INDUSTRIAL SOLUTIONS USA
Coatings. Protection. Innovation.

Nano-Clear Industrial Coating

Test Result Summaries

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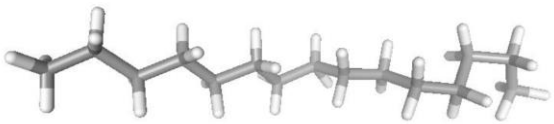
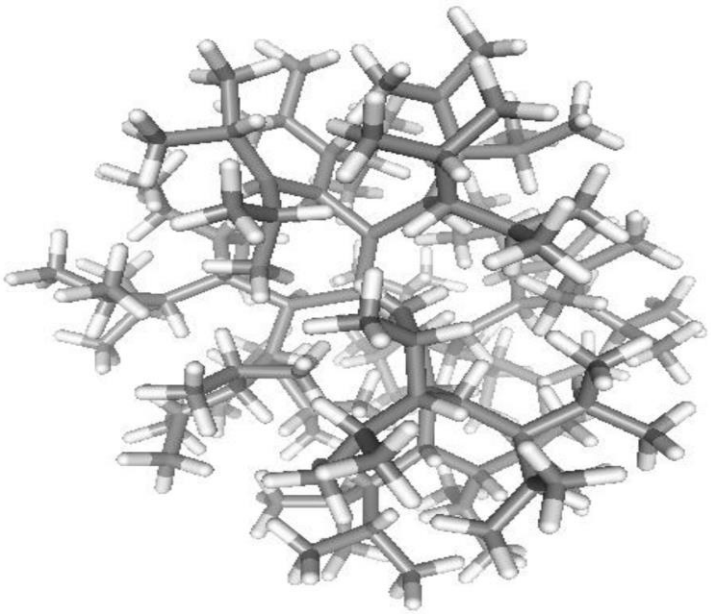
November 2015

1 FORMULATION – STRUCTURE

Conventional Coatings –
Linear Chain Molecules =
Low crosslink density = …

- Poor long-term weathering
- Poor chemical resistance
- Poor scratch resistance
- Poor cleaning properties

