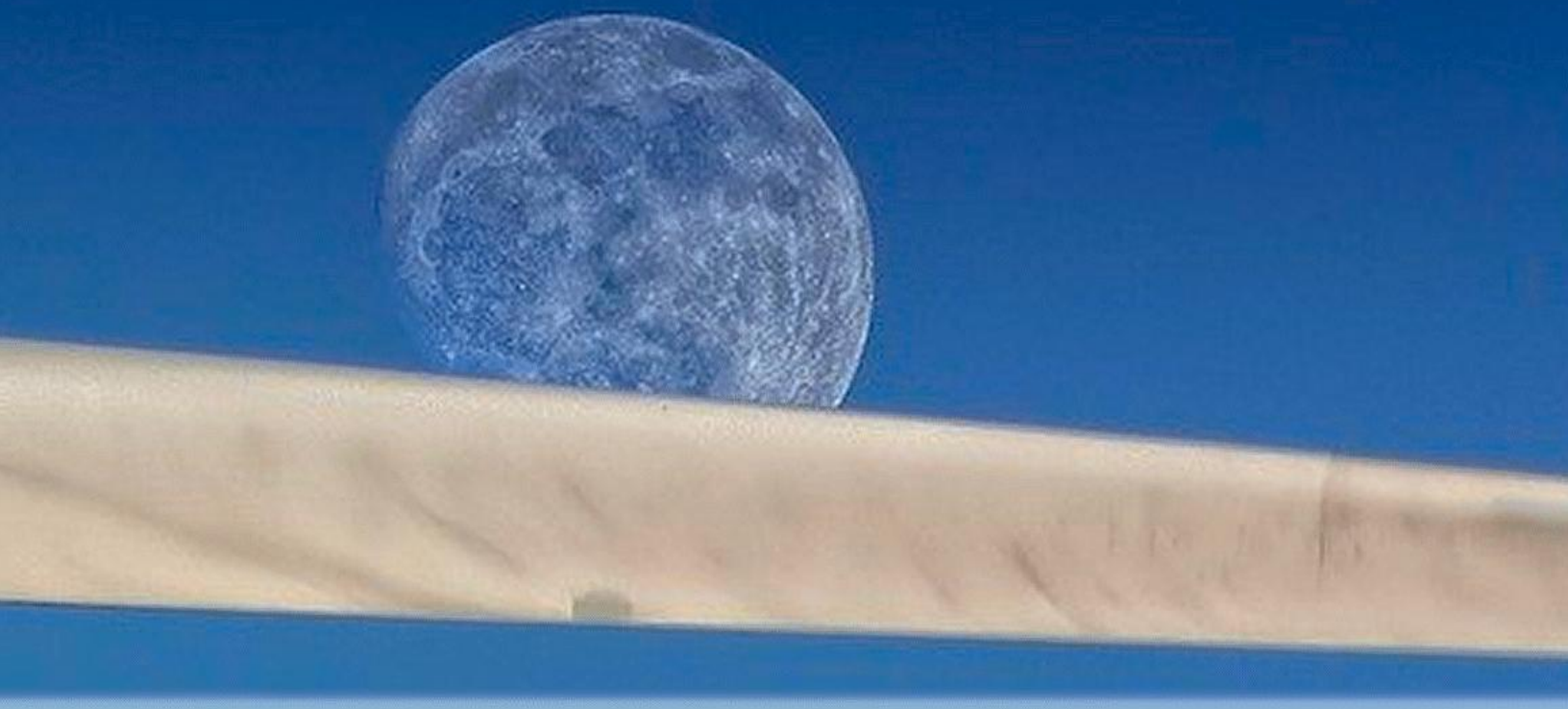
RESTORE, ENHANCE, EXTEND & PROTECT

NANO-CLEAR®
FOR WIND TURBINE BLADES

- Industry Award Winning, Eco-Friendly Coatings Guaranteed to Extend the Service Life of Valuable Assets
- 23x (2,300%) More Scratch Resistant Compared To A Leading Aerospace Grade Coating for Fibreglass
- Unmatched Durability, Even in the Harshest Environments

(For Oxidized or Freshly Painted Surfaces)

v-2023.04.19-1



WIND TURBINE OPERATIONS

700,000 blades in operation growing by 50,000+ blades annually. Fiberglass turbine blades and their supporting structures are subjected to conditions that lead to extreme erosion, corrosion and material fatigue. 1/3 of downtime is caused by blade failures.

TCO & ROI Impact:

- Reduced performance **5 - 8%**
- Shortened service lifespan **5 - 10 yrs**
- Increased maintenance **25%**

50,000 tons / year of wind blades are landfilled.

Nano-Clear®

Nano-Clear® dramatically increases service lifespan, reduces surface maintenance costs and increases ROI.

COATINGS FOR WIND TURBINE BLADES

"To protect your investment in the future, you need wind turbine coatings which protect against the erosion and corrosion of the entire structure due to the harsh environmental conditions it faces daily."
CoatingPaint.com

Nano-Clear® *reduces erosion-caused drag resistance to improve performance.*

Nano-Clear® is *23x (2,300%) more* *scratch resistant* *as compared to a leading aerospace grade coating for fiberglass.* *(independently tested / validated - * see test results: pg 8, Table 2)*

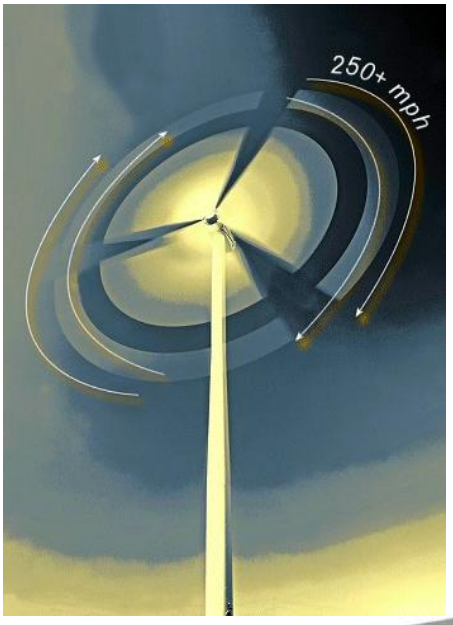
For Newly Manufactured Assets or In-Field Repair Work

Applied During Manufacturing Process

Nano-Clear® - can be integrated into current manufacturing processes.

During Maintenance Procedures

Nano-Clear® - can be incorporated into regular maintenance routines.



Leading Edge Erosion (LEE)

The front edge of a turbine blade is subjected to constant impact from airborne projectiles such as rain, ice, salt, and sand.

> *"The impact of liquid droplets on rigid surfaces generates water hammer pressure of several gigapascals. Later, the droplet depressurizes through lateral jets that can move two (2) to six (6) times faster than the impact velocity. Lateral jetting and water hammer pressure can exert stress beyond the solid surface's endurance limit, resulting in failure mechanisms like increased roughness, fatigue cracks, delamination, spalling, and pitting."* **Ducom Water Droplet Erosion Tester.**

It's well known that Leading Edge Erosion is one of the largest and most costly maintenance, repair, and overhaul (MRO) issues for wind turbine blades.

NOTE - Nano-Clear® is the optimum solution for *entire blade surfaces*, not just leading edges.

Impact On Performance

Testing has shown a drag increase of **80 - 500%** due to leading edge erosion (light-to-heavy erosion cases).

Erosion also caused a substantial reduction in lift coefficient, especially at the higher angles of attack that are experienced by wind turbines during their operation.

Aerodynamic Characteristic	Impact	Energy Capture Losses
Leading Edge Erosion	TBD	5 - 8%
Drag	80% (Low) 400 - 500% (High)	5% 25%

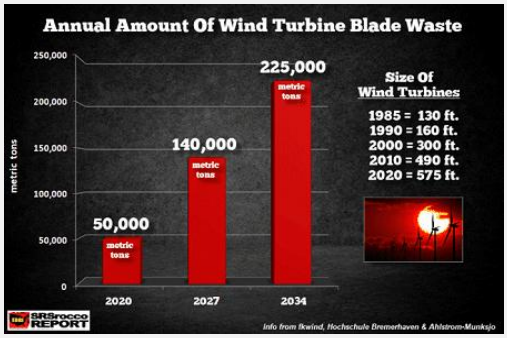
REDUCE CARBON FOOTPRINT / ENHANCE BRAND REPUTATION

These unrecyclable blades will lie in the ground essentially forever (or at best for many hundreds of years), as they don't degrade over time.

Operations and Maintenance (O&M) costs can total 30% of a turbine's overall annual price tag and continues to be a burden for operators.

Accelerated replacement of turbines becomes expensive: up to **2% to 4%** of the value of all wind-generated power is lost as a result of this problem.

"50,000 tons of blade waste in 2020 ... will quadruple to 225,000 tons by 2034."



IMPROVING BLADE MANUFACTURING QUALITY AND THE MITIGATION OF ENVIRONMENTAL DAMAGE

"Unplanned maintenance and component failures are concern to both wind plant owners-operator and wind turbine manufacturers." **Sandia Energy**

NANO-CLEAR® PERFORMANCE FEATURES

- ✓ Reduces blade vibration / noise levels
- ✓ Increases impact resistance (superior water droplet shock absorption
- ✓ Exceptional substrate delamination prevention
- ✓ Hydrophobic surface increases water and ice repellency
- ✓ Improves airflow (less drag)

Nano-Clear® is *23x (2,300%) more scratch resistant* *as compared to a leading aerospace grade coating for fiberglass.* *(independently tested / validated - * see test results: pg 8, Table 2)*

NANO-CLEAR® - THE SUSTAINABLE OPTION

- ❖ Eco-innovative / Eco-responsible, Low VOC, Green Solution
- ❖ Unmatched Durability, Even in the Harshest Environments

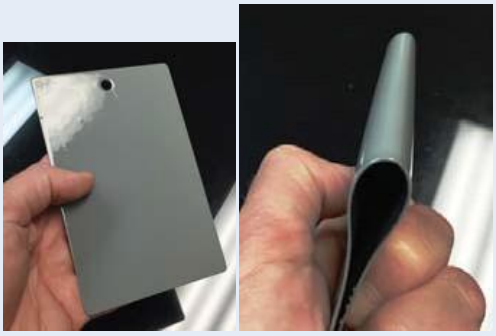
NANO-CLEAR® - A NEW & BETTER OPTION

Nano-Clear® is a unique technology that uses proprietary 3D nano-structured polymers with extreme crosslink (xxLink™) density.

Nano-Clear® Dramatically Improves Resistance To:

- ✓ **Erosion**
- ✓ **Weathering**
- ✓ **Abrasion**
- ✓ **Scratching**
- ✓ **Chipping**
- ✓ **Marring**
- ✓ **Chemical Attack**
- ✓ **UV Degradation**

AMAZING FLEXIBILITY!



Before / After

- ✓ *Nano-Clear® has both remarkably high surface hardness and flexibility.*
- ✓ *Steel panel coated with Nano-Clear®, bends in-half without cracking or any other failure to the coating.*

Client Testimonial 1

MarAd Fleet

BEFORE Application of Nano-Clear®

AFTER Application of Nano-Clear®

Note: *Original colour and gloss was restored with Nano-Clear®. Fiberglass lifeboats were* ***not*** *repainted.*

"The results are stunning. I have a meticulous bosun who rolled and back brushed the product onto the boat, and despite having far from ideal circumstances (outdoors, wind, dust) the improvement to my lifeboats is remarkable."

Master/Chief Mate - MarAd Fleet

Client Testimonial 2

Metrolinx / GO Transit

After a demanding 3 year field evaluation, the contrasting images below of the entire front fiberglass sections (including light & accessory panels) of these buses clearly demonstrate the extreme protective capabilities of **Nano-Clear® (NCI)**.

✗ (8304) Conventional Clearcoat

✓ (8305) **Nano-Clear®**

METROLINX

NCI = Reduction of Damage

82%

NCI = Reduction of Product Costs

33+%

According to Metrolinx Engineering,

"*As shown above, 2 layers of Nano-Clear® has outperformed 6 layers of the (current) stone guard ... As Nano-Clear® has significantly reduced the number of stone chips to the front bumper, and has proven to be a more resilient stone guard, Engineering recommends that future bus deliveries, and buses that go out for refurbishment have the NCI stone guard applied.*"

Michael Battiston, Equipment Engineering Officer
GO Transit - Metrolink

A comprehensive System Evaluation Report from Metrolinx Engineering is available upon request.

INDUSTRIAL USERS OF NANO-CLEAR®

- Royal Caribbean International
- Carnival
- General Dynamics Land Systems
- Sterling Crane
- Celebrity Cruises
- CASE Construction
- Holland America Line
- PEMEX
- Chevron

INDUSTRY RECOGNITION

Nano-Clear® has been recognized for its innovative engineering by:

- **NACE MP 2019 / 2020 Corrosion Innovation of the Year Award**
  NACE (the National Association of Corrosion Engineers) sets the standards for surface preparation, coating selection, coating application, painting contractor certification, and testing.
- **Frost & Sullivan Technology Leadership Award 2020**
  Frost & Sullivan is the premiere business consulting firm to the Paints and Coatings Industry.
- **PaintSquare Prestige Award 2020 (Top Product: Coatings for Steel)**
  PaintSquare is the premier industry publication to the Paints & Coatings Industry.

To arrange a Nano-Clear® application demonstration, contact Assero at:

+1.888.588.6986
or
info@assero.co

ASSERO COATING TECHNOLOGIES

Assero Coating Technologies delivers Exceptional Surface Protection™ which extends the useful service life of valuable assets that operate in harsh environments. Assero is built around an ethos of delivering eco-innovative / eco-responsible, sustainable, green chemistry solutions with a line of Protective Clearcoats that reduce damage to the environment.

Nano-Clear®

Nano-Clear® Third Party Test Results

Chemistry: 3D Nano-Structured Polyurethane / Polyurea Hybrid

High Cross-Link
3D® Molecules Inside™

TABLE 1

	TEST METHOD DETAILS			
	PRIMARY SPECIFICATIONS	**TEST STANDARD**	**RESULTS**	
1	VOC	ASTM D3960	1.25 lb / gal / ~150 g/l	1
2	Recommended Dry Film Thickness *(DFT)*	ASTM D5796	1.0 mil - 2.5 mils (/ 50.4µm to 63.5µm)	2
3	Coverage: *1 US Gal / 3.8 Ltr.*	Nanovere Inhouse	1,122ft² @1.0 mil	3
4	Specular Gloss: *@ 20° / 60°*	ASTM D523	86.0 / 92.2	4
	IN SERVICE PHYSICAL DAMAGE RESISTANCE	**TEST STANDARD**	**RESULTS**	
5	Abrasion Resistance by Taber: *CS-17, 1 kg, 1,000 cycles*	ASTM D4060	8.4 mg loss	5
6	Coating Hardness by Pencil Test: *Scratch*	ASTM D3363	4H	6
7	Coating Hardness by Pencil Test: *Scratch*	SASO 2833	2500 gm	7
8	Coating Hardness by Pencil Test: *Gouge*	ASTM D3363	5H	8
9	Coating Hardness by Pendulum Damping: *Persoz*	ASTM D4366	> 250 oscillations	9
10	Coating Rapid Deformation by Impact: *18°C Direct in./lbs.*	ASTM D2794	50 Pass / 60 Fail	10
11	Coating Rapid Deformation by Impact: *18°C Reverse in./lbs.*	ASTM D2794	10 Pass / 20 Fail	11
12	*Coating Rapid Deformation: Impact Strength*	ASTM D2794	145 kg - cm	12
13	Impact Resistance: *Single or Multi-coat Systems*	SASO ISO 3248	1kg-160cm	13
14	Chip Resistance of Coatings: *23°C / 73.4°F @ 2.0 mils DFT*	ASTM D3170	7A	14
15	Chip Resistance of Coatings: *-29°C / -9.4°F @ 2.0 mils DFT*	ASTM D3170	7B	15
16	Abrasion Resistance by Falling Abrasion: *100 liters*	ASTM D968	Pass	16
17	Mar Resistance of Organic Coatings	ASTM D5178	5.0 kg	17
18	Flexibility - