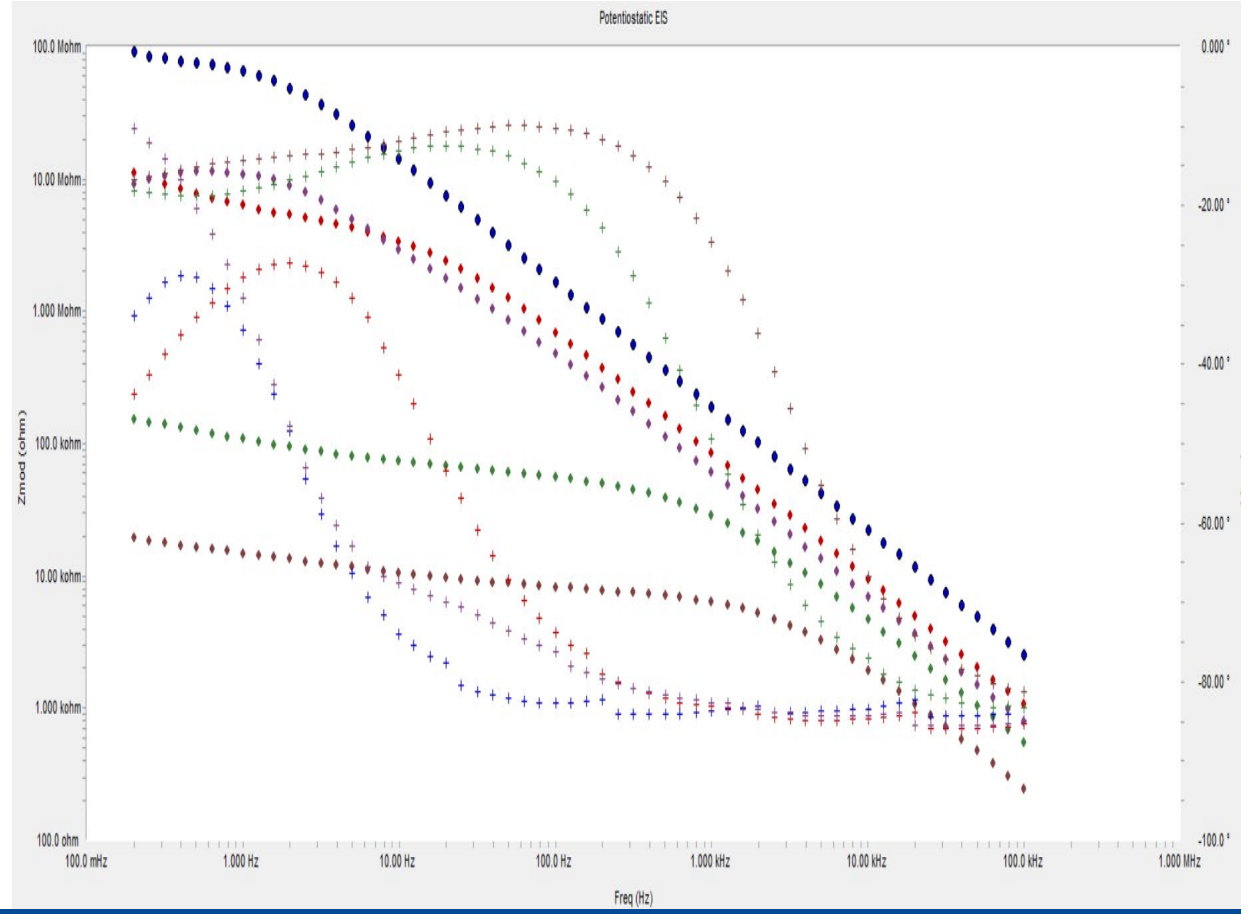
Developing Waterborne DTM Binders





0 hr **24 hrs**

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Developing Waterborne DTM Binders

- A proper choice of binder composition and chemistry is needed to improve barrier properties toward ingression of water and salt
  - The polymer needs to be hydrophobic and minimize the use of ionic compounds to prevent water from entering the film

- A proper design of particle morphology helps with tuning the film formation properties while minimizing the use of solvents and plasticizers

Formulating Corrosion-resistant Coatings

- The corrosion protection provided by waterborne acrylic coatings is highly dependent on both the resin and the formulation of the coating
- Often, attempting to drop in or directly replace resins in waterborne formulations does not result in optimum performance
- Choosing the appropriate cosolvents, additives, and pigments is necessary to optimize the performance of the coating

Formulating Corrosion-resistant Coatings: Additives

- Dispersants:
  - A very good dispersion of pigments is necessary to avoid agglomeration and resulting film defects that allow penetration of the film
  - Dispersant choice is critical to corrosion resistance (the more hydrophobic the better)
  - Compatibility of the dispersant with the binder is also a factor

Dispersant A
44 hours Salt Spray Exposure

Dispersant B
44 hours Salt Spray Exposure

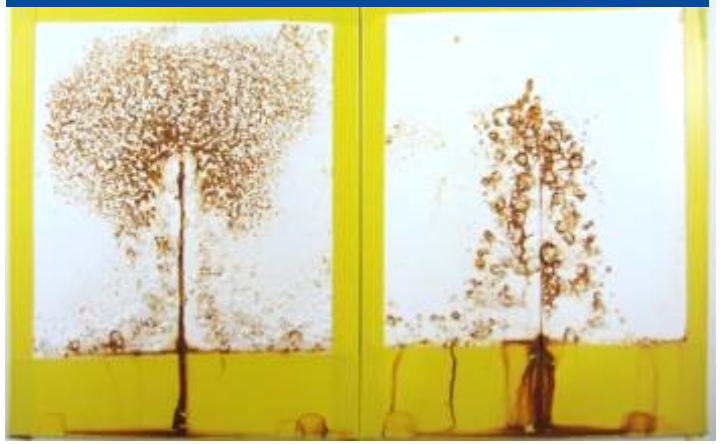
Formulating Corrosion-resistant Coatings: Pigments

- Titanium Dioxide
  - The grade of TiO_2 or TiO_2 treatment can have a significant effect on the corrosion resistance

- Colorant
  - Dispersed pigments contain surfactants that can also adversely affect the corrosion resistance
  - Choose colorants recommended for industrial coatings

TiO_2 Grade A
276 hours Salt Spray Exposure

TiO_2 Grade B
276 hours Salt Spray Exposure



Waterborne Protective Resins

Waterborne Protective Resins

DTM

- **Joncryl® PRO 1522**
  - Excellent corrosion resistance
  - Flexibility
  - Compatible with anti-corrosive pigments
- **Joncryl PRO 1524**
  - Wet and dry adhesion to multiple metal substrates
  - Chemical resistance
  - Low VOC capable

For plastic, aluminum, galvanized

- **Joncryl 1532**
  - Wet and dry adhesion to difficult substrates
  - Low VOC capable

Waterborne 2K

- **Joncryl OH 8313 / Luhydran® S938T**
  - 2K PU waterborne
  - Hydroxyl number 100
  - Good scratch resistance
- **Joncryl OH 8314**
  - 2K PU waterborne
  - Pot-life indication
  - Low VOC capable

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Joncryl PRO 1522

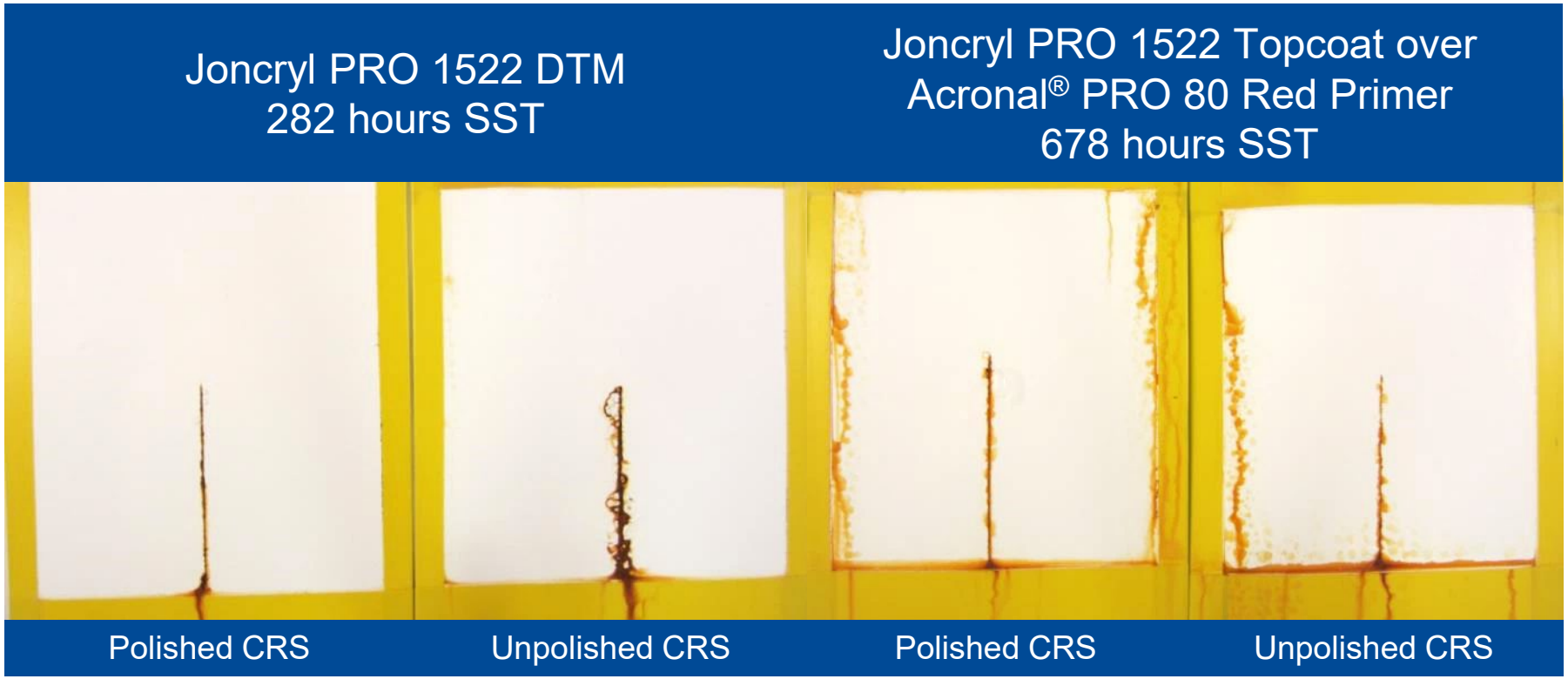
Acrylic emulsion

- Joncryl PRO 1522 has excellent corrosion resistance without the use of anti-corrosive pigments. This emulsion offers exterior durability, is compatible with anti-corrosive pigments, and can be formulated between 100 – 250 g/L VOC
- Target market: light-duty industrial metal coatings (DTMs and topcoats)
- Joncryl PRO 1522 has a hydroxyl number of ~11 and can be crosslinked with melamine in a baking system

Joncryl PRO 1522

Salt-spray testing (B-117)

- Joncryl PRO 1522 performs well in salt spray as a DTM and as a topcoat (240 g/L, 2.0 DFT)

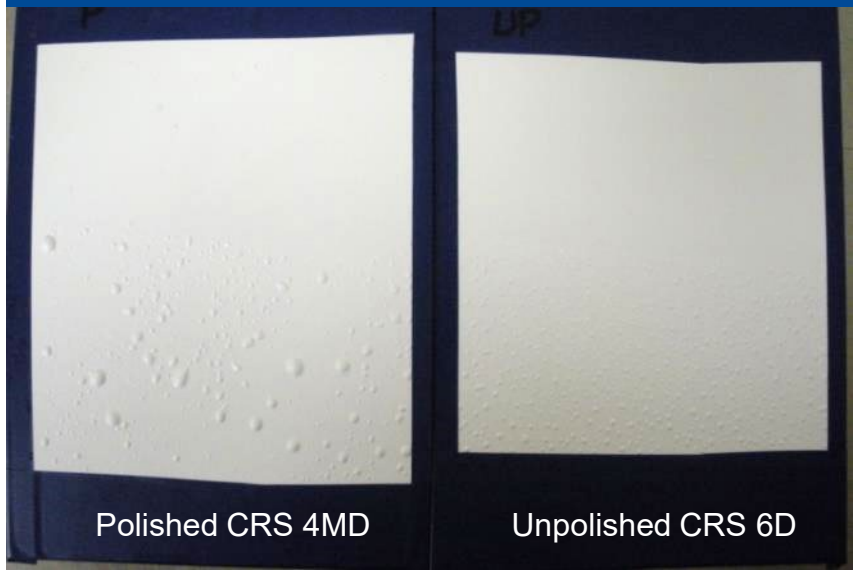


Joncryl PRO 1522

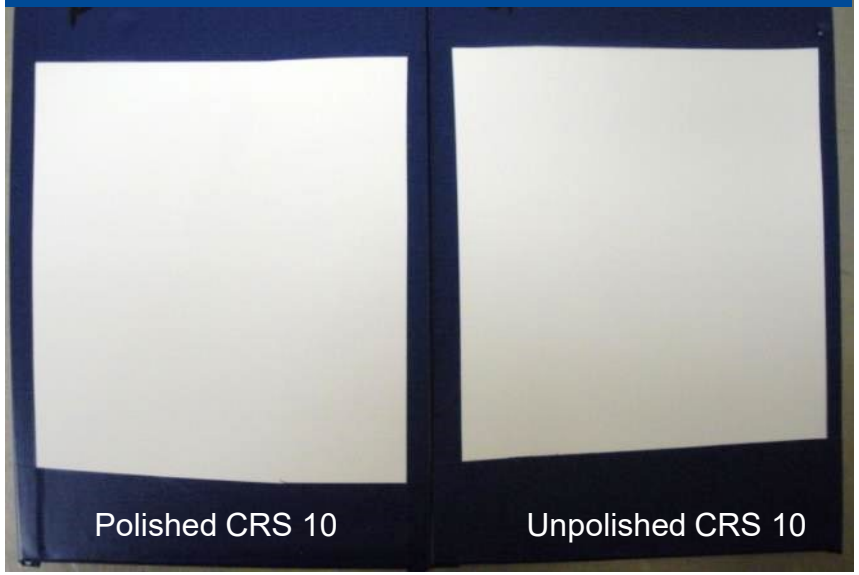
Early water soak formulation

- A formulation has been developed for better early water resistance, completing overnight immersion testing after 4-hours dry time with no rust, no blistering and ~ 80% gloss retention after recovery

Formulation A
4-hr dry, overnight immersion



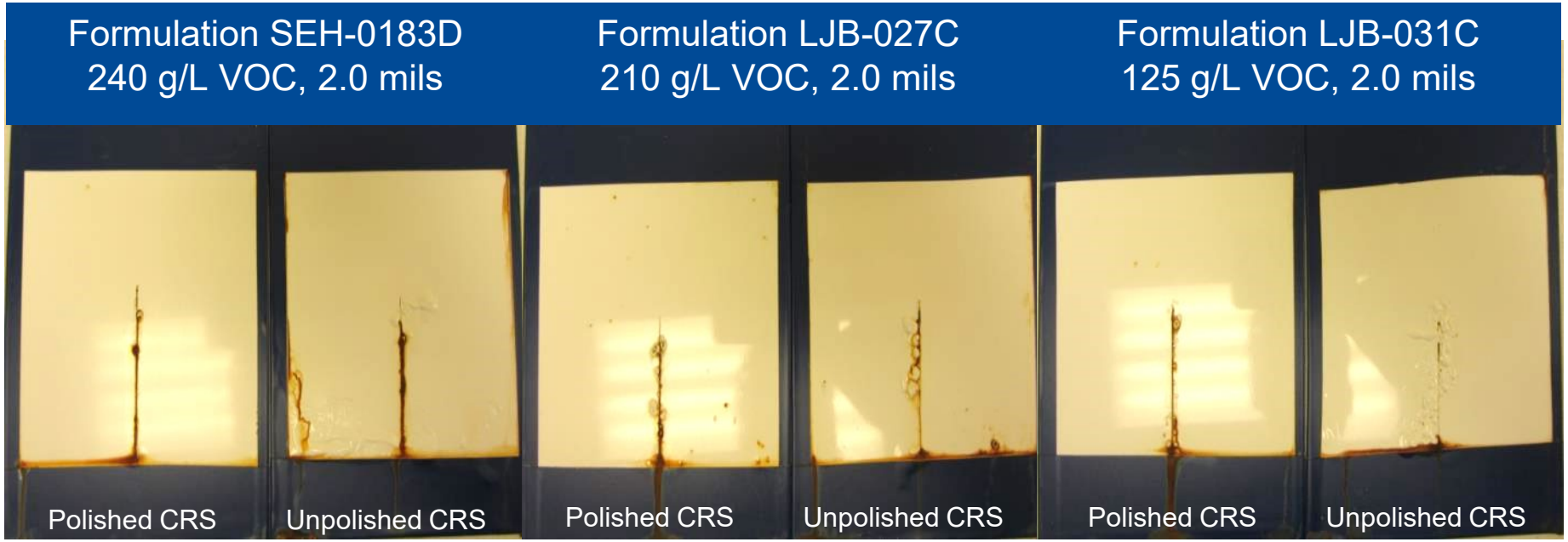
Formulation B
4-hr dry, overnight immersion



Joncryl PRO 1522

Salt spray @ 336 hours

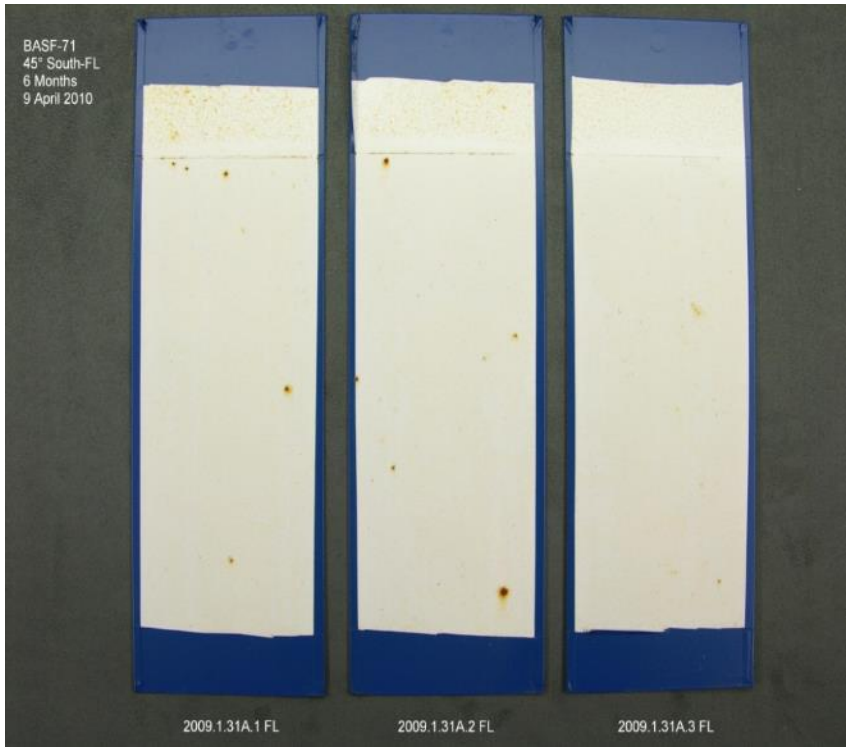
- The early water soak formula was also tested in salt spray and performed equal to the standard Joncryl PRO 1522 starting point formulation, even at lower VOC



Joncryl PRO 1522: 100 g/L

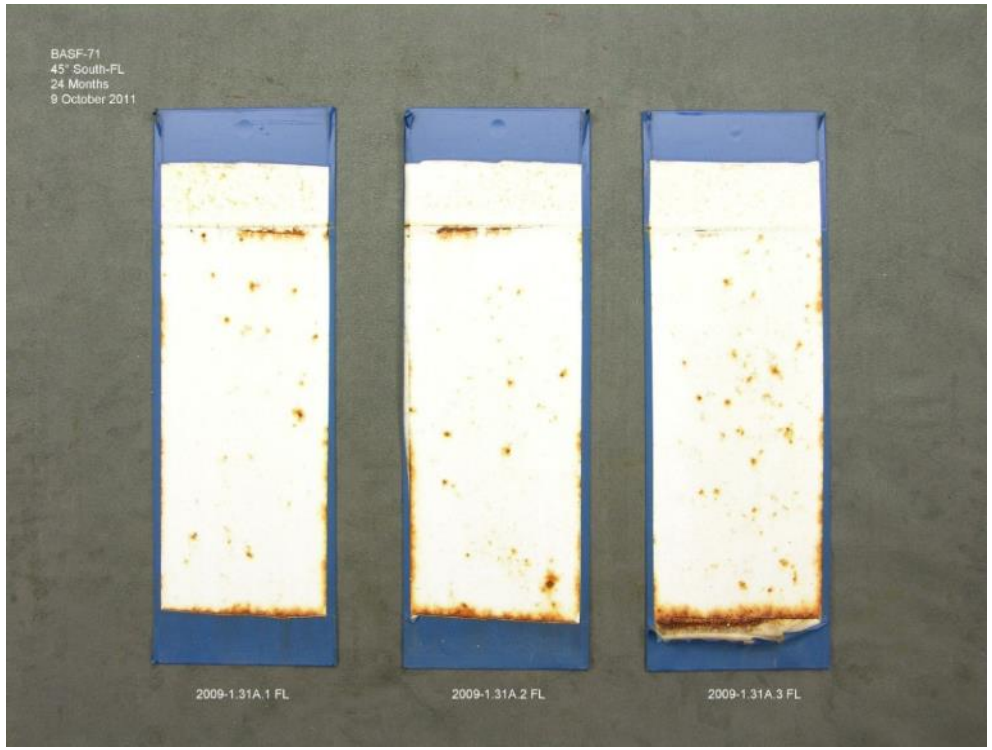
Florida weathering exposure (6 and 24 months)

CRS, clean-polish (6 months)



VOC (g/L): 100

CRS, clean-polish (24 months)



VOC (g/L): 100

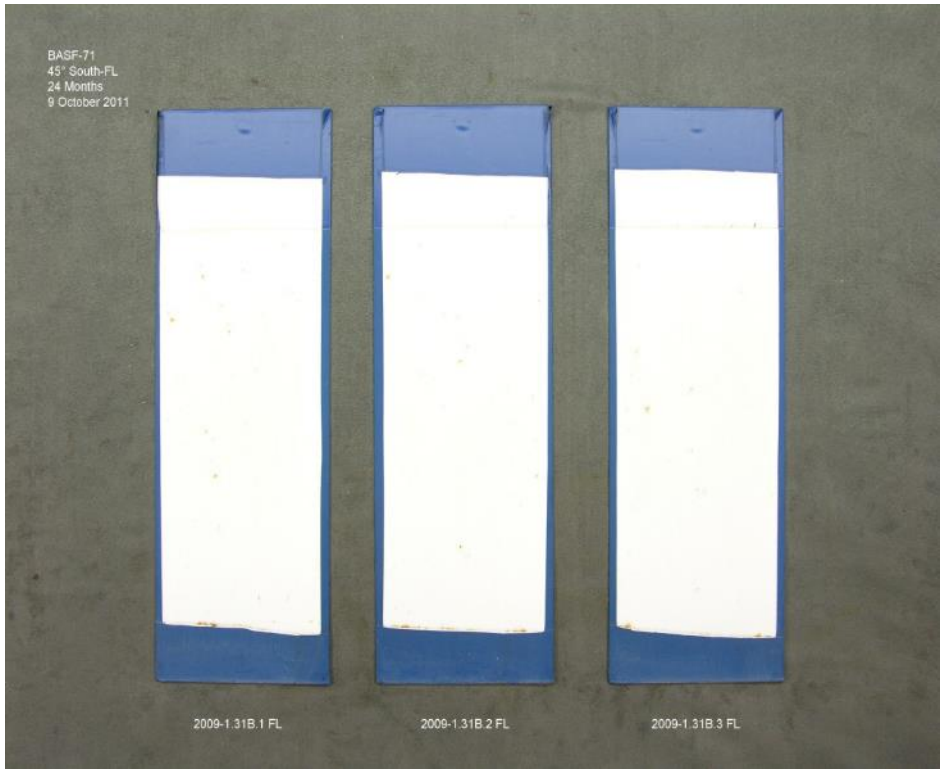
Joncryl PRO 1522: 150 g/L

Florida weathering exposure (6 and 24 months)

CRS, clean-polish (6 months)

VOC (g/L): 150

CRS, clean-polish (24 months)



VOC (g/L): 150

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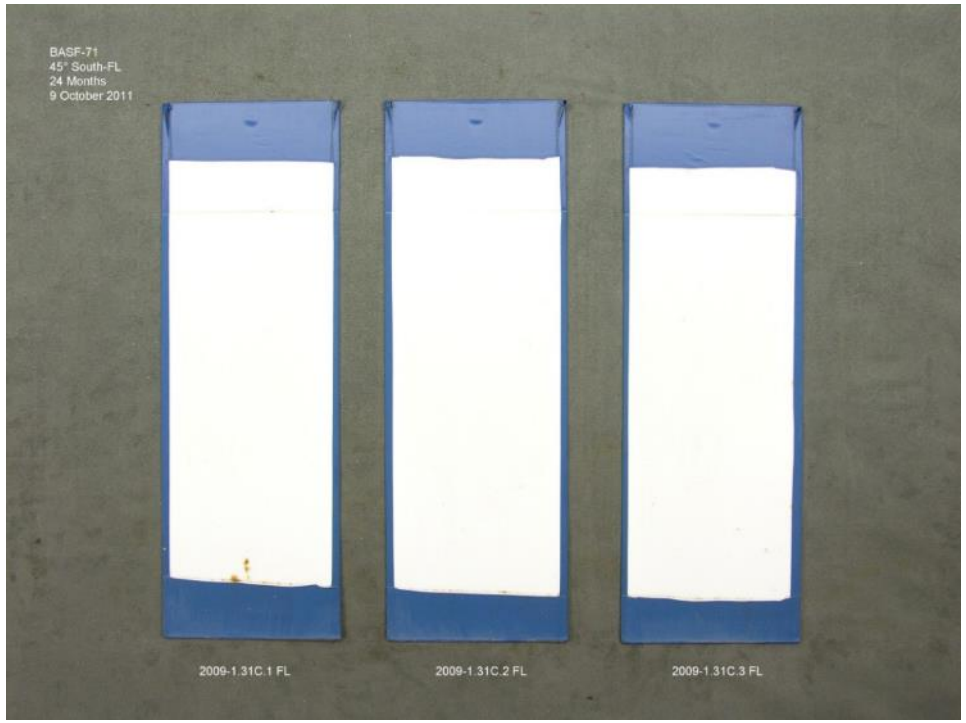
Joncryl PRO 1522: 240 g/L

Florida weathering exposure (6 and 24 months)

CRS, clean-polish (6 months)

VOC (g/L): 240

CRS, clean-polish (24 months)



VOC (g/L): 240

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Waterborne Protective Resins

DTM

- **Joncryl PRO 1522**
  - Excellent corrosion resistance
  - Flexibility
  - Compatible with anti-corrosive pigments
- **Joncryl PRO 1524**
  - Wet and dry adhesion to multiple metal substrates
  - Chemical resistance
  - Low VOC capable

For plastic, aluminum, galvanized

- **Joncryl 1532**
  - Wet and dry adhesion to difficult substrates
  - Low VOC capable

Waterborne 2K

- **Joncryl OH 8313 / Luhydran S938T**
  - 2K PU waterborne
  - Hydroxyl number 100
  - Good scratch resistance
- **Joncryl OH 8314**
  - 2K PU waterborne
  - Pot-life indication
  - Low VOC capable

Joncryl PRO 1524

Acrylic dispersion

- Joncryl PRO 1524 is a DTM resin that has good chemical resistance, hardness and UV durability in addition to excellent adhesion and corrosion resistance
- Target market: interior/exterior general metal industrial coating applications (DTMs and topcoats)
- Consider Joncryl PRO 1524 for coatings for aluminum, concrete, high temperature and aerosol applications

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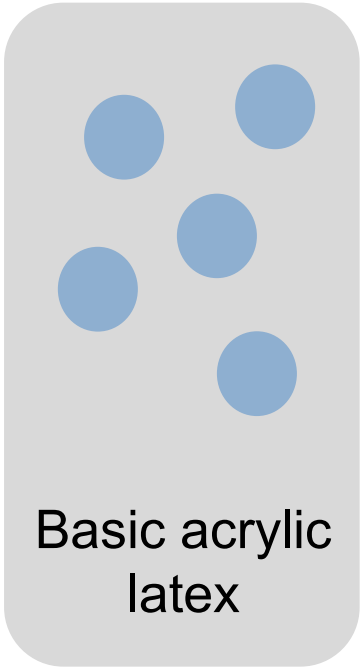
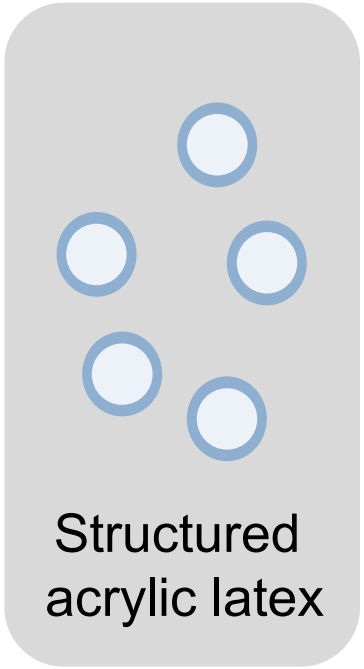
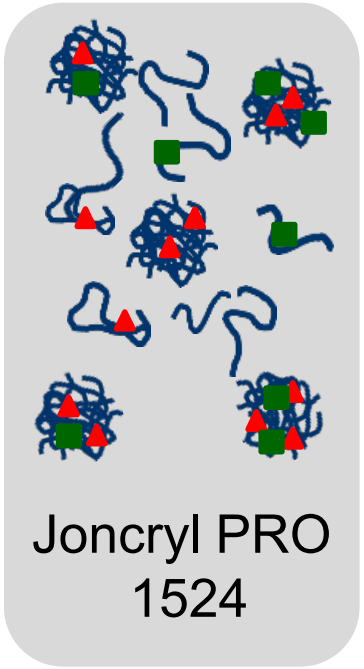
Joncryl PRO 1524

Acrylic dispersion technology





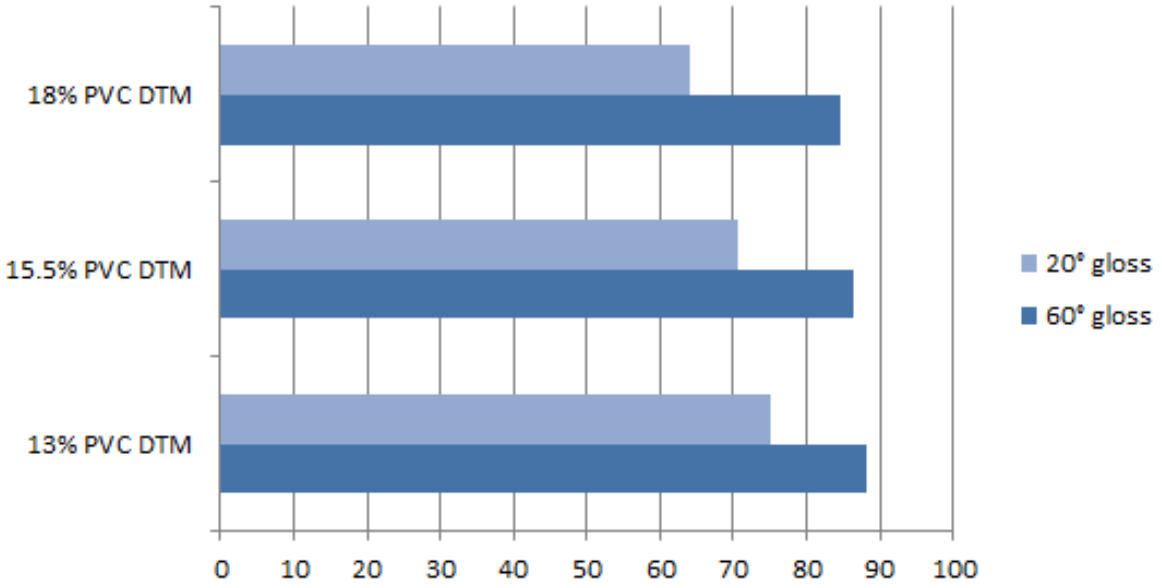


- Joncryl PRO 1524 is a unique product that represents the next generation in latex technology

Joncryl PRO 1524

Test results

- Joncryl PRO 1524 was tested in a 100 g/L white DTM formulation with no anti-corrosive pigments added
  - Films were applied using conventional air atomized spray
    - 7-day air dry
    - Dry film thickness ~ 2 mils



Gloss at 60° is >80

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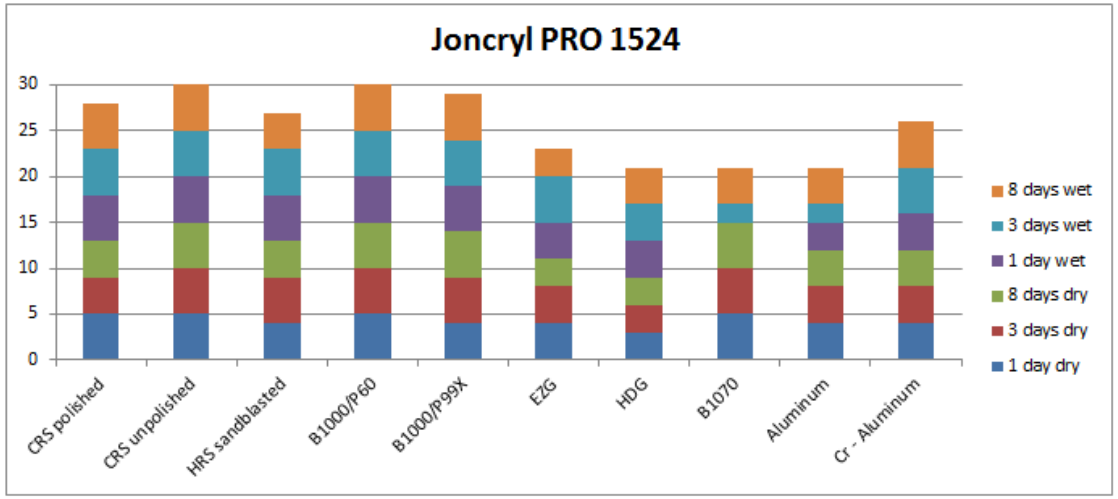
Joncryl PRO 1524

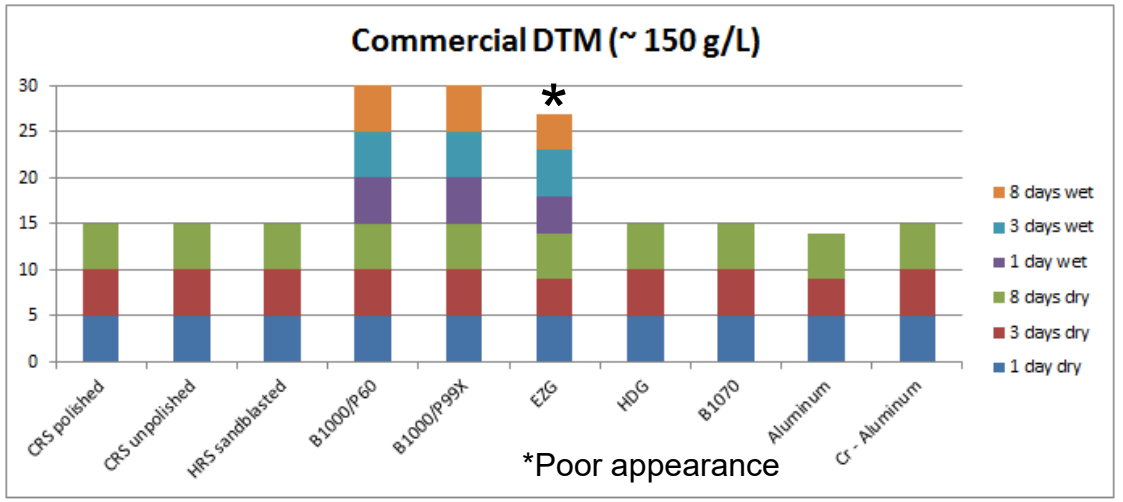
Water resistance

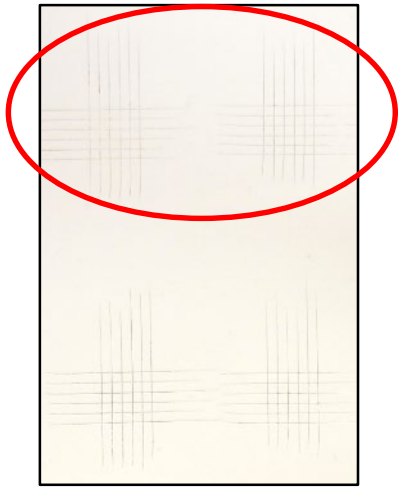
- No blistering was observed in >500 hours of standard humidity testing (ASTM D2247):
  - 100 °F (35 °C), 100% relative humidity
- No blistering was observed in early water soak testing:
  - White DTM was spray applied and allowed to cure at room temperature for four hours
  - Panels were taped and immersed in DI water overnight
- Joncryl PRO 1524 has good dry adhesion and superior wet adhesion to a variety of metal substrates compared to a commercial DTM (~150 g/L)

Joncryl PRO 1524

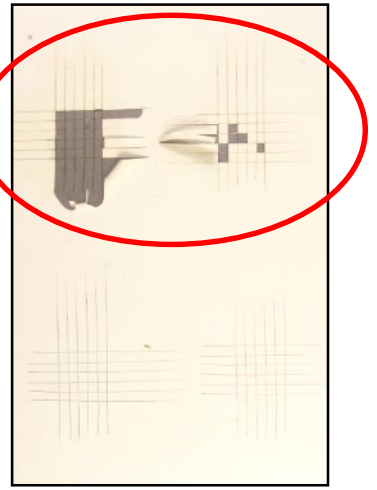
Dry and wet adhesion (ASTM D3359 Method B)







Wet Adhesion



Wet Adhesion

B, P = Bonderite® and Parcolene® are registered trademarks of Henkel Corporation.

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Salt-spray testing (ASTM B117), 322 hours

- Salt-spray testing was completed on the white DTM formula with no anti-corrosive pigments
- Salt-spray performance is much improved over the commercial DTM
- Better performance can be achieved with higher film builds

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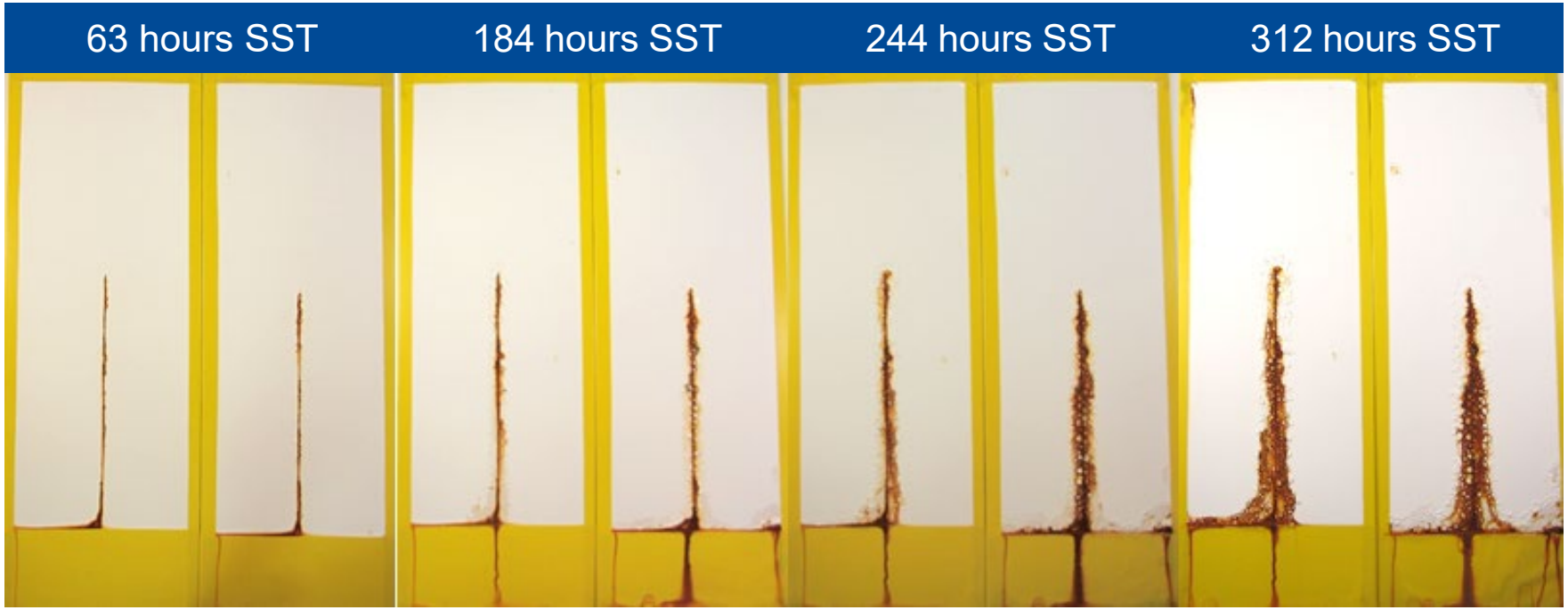
Salt-spray testing

- Salt-spray testing (ASTM B117) on the white DTM formula with no anti-corrosive pigments: DFT 1.5-2.0 mils



Polished CRS Unpolished CRS

Joncryl PRO 1524

Salt-spray testing

- Salt-spray testing (ASTM B117) on the white DTM formula with no anti-corrosive pigments: DFT 2.5-3.0 mils

Polished CRS Unpolished CRS

34

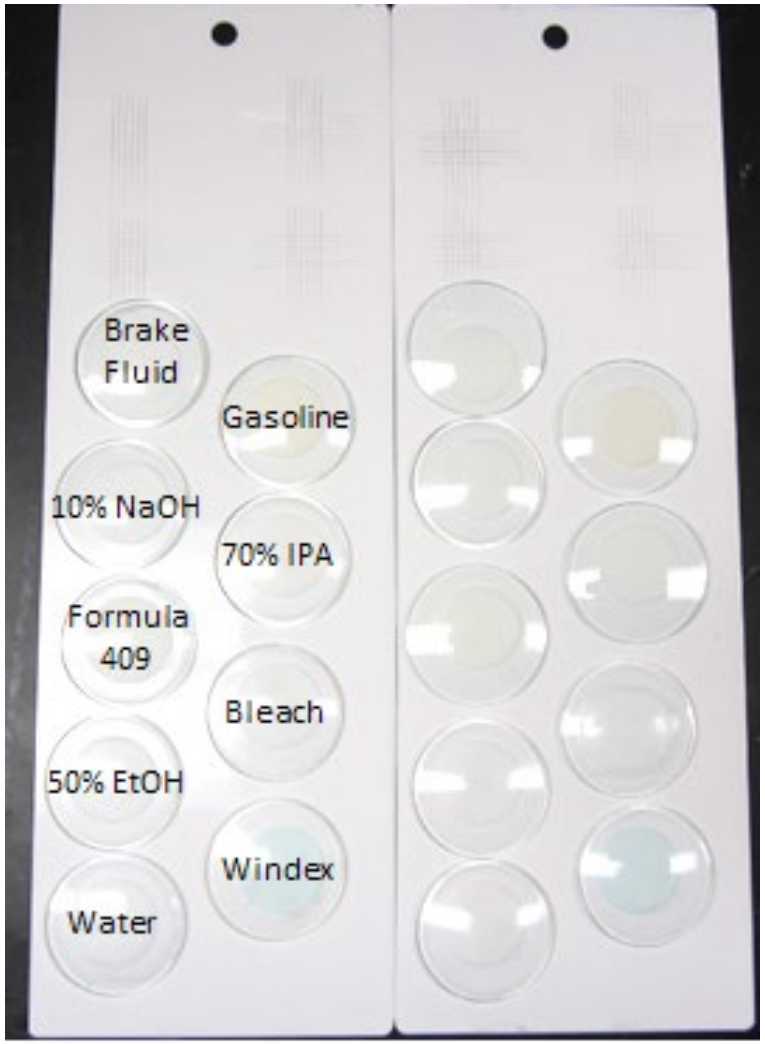
Joncryl PRO 1524 103 g/L

Chemical testing

One hour covered spot test rating:

- 4 = complete destruction of coating
- 0 = no effect
- Results comparable to commercial ~150 g/l DTM

	Recovered Ratings (24 hours)	
	Joncryl PRO 1524	Commercial DTM
Brake Fluid	4	3
Gasoline	2	2
10% Sodium Hydroxide	1	0
70% Isopropyl Alcohol	2	2
Formula 409	1	0
Clorox Bleach	0	0
50% Ethanol	1	1
Windex	1	1
Water	0	0

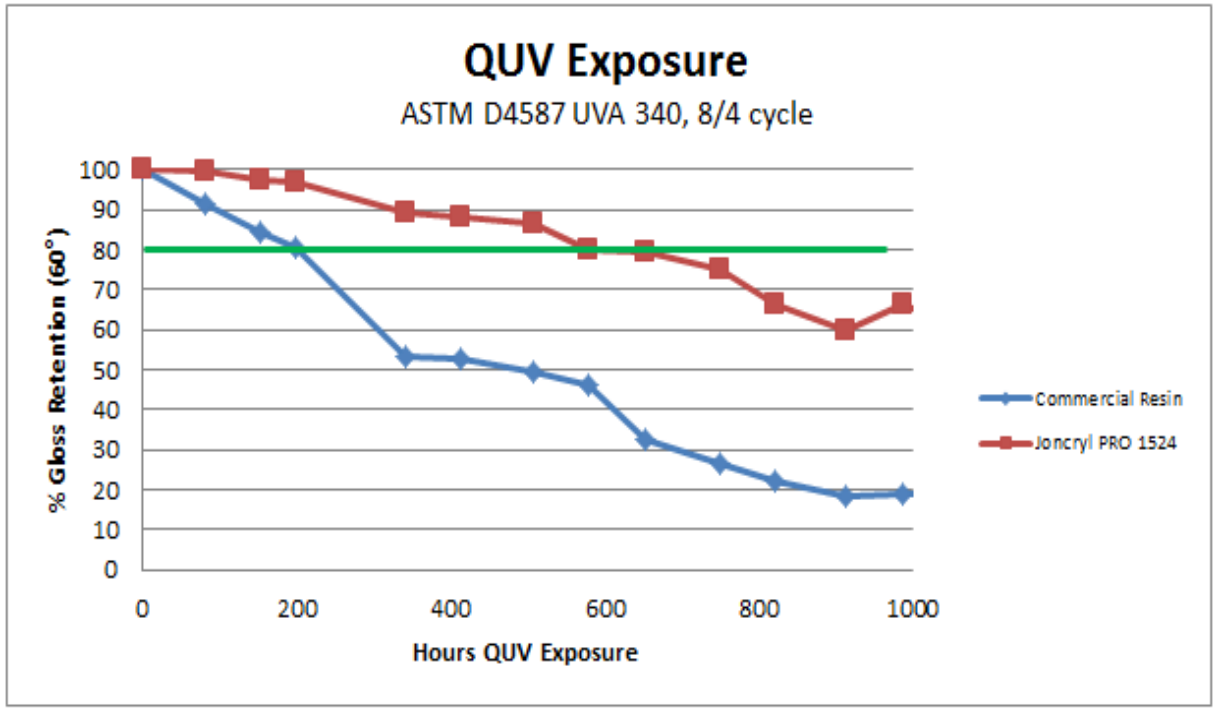


Formula 409 and Clorox Bleach are registered trademarks of The Clorox Company.
Windex is a registered trademark of SC Johnson & Son, Inc.

Joncryl PRO 1524

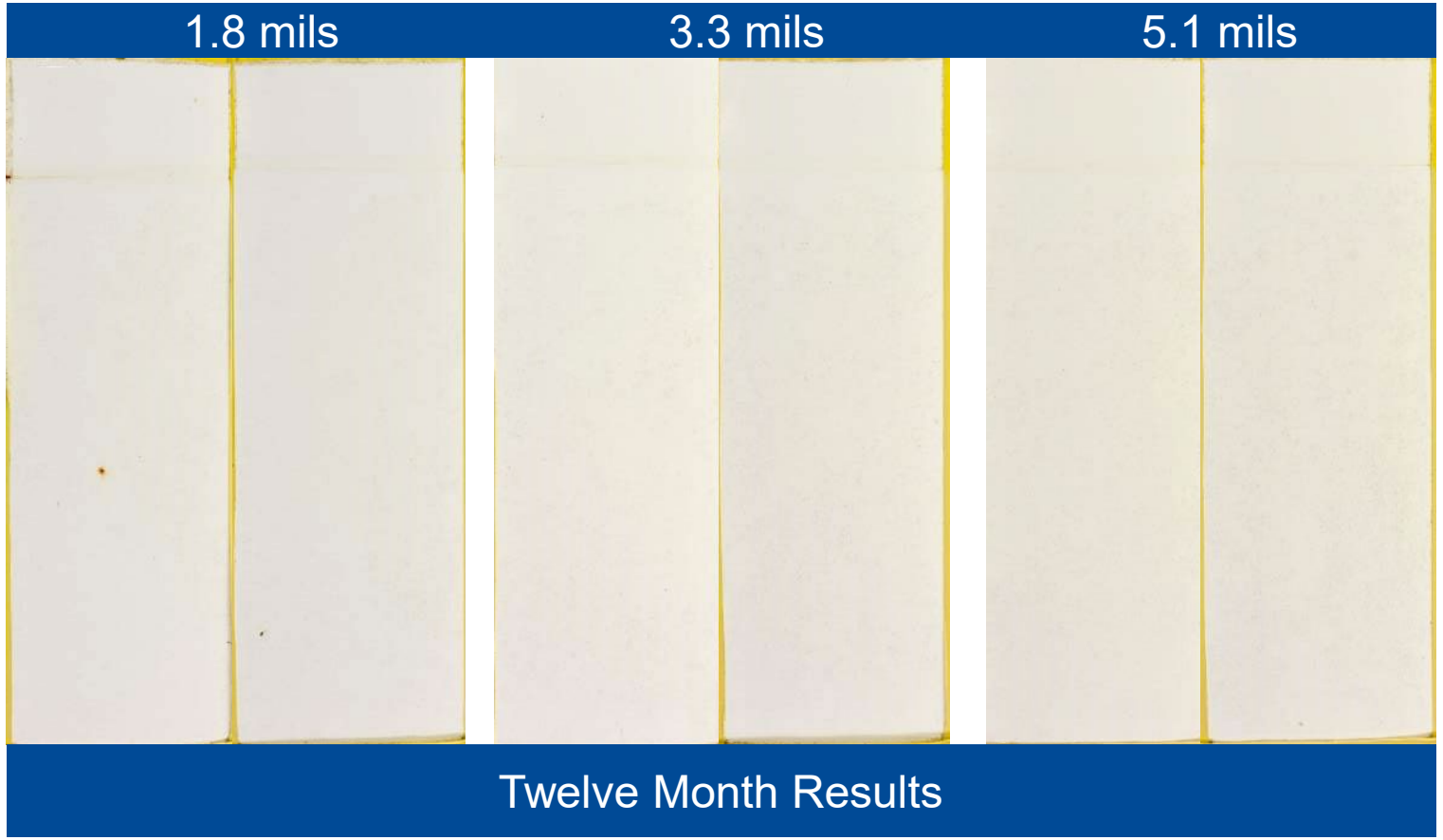
UV durability

- UV durability of Joncryl PRO 1524 (103 g/L VOC) compared with commercial DTM (150 g/L) resin in a white DTM coating
- Gloss retention >80% for more than 500 hours



Joncryl PRO 1524

UV durability testing, direct 45° exposure, south FL



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Joncryl PRO 1524

with plasticizer

- Formulations with plasticizer show advantages
  - 1.5 – 2% plasticizer such as Loxanol® CA 5320* added to 10 – 100 g/L formulation can be used to help with coalescence
    - Loxanol CA 5320 reduces the minimum film-forming temperature (MFFT) at extremely low VOC content
    - No negative effect on water resistance or corrosion resistance because it is hydrophobic
    - Other benefits include improved rheology modifier efficiency and gloss enhancement
    - Loxanol CA 5320 is non-hazardous and based on renewable resources, ecologically friendly

- Other plasticizers tested:
  - Optifilm[1] enhancer 400
  - K-FLEX[2] 500P and K-FLEX 975P

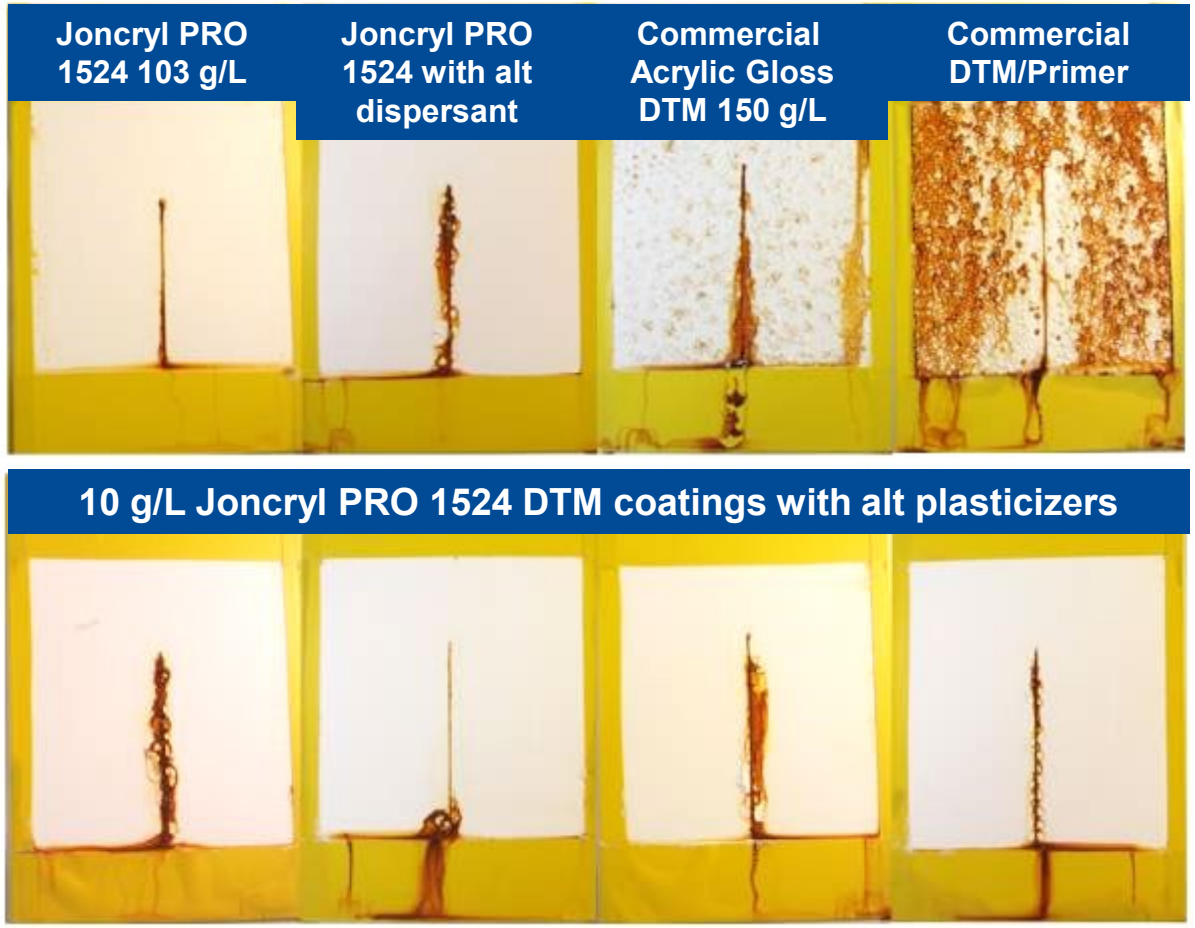
*Loxanol CA 5310 should be considered, Loxanol CA 5320 is no longer available.

[1]*Registered trademark of Eastman Chemical Company.*
[2]*Registered trademark of Emerald Performance Products, LLC.*

Joncryl PRO 1524

with plasticizer

- Salt spray results for 327 hours exposure (ASTM B117)
- Better salt spray resistance than commercially available DTM coatings
- No change in humidity resistance or wet and dry adhesion



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Joncryl PRO 1524 blended with Joncryl PRO 1522

- Joncryl PRO 1522 and Joncryl PRO 1524 are compatible and have excellent corrosion resistance when blended
  - The wet adhesion and water resistance properties of the Joncryl PRO 1522 were improved with the addition of Joncryl PRO 1524 while keeping good direct impact resistance
  - Optimum blend ratio of approximately 50:50

Primer – Topcoat Testing

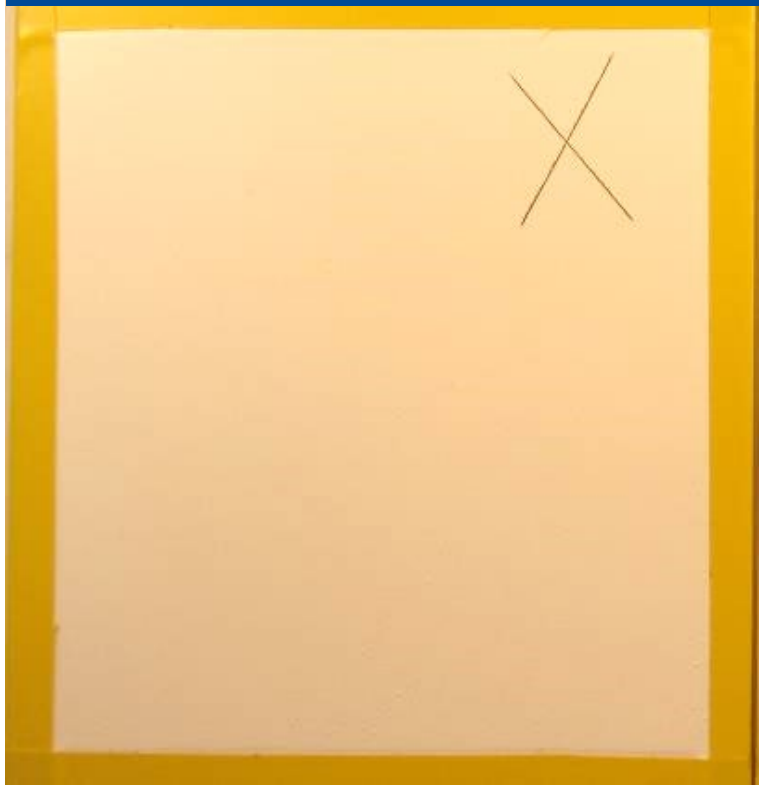
- **TOPCOAT:**
  - Commercial DTM A: White primer/DTM, 77 g/L
  - Commercial DTM B: 100% Acrylic, Low VOC DTM Industrial Enamel, 90 g/L
  - White DTM formulas containing:
    - Joncryl PRO 1522, 198 g/L
    - Joncryl PRO 1524, 103 g/L
    - Joncryl 2981, 198 g/L

- **APPLICATION:**
  - DTM topcoats were sprayed over the primer films after 24 hours (~2-3 mils DFT) and allowed to cure for 7 days ambient prior to testing

Adhesion and Standard Humidity

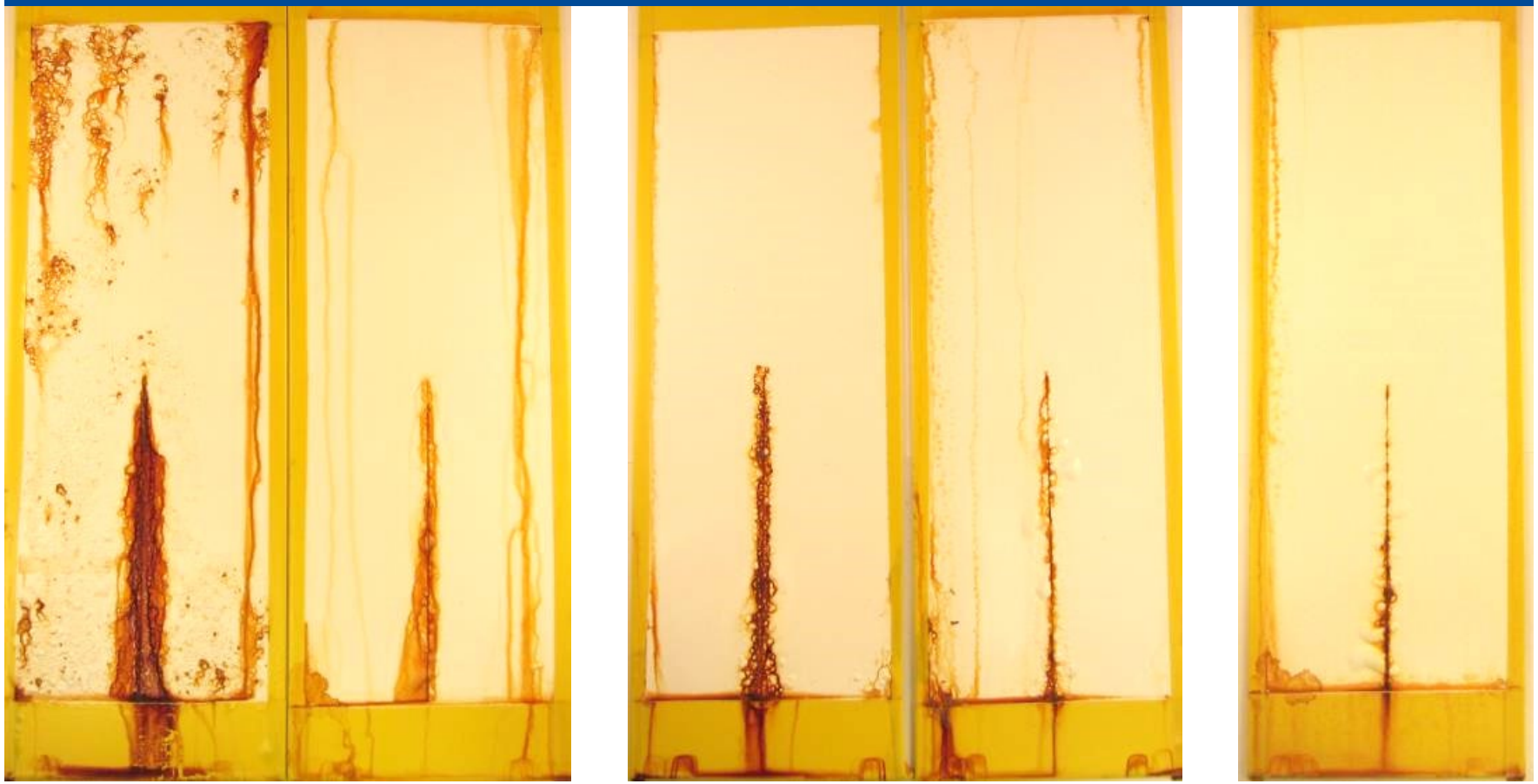
- **RESULTS:**
  - No failure in wet and dry adhesion, initially and at 7 days for primer alone on cold rolled steel and with all topcoats
  - Joncryl PRO 1524 DTM Topcoat had the best performance in standard humidity testing with no blistering after 332 hours

Acronal PRO 80 NA Red Primer with Joncryl PRO 1524 DTM Topcoat



Salt-spray Testing (ASTM B-117)

Topcoated Acronal PRO 80 na Red Primer, 975 hours SST



Waterborne Protective Resins

DTM

- **Joncryl PRO 1522**
  - Excellent corrosion resistance
  - Flexibility
  - Compatible with anti-corrosive pigments
- **Joncryl PRO 1524**
  - Wet and dry adhesion to multiple metal substrates
  - Chemical resistance
  - Low VOC capable

For plastic, aluminum, galvanized

- **Joncryl 1532**
  - Wet and dry adhesion to difficult substrates
  - Low VOC capable

Waterborne 2K

- **Joncryl OH 8313 / Luhydran S938T**
  - 2K PU waterborne
  - Hydroxyl number 100
  - Good scratch resistance
- **Joncryl OH 8314**
  - 2K PU waterborne
  - Pot-life indication
  - Low VOC capable

Joncryl 1532

Acrylic emulsion

- Joncryl 1532 is a versatile emulsion offering excellent adhesion to a wide variety of substrates including plastics, galvanized steel and previously painted or chalked surfaces

- Target markets:
  - interior/exterior general metal industrial coating applications
  - interior/exterior wood coatings for flooring, furniture or millwork applications

Joncryl 1532

Performance highlights

- Adhesion to difficult substrates, both wet and dry
- Room temperature film former, good at low VOC or for difficult cure conditions
  - APEO Free, 14 °C MFFT
  - VOC latitude range: 0 – 200 g/L
- May be used as a pigment grind vehicle
- Joncryl 1532 can be used for metal primer with the use of anti-corrosive pigments to improve corrosion resistance
- A resin solution of Joncryl 1532 can be applied over concrete/ceramic tiles to help improve adhesion of the topcoat to the substrate

Joncryl 1532

Metal adhesion

- In a DTM formulation, Joncryl 1532 had excellent wet and dry adhesion to:
  - Cold Rolled Steel, unpolished and polished
  - Sandblasted Hot Rolled Steel
  - Zinc Phosphated CRS (Bonderite[1] 1000 & 1070)
  - Zinc Electro Galvanized
  - Zinc Hot Dipped Galvanized
  - Aluminum, bare and chromated
- In a 30 PVC, 0 VOC primer (1.0 – 1.5 mils, flash dried ~ 55 seconds in a 300°F oven) Joncryl 1532 had excellent wet and dry adhesion to:
  - Aluminum, bare and chromated
  - Zinc Electro Galvanized
  - Zinc Hot Dipped Galvanized
  - Galvalume[2]

Joncryl 1532 adhesion to Galvalume[2] after 16 hours water immersion

Pre-scribed Post-scribed

[1]Registered trademark of Henkel Corporation.
[2]Registered trademark of BIEC International Inc

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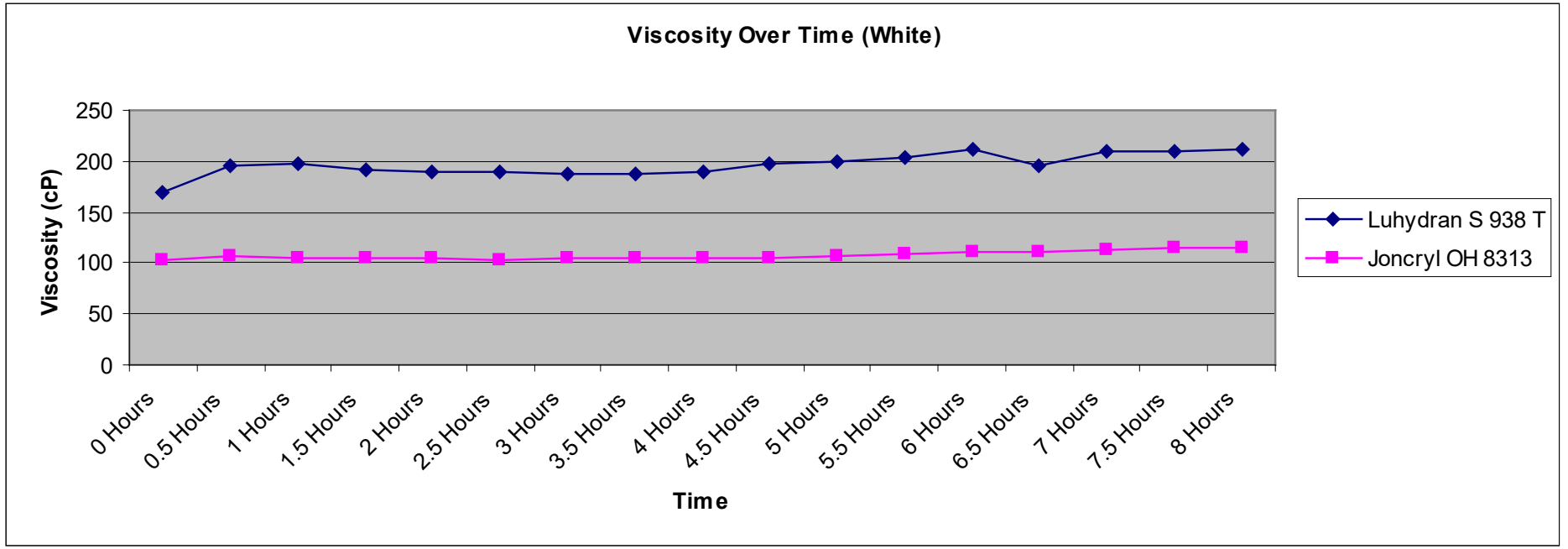
Luhydran S 938 T, Joncryl OH 8313:

Properties at a glance

- Hydroxyl Number: 100
- pH:
  - Joncryl OH 8313: 2.7
  - Luhydran S 938 T: 2.0
- Recommended VOC: > 100 g/L
- Recommended NCO:OH Ratio 1:1
- 60° Gloss:
  - Joncryl OH 8313: 87-90
  - Luhydran S 938 T: 71-75

Viscosity over Time:

Luhydran S 938 T, Joncryl OH 8313 (White with Basonat® HW 1000)



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Chemical Resistance – White with Basonat HW 1000

	Wood		Concrete		Metal		
	Joncryl OH 8313	Luhydran S 938 T	Joncryl OH 8313	Luhydran S 938 T	Joncryl OH 8313	Luhydran S 938 T	Joncryl 500
Water	0	0	0	0	0	0	1
Ethanol 50%	0	0	4	4	0	1	0
Ethanol 100%	1	0					
Isopropanol 70%	1	0	4	4	1	0	1
Formula 409	0	0	0	4	1	0	0
NKCA	0	0					
Mustard	1	1			0	0	0
Brake Fluid			0	0	0	0	1
Gasoline			4	0	0	0	0
Sodium Hydroxide 10%			0	0	0	0	0
Clorox Bleach			0	0	0	0	0
Windex			0	0	0	1	0
MEK					1	1	1
Mineral Spirits					0	0	0
Ammonium Hydroxide 10%					0	0	0
Acetic Acid 5%					1	0	0
Nitric Acid 5%					1	1	0
Skydrol					0	1	1

Formula 409 and Clorox Bleach are registered trademarks of The Clorox Company.
Windex is a registered trademark of SC Johnson Company.
Sydrol is a registered trademark of Solutia, Inc.

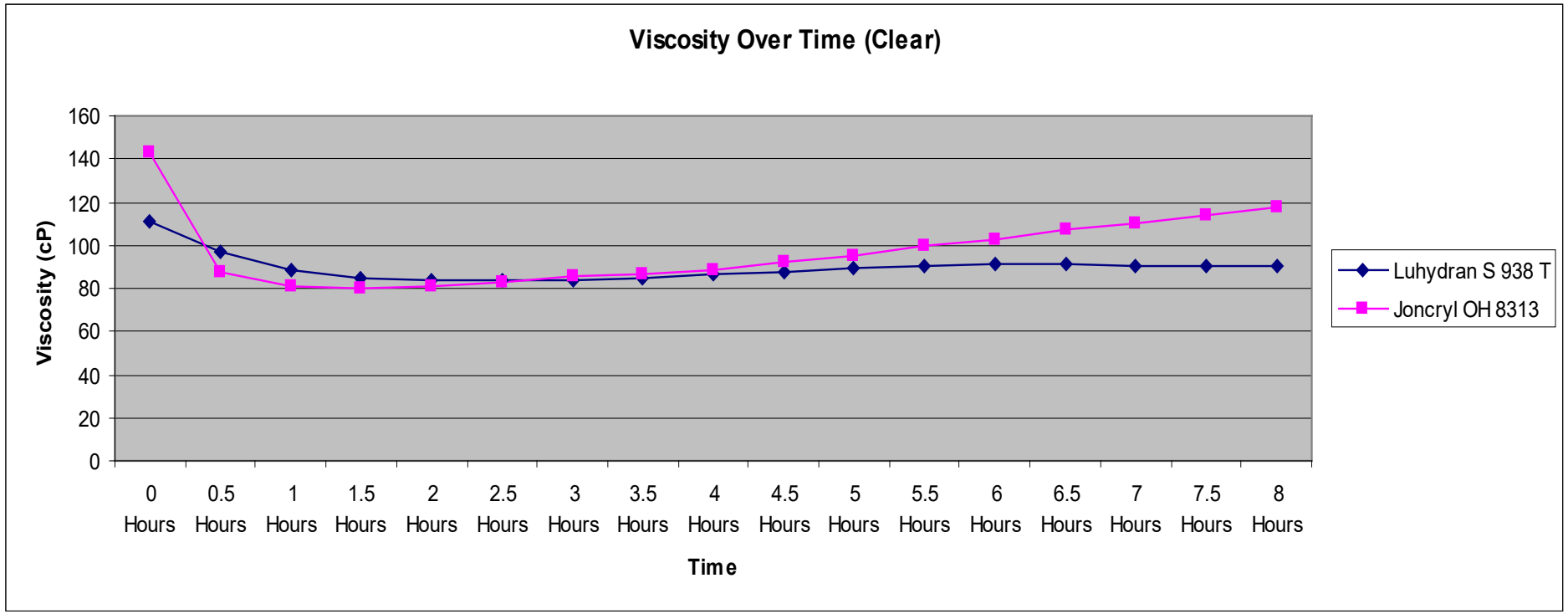
Scale:
0 – No Effect
4 – Complete Destruction of Coating

Taber Abrasion – White with Basonat HW 1000(CS-10 Stone, 1000g)

Product	Elapsed Time after Activation	Average mg lost per 1000 cycles
Luhydran S 938 T	5 minutes	137.8
Luhydran S 938 T	3 hours	148.37
Joncryl OH 8313	5 minutes	55.86
Joncryl OH 8313	3 hours	58.57

Viscosity over Time:

Luhydran S 938 T, Joncryl OH 8313 (Clear with Basonat HW 1000)



Chemical Resistance – Clear with Basonat HW 1000

	Wood		Concrete		Clay Tile	
	Joncryl OH 8313	Luhydran S 938 T	Joncryl OH 8313	Luhydran S 938 T	Joncryl OH 8313	Luhydran S 938 T
Water	0	0	0	0	0	0
Ethanol 50%	0	0	1	0	4	4
Ethanol 100%	1	0				
Isopropanol 70%	1	0	1	1	4	4
Formula 409	0	0	1	1	2	0
NKCA	0	0				
Mustard	1	0				
Brake Fluid			1	1	1	0
Gasoline			1	0	4	0
Sodium Hydroxide 10%			0	0	4	0
Clorox Bleach			0	0	0	0
Windex			0	0	4	1

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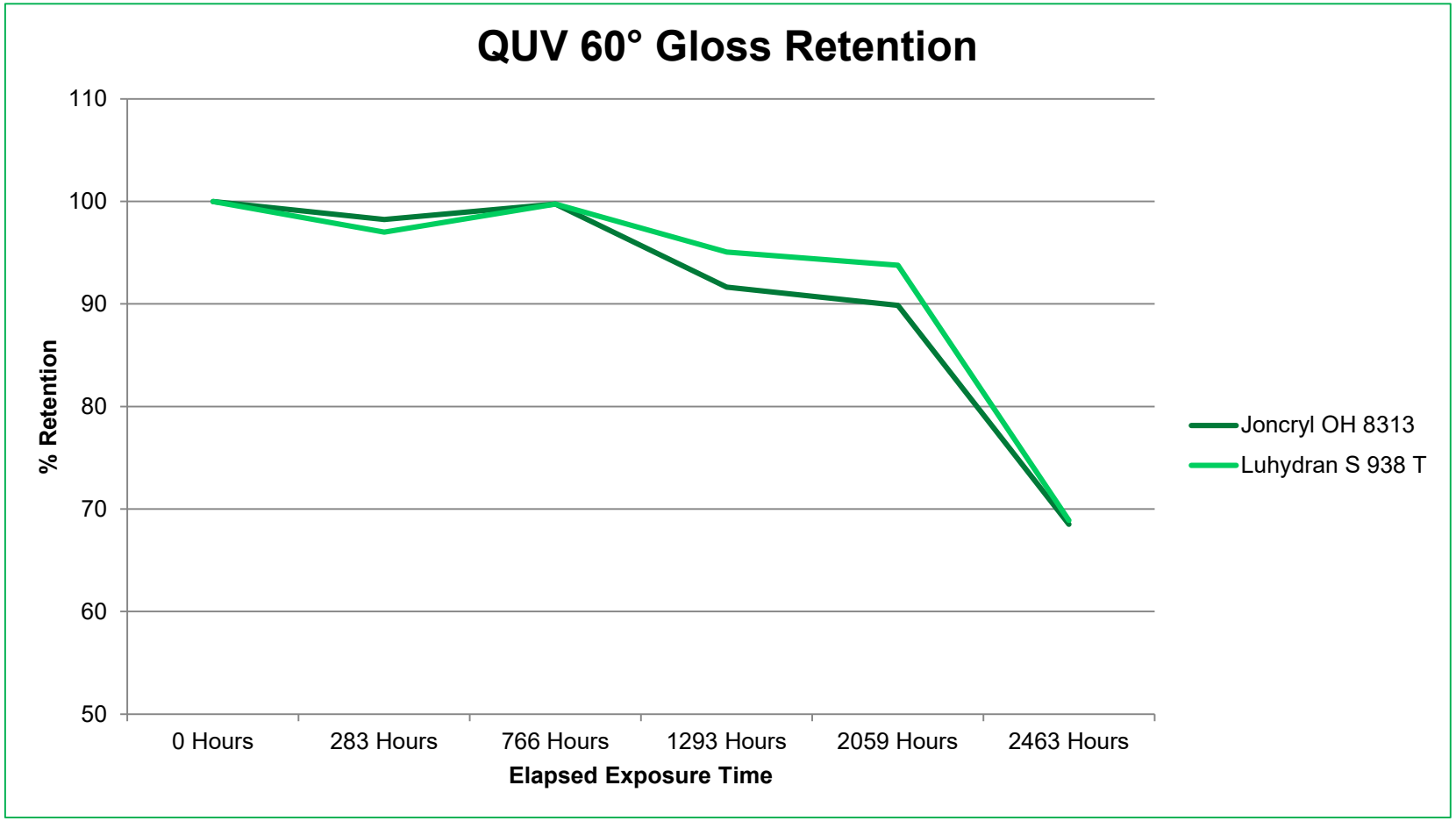
Taber Abrasion – Clear with Basonat HW 1000(CS-10 Stone,1000g)

Product	Elapsed Time after Activation	Average mg lost per 1000 cycles
Luhydran S 938 T	5 minutes	38.1
Luhydran S 938 T	3 hours	46.3
Joncryl OH 8313	5 minutes	36.2
Joncryl OH 8313	3 hours	44.7

Weathering of Luhydran S 938 T, Joncryl OH 8313 White Formulation with Basonat HW 1000 (No HALs or UVAs)



Luhydran S 938 T, Joncryl OH 8313:
Formulation and use

- Pot life cannot be measured by an increase in viscosity
  - Measured by:
    - Decrease in properties
    - When paint starts to foam
- Both Luhydran S 938 T and Joncryl OH 8313 have ~3 hour pot life
- Caution using solvents having any OH functionality in the formula as they may react with NCO
  - Use acetate versions if possible
- As both Luhydran S 938 T and Joncryl OH 8313 are supplied at low pH, only tertiary amines should be used to adjust the pH of the final formulation:
  - Dimethylethanolamine (DMEA)
  - Triethanolamine

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Joncryl OH 8314

at a glance

OH functional binder for water-based 2K PUR gloss DTM with end-of-pot-life indication

Physical Properties	Values
N.V.	43 - 45%
Viscosity	100 – 700 cps
pH	7.8 – 8.3
Hydroxyl Number	70 mg KOH/g
MFFT	41 – 43°C
Appearance	Milky white emulsion

- **Suitable Applications**
  - Interior/exterior industrial and Institutional maintenance
  - Interior/exterior general industrial metal
  - Direct-to-metal protective
  - Automotive interior

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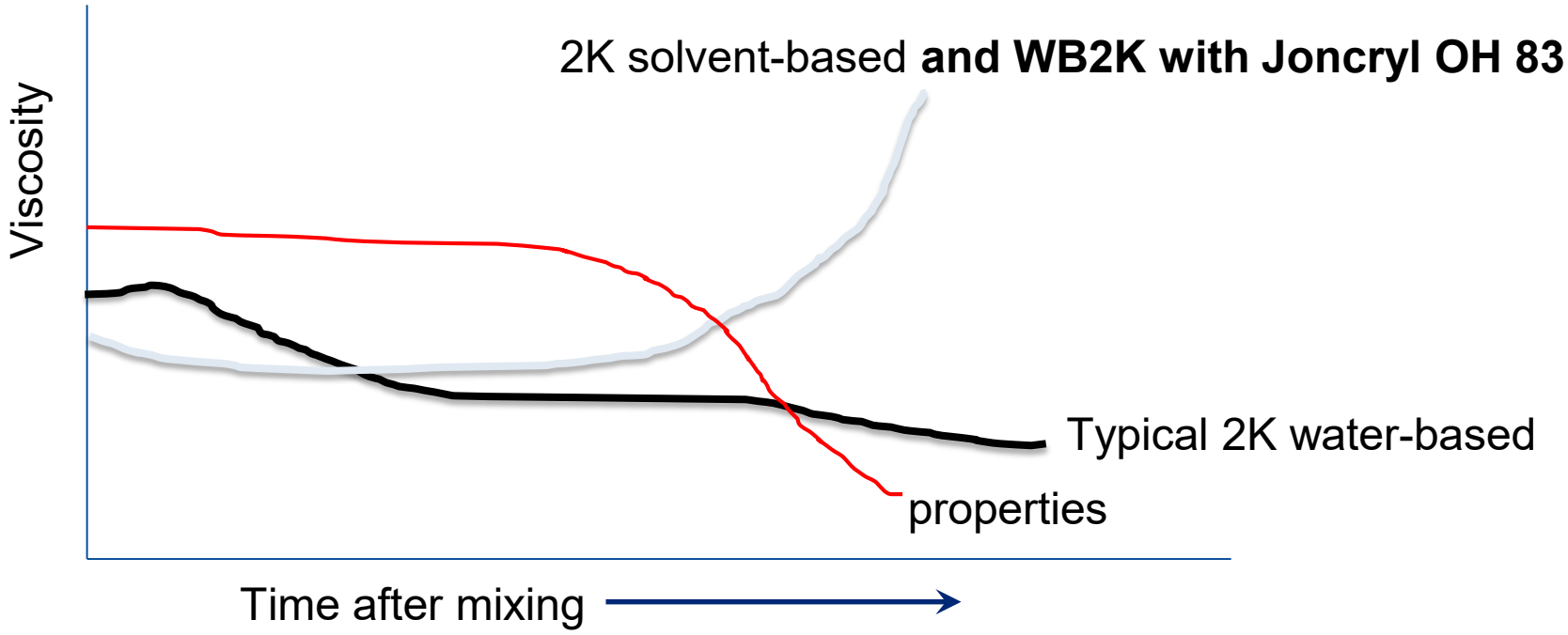
Pot Life: Properties vs Time

- Typical WB2K systems show no increase in viscosity. Reactions happen in the dispersed phase. Our system behaves like a solvent-based system.



A viscosity increase is an easy indicator for the user to stop using the coating

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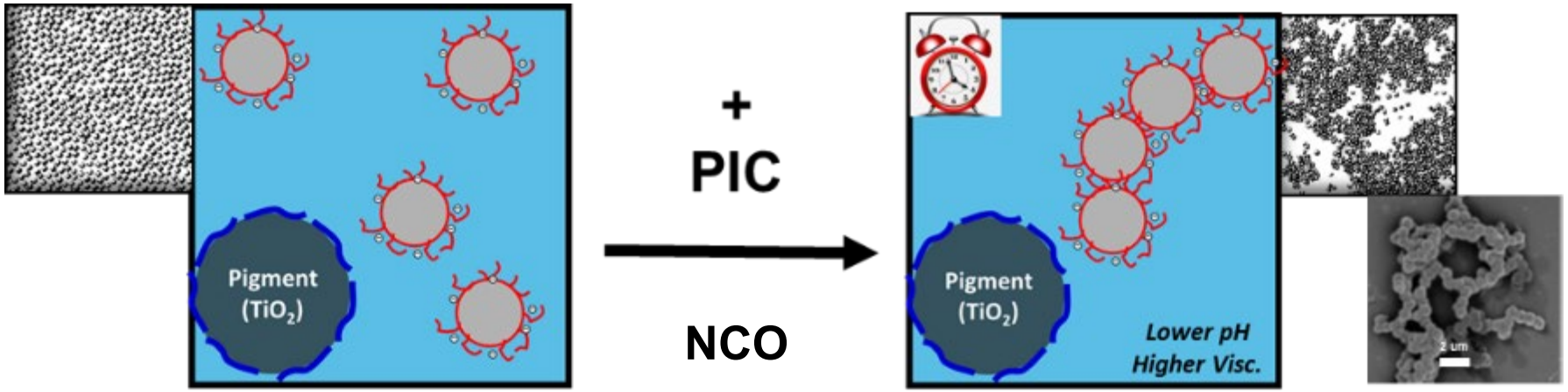
Polyol Dispersions with Pot-life Marker

New BASF technology

Synthesis Capability	Performance Advantage
Clean water-phase (no salt and hydrophilic polymer)	Water resistance, Corrosion resistance
Tuning the structure/composition of particle surface	Discernable end of pot-life marker
Tuning gel content and molecular weight of the sol-polymer	Reduced cost-in-use, compatibility with NCO
Tuning Tg, acid content, hydroxyl content, etc.	Dial in specific performance attributes...



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Joncryl OH 8314 White DTM with Basonat HW 1000

Formulation Attributes	
PART A	
Solids	44.37% by wt, 34.44% by vol
Viscosity (Stormer)	65 KU
pH	~8.0
PART A + PART B	
Solids	47.2% by wt, 38.48 by vol
Viscosity (Brookfield)	~975 cps
PVC	14%
VOC (calculated)	167 g/l
NCO:OH Ratio	1.5
pH	~8.0
Pot Life (20 – 22°C)	**120 minutes**

BASF Novel Polyol Dispersion

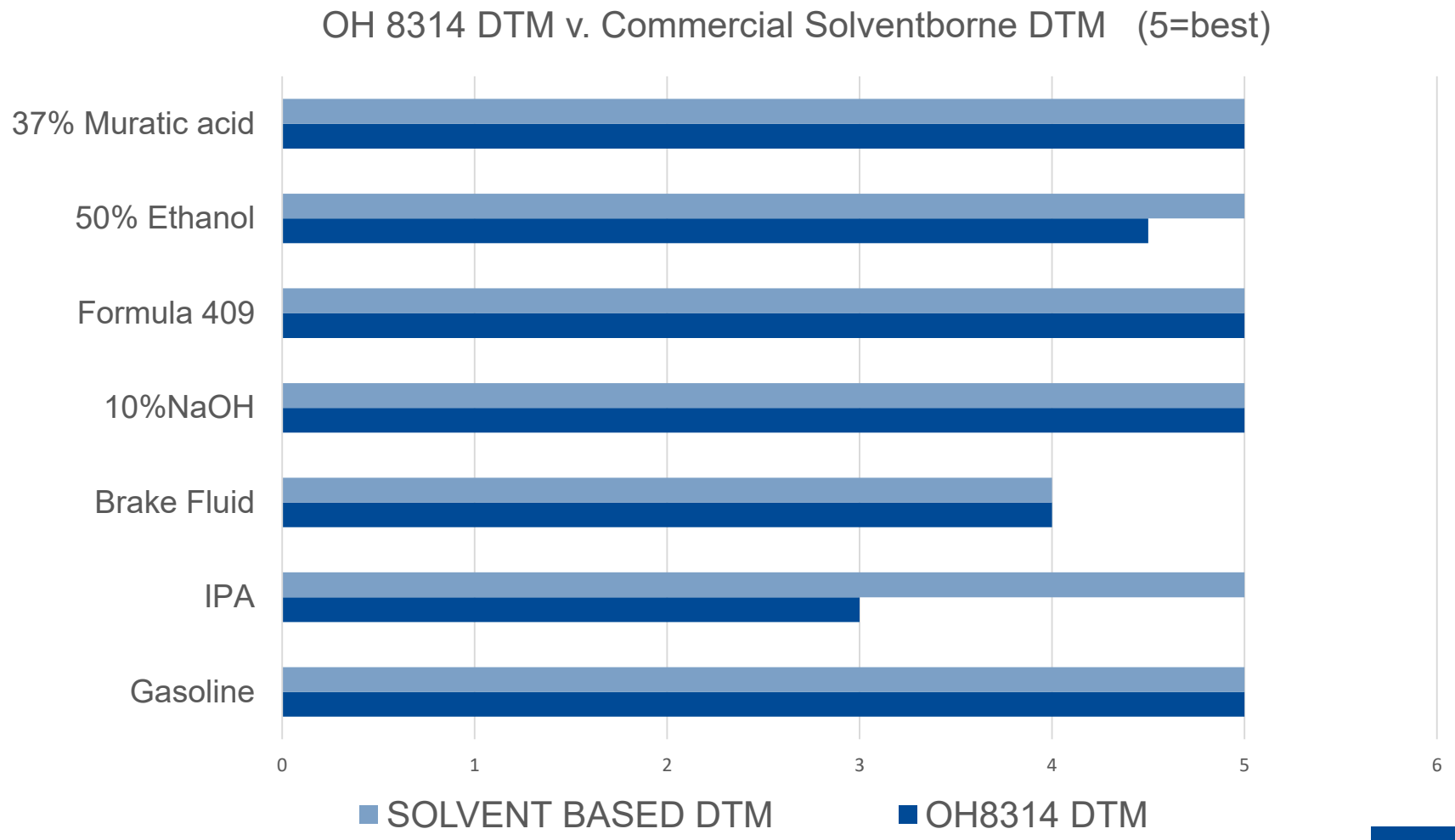
*White DTM performance**

Property	Test	Result
Gloss	60°	86
Solvent resistance	MEK double rubs	> 180
Adhesion dry UP CRS	ASTM D3359 (B)	5B
Adhesion HDG, EZG	ASTM D3359 (B)	4-5B
Adhesion wet UP CRS	X-scribe, 1 hr water spot test	4A
Hardness	König (pendulum - swings)	65
Hardness	Pencil	F-H
Flexibility	⅛″ Conical Mandrel	0″
Salt Spray	ASTM B117	> 250 hrs
Weathering (no UVA/HALS)	ASTM D4587 (QUV A 340 @1000 hrs)	>90% gloss retention
Pot Life (20 – 22°C)	Time to double visc	2 hrs

*Panels aged at 50°C for 24 hours prior to testing to approximate ~7 days ambient cure

Chemical Resistance

Spot tests (1 hour) per ASTM D1308



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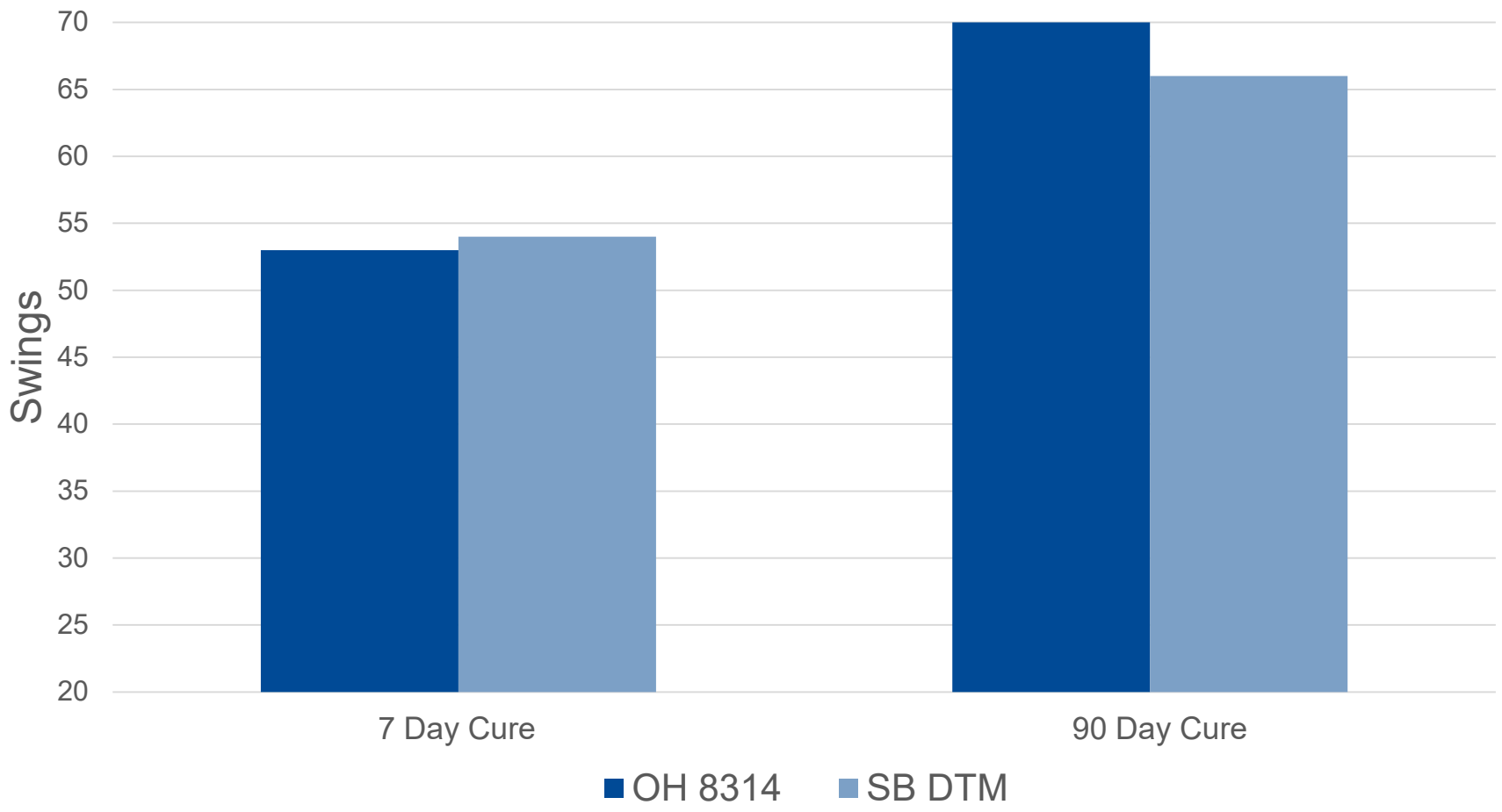
Pendulum Hardness

König hardness



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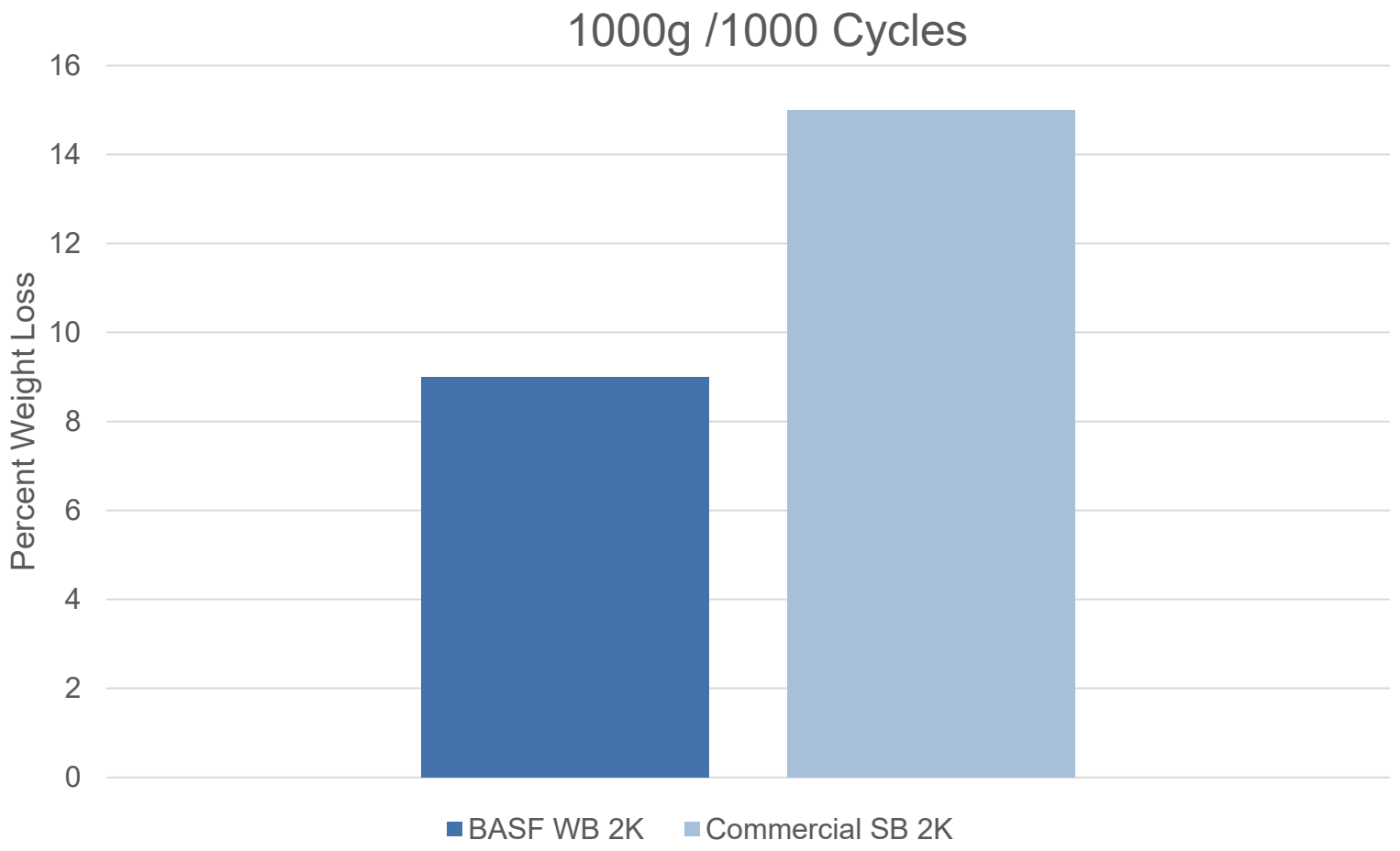
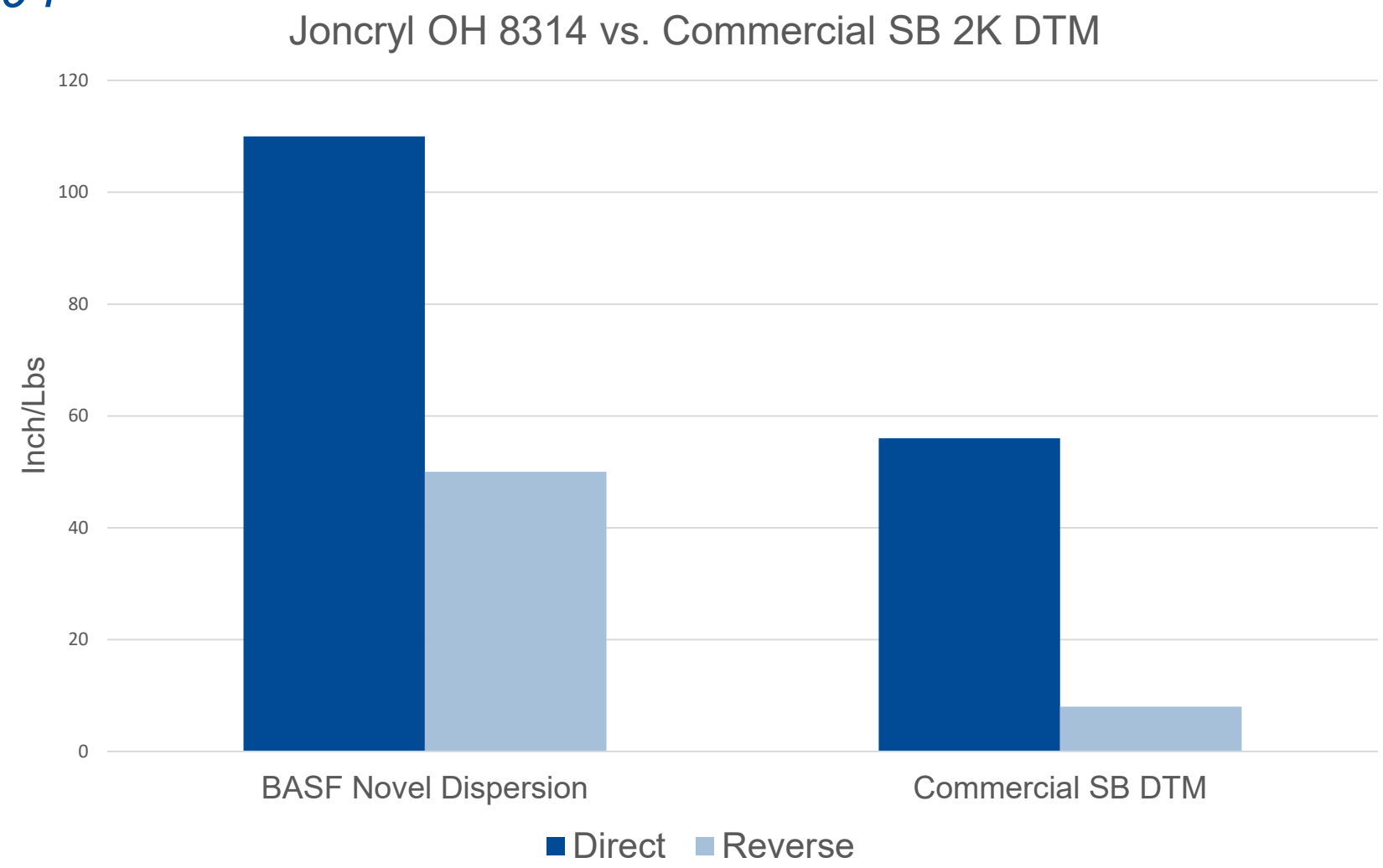
Taber Abrasion

per ASTM D4060



Forward and Reverse Impact Resistance

per ASTM D2794



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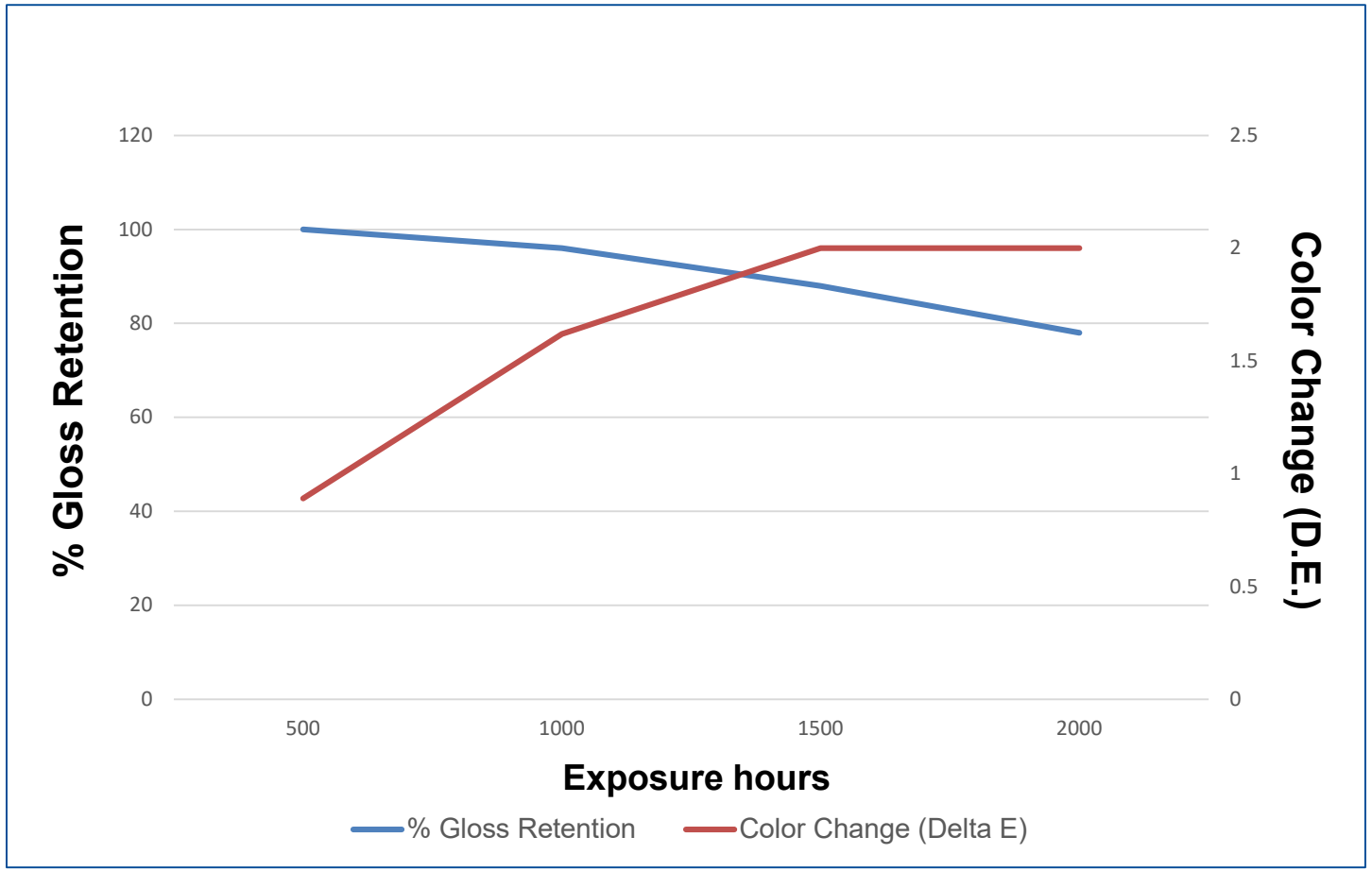
432 Hours of Salt Spray OH 8314 v. Commercial SB

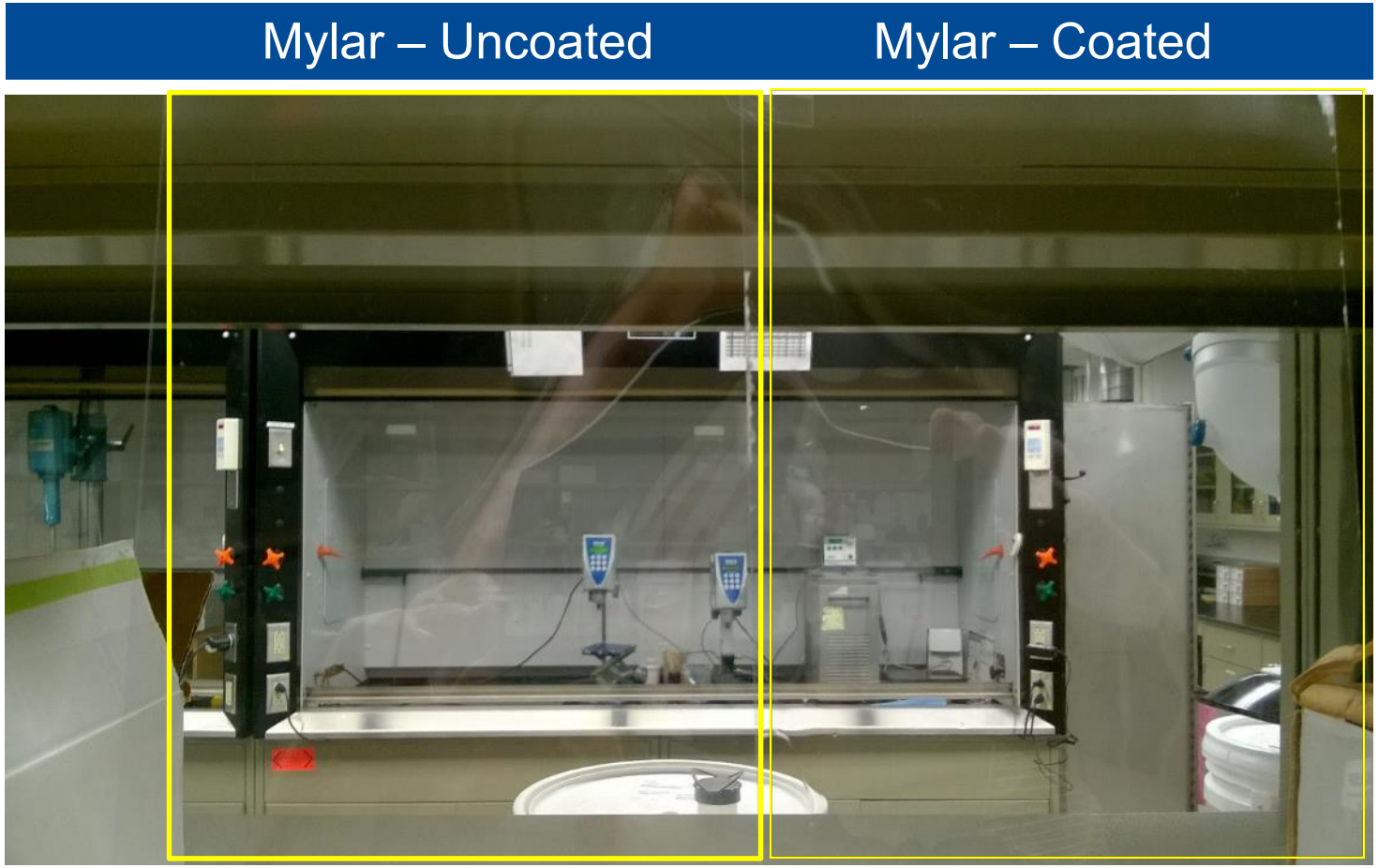
DFT = 2.5 mils

Joncryl OH 8314 Gloss Retention

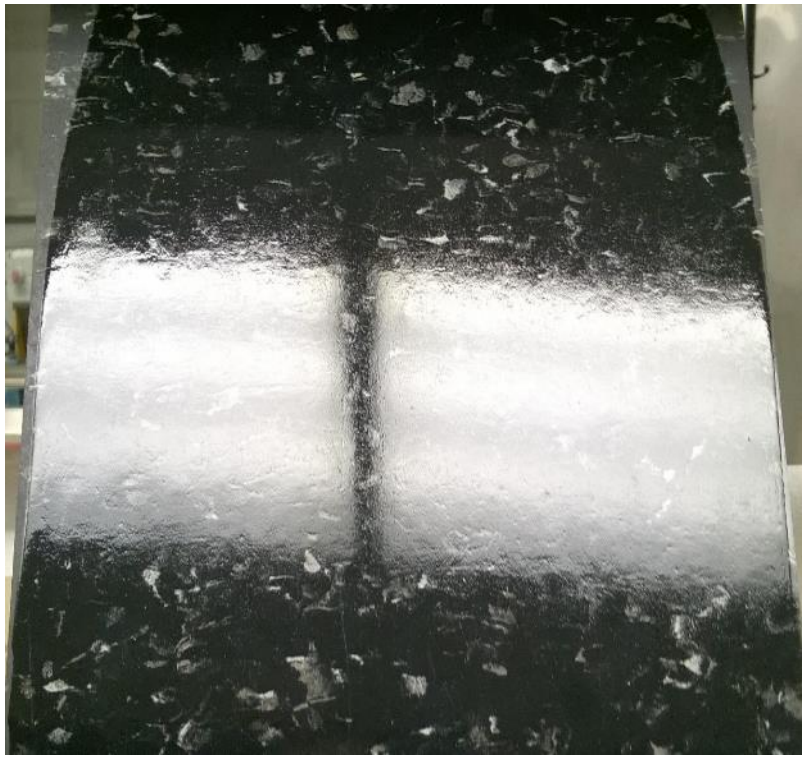
No UVA or HALS added



Film Clarity



Vinyl Composite Tile and Maple



BASF Waterborne Isocyanates

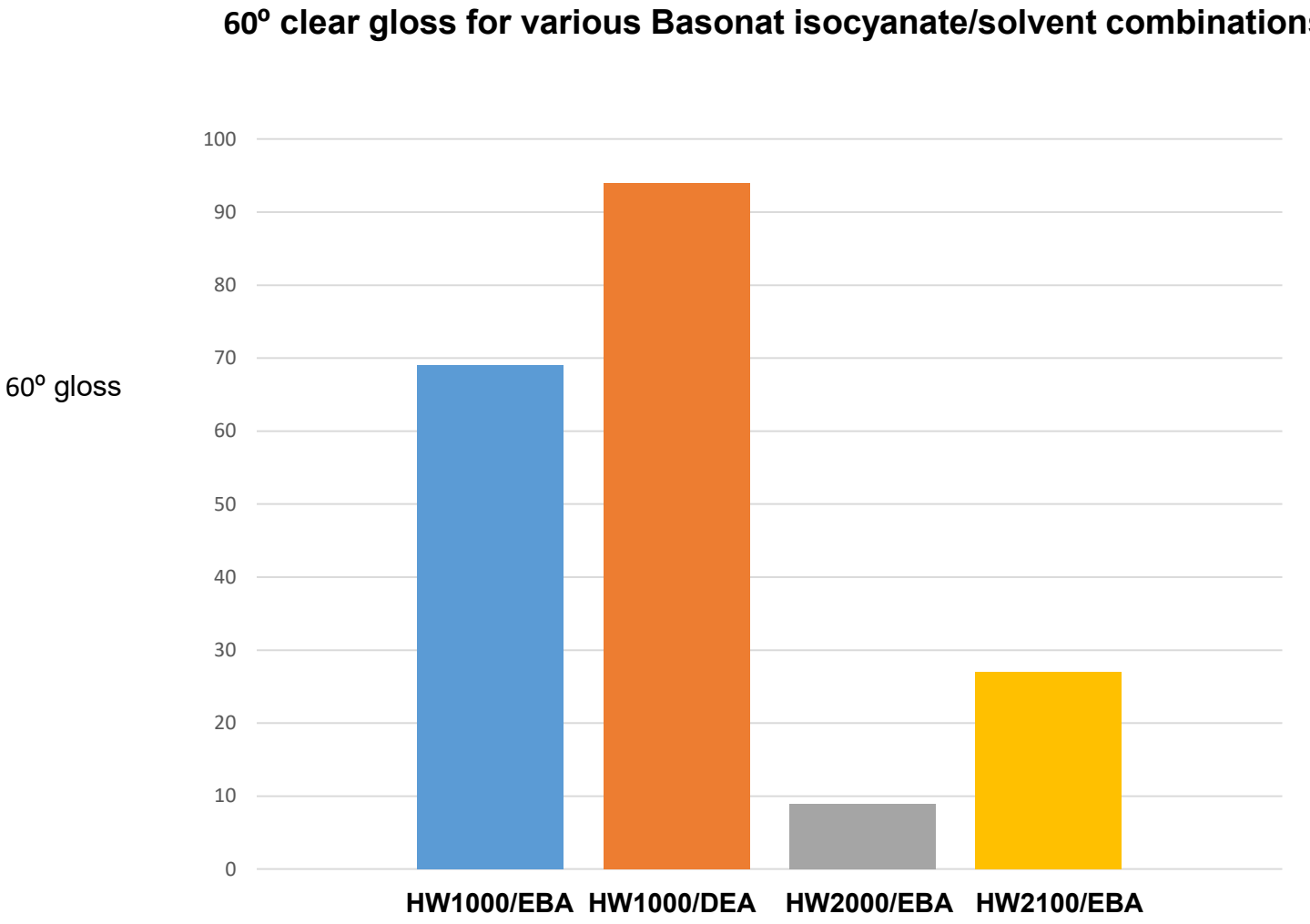
- Isocyanate choice will impact properties, ease of incorporation (hand stirring), and may result in coatings with lower gloss levels (desirable for some applications)

Basonat®	HW 1000 (gloss finish)	HW 1180 PC (for low VOC)	HW 2000 (matte finish)
Solid Content	100%	80% with propylene carbonate	100%
NCO (%)	16.5 – 17.5%	13-14%	17.5 – 18.5%
NCO equivalent weight	~247	~312	~233
Viscosity at 23 °C (100 s^{-1})	2000 – 6000 cP	450 – 850 cP	1500 – 3000 cP
Platinum-cobalt color number	≤ 100	≤ 100	≤ 40
Key Properties	Excellent weather and chemical resistance Excellent adhesion to various substrates Easily emulsifiable in water Excellent pot life	Excellent weather and chemical resistance Excellent adhesion to various substrates Easily emulsifiable in water Low VOC Excellent pot life	Simplified incorporation, low foaming Excellent weather and chemical resistance Non-yellowing Excellent hardness/flexibility for demanding applications

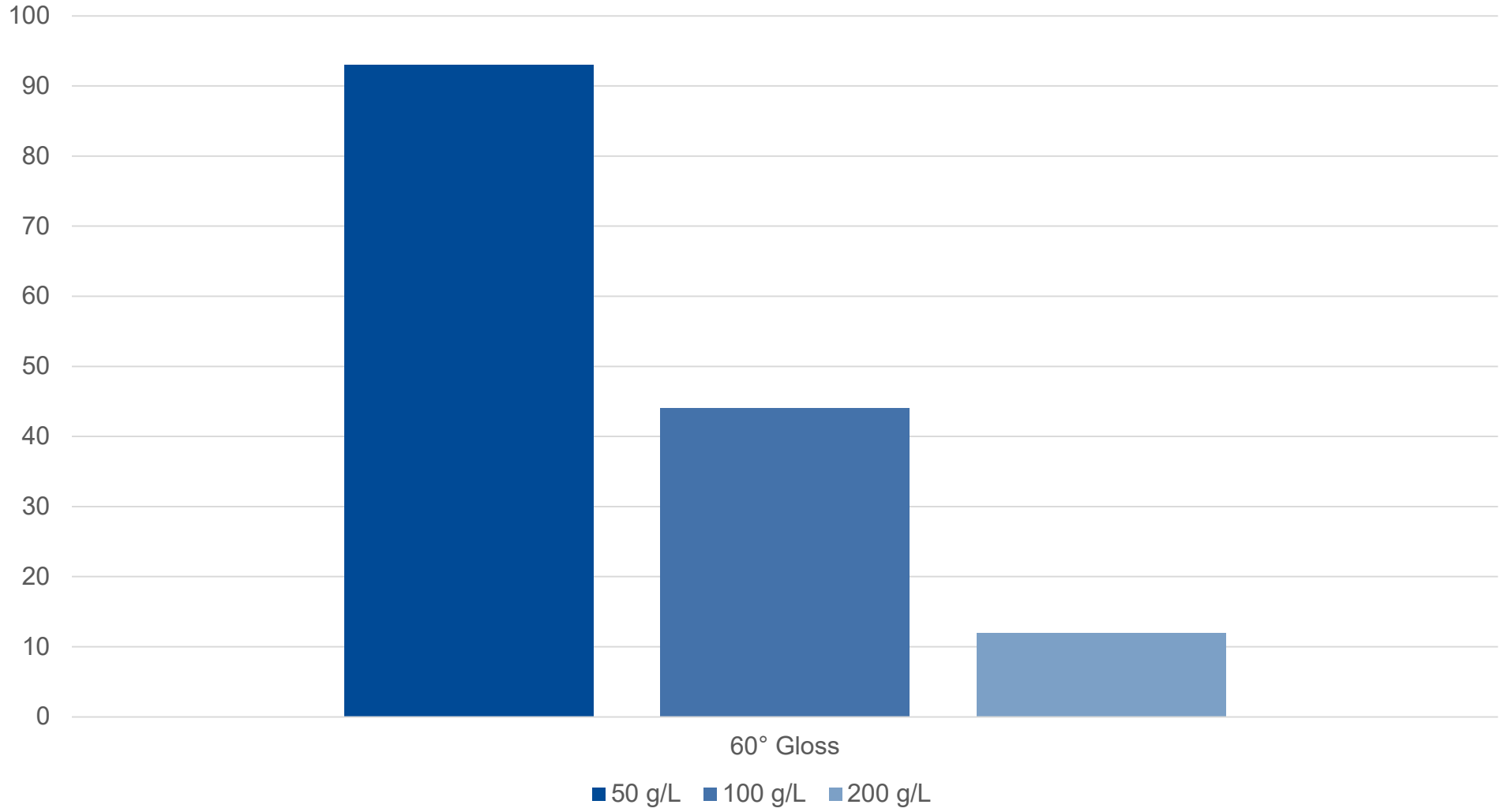
Solvent Choice and VOC

- **VOC levels of 50-100 g/L are attainable by using all DE Acetate as the co-solvent**
- **VOC levels of 0 g/L are attainable by using Basonat HW 1180 P,** which is a 0 VOC cut of isocyanate in 20% propylene carbonate
- Solvents with some amount of miscibility with water are preferred
  - These include but are not limited to: PM Acetate, DE Acetate, propylene carbonate and ethylene glycol diacetate
- The use of EB acetate is possible but will result in coatings with lower gloss levels
- It is recommended that most of the solvent package should be added to Part B (isocyanate)
- Use urethane grade (< 500 ppm water content) solvent when packaging it with the isocyanate

Varying Gloss Levels with Different Iso and Solvents 200 g/L



Joncryl OH 8314 with HW 2000, Propylene Carbonate, and EB Acetate



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Conclusion

- BASF offers a wide range of 1K and 2K waterborne DTM products that enable sustainable, low VOC solutions at high levels of performance
- BASF offers waterborne DTMs that perform like traditional solvent-borne systems, enabling cost savings
- New innovations provide unprecedented corrosion resistance and adhesion performance
- Focused innovation in this space will continue to bring unique and unrivaled advancements in performance and cost savings

Contacts

Please don’t hesitate to contact us for more information. If you would like samples or if you would like to have any other conversation, we would be happy to help.

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