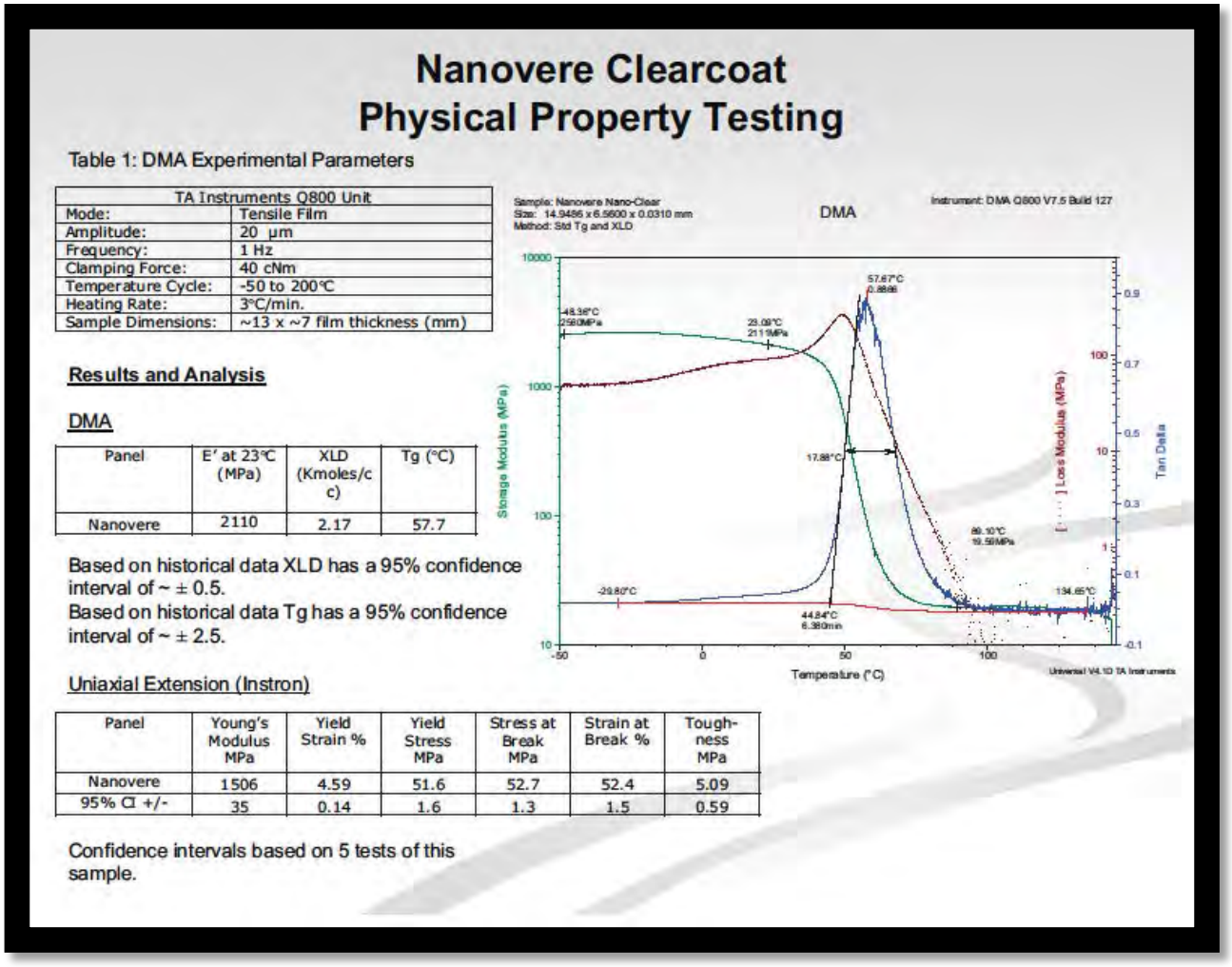




Nano-Clear Coating =
High crosslink density = …

- High UV resistance
- High chemical resistance
- High abrasion resistance
- High chip resistance
- High scratch resistance

2 TEST RESULTS – CROSSLINK DENSITY



Nanovere Clearcoat
Physical Property Testing

Table 1: DMA Experimental Parameters

TA Instruments Q800 Unit	
Mode:	Tensile Film
Amplitude:	20 µm
Frequency:	1 Hz
Clamping Force:	40 cNm
Temperature Cycle:	-50 to 200°C
Heating Rate:	3°C/min.
Sample Dimensions:	~13 x ~7 film thickness (mm)

DMA

Sample: Nanovere Nano-Clear
Size: 14.9486 x 6.5600 x 0.0310 mm
Method: Std Tg and XLD

Instrument: DMA Q800 V7.5 Build 127

Results and Analysis

DMA

Panel	E' at 23°C (MPa)	XLD (Kmoles/cc)	Tg (°C)
Nanovere	2110	2.17	57.7

Based on historical data XLD has a 95% confidence interval of ~ ± 0.5.
Based on historical data Tg has a 95% confidence interval of ~ ± 2.5.

Uniaxial Extension (Instron)

Panel	Young's Modulus MPa	Yield Strain %	Yield Stress MPa	Stress at Break MPa	Strain at Break %	Toughness MPa
Nanovere	1506	4.59	51.6	52.7	52.4	5.09
95% CI +/-	35	0.14	1.6	1.3	1.5	0.59

Confidence intervals based on 5 tests of this sample.

Nano-Clear Coatings are manufactured using proprietary 3D nanostructured polymers resulting in cured films with:

- remarkable surface hardness
- extreme UV resistance
- excellent chemical resistance
- high flexibility – no embrittlement

Dynamic Mechanical Thermal Analysis (DMTA) is utilized to calculate the "crosslink density" of coating polymers.

Nano-Clear Coatings do not contain any nanoparticles like many marketed nanocoatings. All Nano-Clear Coatings rely on crosslink density to exceed automotive OEM and aerospace OEM technical specifications.

3 TEST RESULTS – NIPPON PAINT

Nano-Clear®

Nano-Clear for Industrial Applications
Product # NCI-RC

Nano-Clear is a one-component industrial grade formulation that cures rapidly in the presence of atmospheric moisture. Nano-Clear forms an extremely cross-linked film with far superior scratch, abrasion, chemical and UV resistance over any leading two-component industrial clear coating. Suitable for use over newly primed, basecoat, topcoat or highly oxidized epoxy, polyurethane or polyester topcoat.

Dry film property*	Spec	Nano-Clear	Test Method
Pencil Hardness	-	4H	ASTM D3363
Pendulum Hardness (Persoz)	-	> 250	ASTM D4366
Abrasion Resistance (CS-17, 1kg, 1000 cycles)	-	8.4 mg	ASTM D4060
Impact Strength (kg-cm)	-	> 140	ASTM D2794
Water immersion test (240 hours @ 50°C)	-	Pass	ISO 2812-2
CASS @ 50°C	-	Pass (240 hours)	JIS H8502-7
% Gloss retention (> 1500 hours QUV 313)	-	> 100	ASTM D4587
% Gloss retention (> 2000 hrs Xenon WOM)	-	> 99	ASTM G155
MEK resistance	-	> 1500	ASTM D4752

* Fully cured clear coat on bare aluminum panels @ 72°F at RT for at least 24 hours prior to testing.

Nanovere

NIPPON PAINT

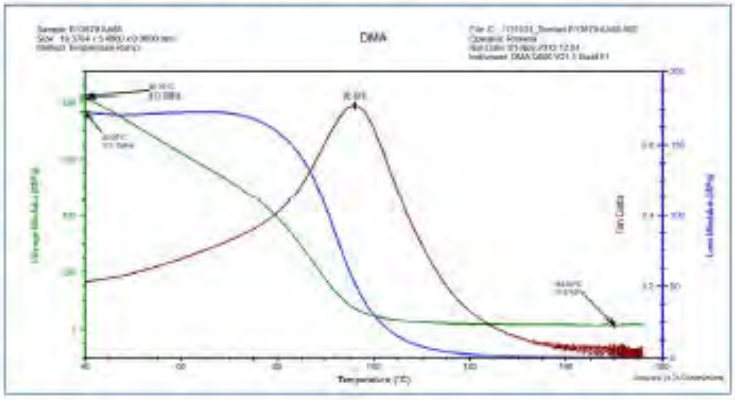
4 TEST RESULTS – NIPPON PAINT

Nano-Clear NCI & BASF Automotive OEM - DMA results (31/10/2013)

Request No. NTP13126

Report No. PR-NT-13-121

Sample Code	Sample Name	System	Tg by DMA (°C)	$T_{E'min}$	E' at $T_{E'min}$ (MPa)	X-linking density by DMA, ($X10^3$ mol/m^3)	E' at 40°C, MPa	E'' at 40°C, MPa
R13879	Nano-Clear NCI	1K Air Cure (72°F)	**96.1**	150	15.97	**1.51**	813.7	173.1
R13724	BASF Auto OEM	1K High Bake (285°F)	**59.75**	109	4.65	**0.49**	389.9	170.3



NIPPON PAINT

5 TEST RESULTS – STONEBRIDGE TECHNICAL SERVICES

Sample	A	B	C
Clearcoat	**Nano-Clear VV39.10**	**CeramiClear**	**SB Acrylic Silane Melamine OEM**
Manufacturer	**Nanovere**	**PPG**	**DuPont**
Cure Schedule	**30' @ 150°F**	**30' @ 150°F**	**30' @ 300°F**
Clearcoat DFT (mils)	**1.8 - 2.0**	**1.8 - 2.0**	**2.0 - 2.1**
Gloss per ASTM D523 (20°/60°)	86.0 / 92.2	85.8 / 92.0	88.1 / 94.1
Adhesion per ASTM D3359 Method B to White BC	5B / 100%	5B / 100%	5B / 100%
Pencil Hardness per ASTM D3363	3H	F	4H
Taber Abrasion per ASTM D4060 (mg lost per 1,000 cycles)	19.85	36.20	52.20
Impact Resistance per ASTM D2794 - Initial			
Direct (inch-pounds)	150 Fail / 140 Pass	90 Fail / 80 Pass	50 Fail / 40 Pass
Reverse (inch-pounds)	160 Pass (Maximum)	120 Fail / 100 Pass	10 Fail / 5 Pass
Impact Resistance per ASTM D2794 - After 48 Hrs. @ 250°F (in/lbs)			
Direct (inch-pounds)	70 Fail / 60 Pass	60 Fail / 50 Pass	20 Fail / 10 Pass
Reverse (inch-pounds)	5 Fail	5 Fail	5 Fail
Flexibility per ASTM D522	Pass 1/4"	n/a	Fail 3/4" Pass 1" **
Chemical Spot Resistance per ASTM D1308			
10% Sulfuric Acid	No Effect	No Effect	No Effect
10% Hydrochloric Acid	No Effect	No Effect	No Effect
10% Sodium Hydroxide	No Effect	No Effect	No Effect
10% Ammonium Hydroxide	No Effect	No Effect	No Effect
Isopropyl Alcohol	No Effect	No Effect	No Effect
Xylene	Slight Softening	Slight Softening	Slight Swelling
MEK	No Effect	No Effect	No Effect
Gasoline (87 Octane)	No Effect	No Effect	No Effect
MEK Resistance per ASTM D4752 (Double Rubs)	> 1500	260 Fail	> 1500

6 TEST RESULTS – STONEBRIDGE TECHNICAL SERVICES

STS #306_1C - Nanovere Secondary Testing for BMW			
Sample	**A**	**B**	**C**
Clearcoat	**Nano-Clear**	**CeramiClear**	**Acrylic Silane**
Manufacturer	**Nanovere**	**PPG**	**DuPont**
Cure Schedule	**30' @ 150°F**	**30' @ 150°F**	**OEM**
Clearcoat DFT (mils)	**2.0 +/- 0.1**	**2.0 +/- 0.1**	**2.0 +/- 0.1**
Scrape Adhesion per ASTM D2197			
Scratch	0.25 Kg	0.10 Kg	
Gouge	> 11 Kg	> 11 Kg	
Chip Resistance Per ASTM D3170 *			
Room Temperature (23°C)	7A	6A	6A
Cold Temperature (-29°C)	7B	5B	5B
Falling Sand Abrasion per ASTM D968 (100 Liters)	Pass	Pass	Fail
Impact Resistance per ASTM D2794 at -18°C			
Direct (inch-pounds)	50P / 60F	30P / 40F	40 P / 50F
Reverse (inch-pounds)	20F / 10P	5F	5F
Humidity Resistance per ASTM D4585			
500 Hours - Blistering per ASTM D714	No Effect	No Effect	No Effect
500 Hours - Appearance	No Effect	No Effect	No Effect
Transmission & Haze per ASTM D1003			
Haze (%)	1.29	1.09	
Total Luminous Transmittance (%)	89.18	89.91	
Diffuse Transmittance (%)	1.15	0.98	
WOM Resistance per SAE J1960			
20° Gloss - Initial	82.0	82.4	87.8
20° Gloss - 500 Hours	88.0	86.8	88.0
20° Gloss - 1,000 Hours	95.0	91.0	95.0
20° Gloss - 2,000 Hours	83.5	79.9	84.0
20° Gloss - 3,000 Hours	83.4	77.9	82.4
20° Gloss - 4,000 Hours	83.1	78.4	80.8
% Gloss Retention - 4,000 Hours	**100%**	**95%**	**92%**
ΔE - 500 Hours	0.35	0.27	0.61
ΔE - 1,000 Hours	0.41	0.35	0.44
ΔE - 2,000 Hours	0.55	0.48	0.32
ΔE - 3,000 Hours	0.57	0.48	0.30
ΔE - 4,000 Hours	0.63	0.48	0.41

* Number & Letter Categories for Chip Ratings:

Rating	No. of Chips	Chip Size
10	0	A = <1 mm
9	1 - 4	B = 1-3 mm
8	5 - 9	C = 3-6mm
7	10 - 24	D = >6mm
6	25 - 49	
5	50 - 74	
4	75 - 99	
3	100 - 150	
2	151 - 250	
1	> 250	

7 TEST RESULTS – ALCOA

NOTE: Coating designation Nano-Clear NCI-RC

8 TEST RESULTS – ASSET OWNER

[redacted]

R[redacted]
Director of Operations - [redacted]
Telephone: 3[redacted]

Interoffice Memorandum

To: J[redacted]

From: R[redacted]

Date: 4/12/14

Subject:: QUV testing of nano coatings

Test Description:

Eleven pre-prepared panels were tested to evaluate UV degradation. They were tested using QUV-A per ASTM G154 for 1500 hours, stopping to evaluate the coatings every 500 hours.

The panels were identified as:

1. Nano-clear self–cleaning black – decal under
2. Nano-clear recoat clear – decal over
3. Nano-clear self–cleaning clear – decal under
4. Nano-clear NCI-SC [redacted] black
5. Nanovere NCP SC clear decal over
6. Nano-black recoat black over blasted jacket
7. Nanovere NCB-SC black coating
8. Nano-clear recoat clear decal under
9. Nanovere NCB-RC black coating decal over
10. Nanovere NCB-RC black coating decal under
11. Nano-black NCI self-cleaning

Results:

All panels displayed no discoloration (chalking) or delamination after 1500 hours on the surface or in between coats.

- Note: 250 hours is comparable to 3 months in summer in the south

Conclusion:

These materials performed very well in regards to UV degradation.

[redacted]

R[redacted]
NACE Certified Coating Inspector – Level 3

9 TEST RESULTS – AMERICAN RACING

Corporate Test Facility
19200 South Reyes Avenue
Rancho Dominguez, California 90221
Tel.: (310) 635-7806 Fax (310) 763-8227

American Racing Custom Wheels

ENVIRONMENTAL TEST REPORT

Request Number: 07050 MD Revision: Init
Customer: A.R.E.
Purpose of Test: R & D Testing Paint & Clear Coat by (Nanovere Technologies)
Sample Description: 2388- Roja Glossy Black
Substrate: Forge Produced At: N-Technologies
Primer: n/a
Paint: Glossy Black
Clear Coat: n/a

Average Film Thickness: (A) Face: n/a Windows: n/a
Average Film Thickness: (B) Face: _____ Windows: _____

Test Number	Test	Specification Number	Test Method/ Test Parameters	Test Results	Tech. Sign./ Date
A: E014607 B:	Initial Adhesion Date: 02-12-07	ASTM D 3359-02	100% Adhesion-X-cut method. No loss of adhesion.	Accepted	A.M. 02-12-07
A: E014607 B:	Impact Date:	463PB-19-01	4lbs 80"lbs drop No cracking or flaking.	Accepted	A.M. 02-12-07
A: E014607 B:	Mar resistance Date: 02-12-07	463PB-43-01	Thumbnail scratch No marred.	Accepted	A.M. 02-12-07
A: E014607 B:	Pencil hardness Date: 02-12-07	463PB-2-01	2H Mininum gouge. Pass @ 2H.	Accepted	A.M. 02-12-07
A: E014607 B:	Solvent Resistance Date: 02-12-07	463PB-07-01	Rub 8 times with XYLENE. No loss of gloss. No change	Accepted	A.M. 02-12-07
A: E014707 B:	Salt Spray Date: 02-13-07	ASTM B 117-97	Apply salt spray for 240hrs. No loss of adhesion. No change	Accepted	A.M. 02-13-07
A: E014807 B:	Humidity Date: 02-13-07	ASTM D 1735-02	100°F RH 100% for 240 hrs. No loss of adhesion. No change.	Accepted	A.M. 02-13-07
A: E014907 B:	Water Immersion Date: 02-15-07	463PB-45-01	Immerse 100°F H_2O 96 hrs. No loss of adhesion. No change.	Accepted	A.M. 02-19-07
A: E015007 B:	Thermal Shock Date: 02-12-07	GM9525P	100°F for 3 hrs.\Freeze for 3hrs. min. \ Steam blast 30 sec. No loss of adhesion. No change.	Accepted	A.M. 02-19-07
A: E015107 B:	Chip Resistance Date: 02-12-07	463PB-39-01	Gravel meter using 1 pint of 3/8 5/8 gravel @ 70psi	Accepted	A.M. 02-22-07
A: E015107 B:	Chip Resistance -20° Date: 02-12-07	463PB-39-01	Gravel meter using 1 pint of 3/8 5/8 gravel @ 70psi	Accepted	A.M. 02-22-07

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10 TEST RESULTS – OSHKOSH CORPORATION

Nano-Clear Industrial Coating w/ Fluoropolymer
Salt Spray (Fog) Corrosion Test

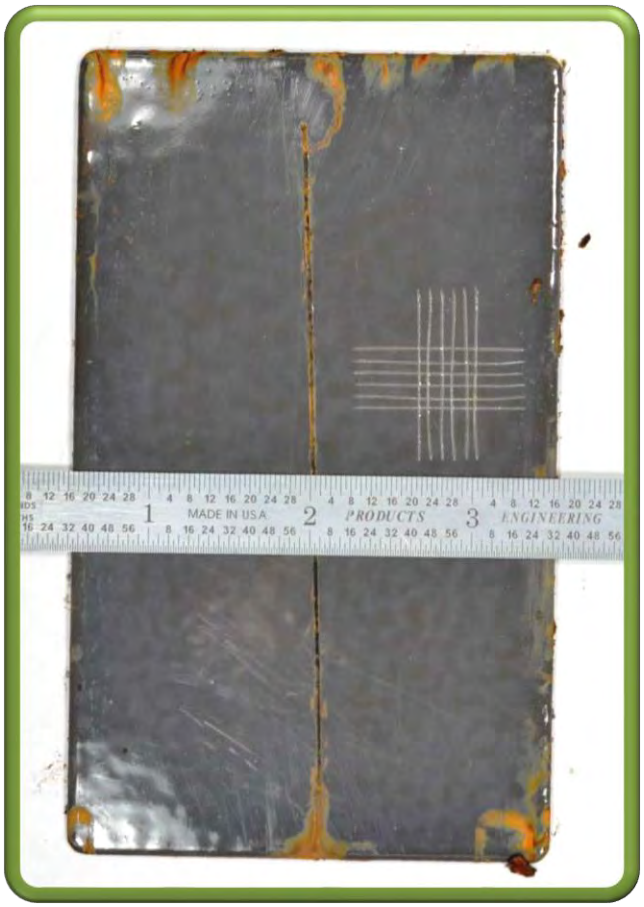
ASTM B117 - Standard Practice for Operating Salt Spray (Fog) Apparatus
ASTM's B117 salt fog or salt spray test is a very popular corrosion test designed to provide corrosion resistance information on metals and coated metals. The ASTM B117 test standard has also been approved for use by Department of Defense agencies.

ASTM D714 Blistering Rating
This test method provides a standard procedure of describing the size and density of the blisters so that comparisons of severity can be made. This test method employs photographic reference standards to evaluate the degree of blistering that may develop when paint systems are subjected to conditions which will cause blistering.

ASTM D1654 Scribe Creep Rating
This test method covers the treatment of previously painted or coated specimens for accelerated & atmospheric exposure tests; their subsequent evaluation in respect to corrosion, blistering associated with corrosion, loss of adhesion at a scribe mark, or other film failure.

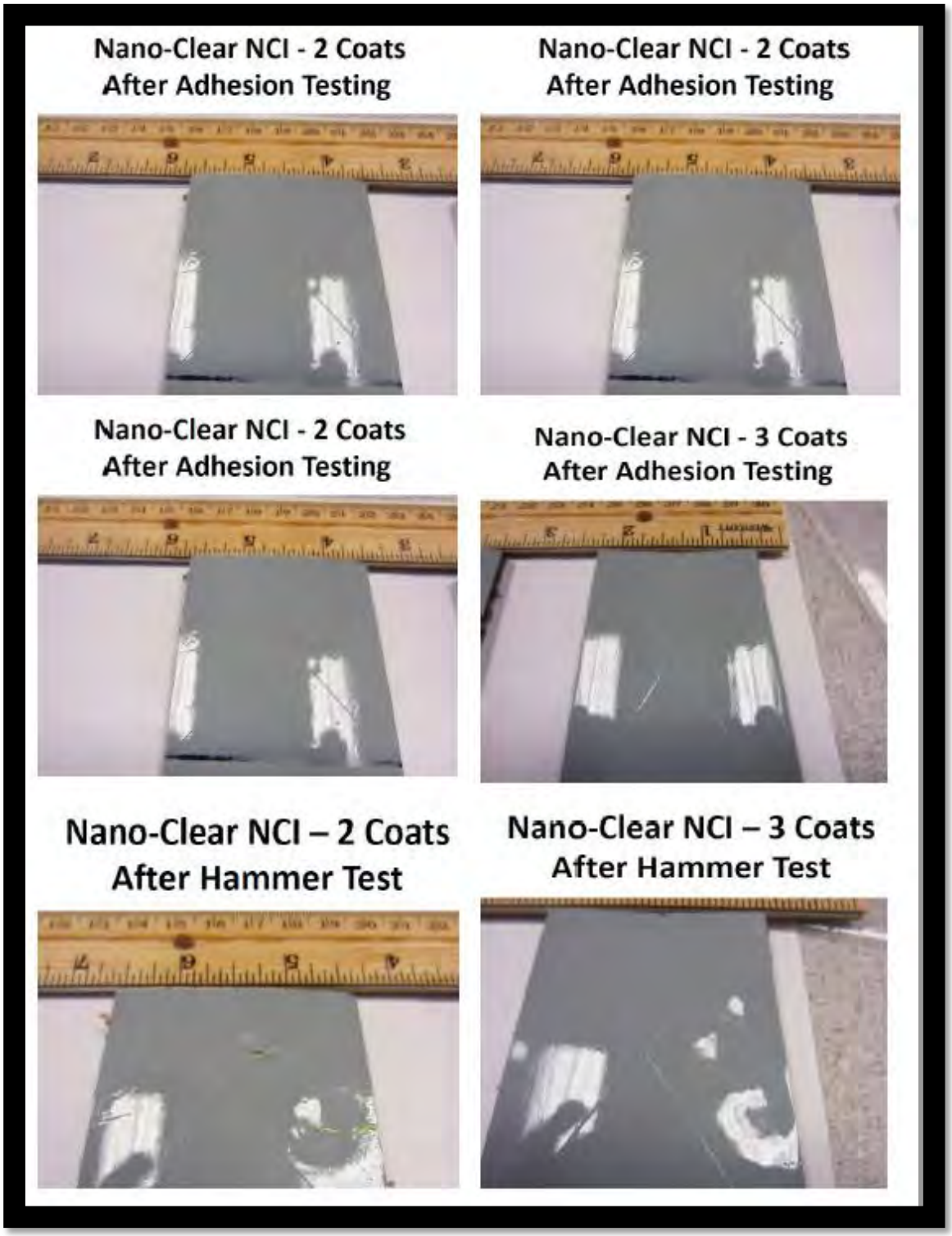
ASTM D610 Degree of Rusting
This practice provides a standardized means for quantifying the amount and distribution of visible surface rust - classified as spot rust, general rust, pinpoint rust or hybrid rust.

ASTM D3359 Coating Adhesion Test
These test methods cover procedures for assessing the adhesion of coating films to metallic substrates by applying and removing pressure-sensitive tape over cuts made in the film.



Sample Labeled:
ISU-NCIF 2 Coats on 2 Part Epoxy Paint #1.
Scribe Creep Rating: 10
0 = worst, 10 = best, zero creepback
Blistering Rating: 10
10 = no blistering,
8-2 represent progressively larger blisters
Degree of Rusting: 10
10 = ≤ 0.01 percent, 0=> 50%
Adhesion: 5B
5B = 0% of area removed, 0B = greater than 65% of area removed

11 TEST RESULTS – UTC AEROSPACE SYSTEMS



10 TEST RESULTS – UTC AEROSPACE SYSTEMS (CONTINUED)

Nano-Clear NCI – 2 Coats After Sand Blasting

Nano-Clear NCI – 3 Coats After Sand Blasting

Test setup:

In the Westford machine shop, With the Empire Sand Blaster, **@ 100 psi,** using Al_2O_3 Brown sand, 80 grit size, From McMaster Carr. Stand-off distance is about 20 inches from the nozzle-to-sample. Blast time is 30 seconds

11 TEST RESULTS – MISSOURI DOT

Missouri Department of Transportation
888-ASK MoDOT (275-6636)

Nano-Clear NCI for Industrial - Ammon Painting Restoration & Abatement

Summary of Bridge Testing, MoDOT Chemical Laboratory - 2014

Test Panels	Test Conditions	Test Method	Testing Time	Test Results Nano-Clear NCI	Test Results Conventional Topcoat
Coating applied over existing paint system	UV Exposure / Condensation	ASTM G154	2000 hr.	**PASS** No Weathering Observed	**Fail**
Coating applied over existing paint system	Salt Fog Exposure / Corrosion Resistance	ASTM B117	2000 hr.	**PASS** No Weathering or Corrosion Observed	**Fail**
Coating applied over existing paint system	UV Exposure on MoDOT Laboratory Roof	NONE	4000 hr.	**PASS** No Weathering Observed	**Fail**

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QUESTIONS – **PLEASE CONTACT**

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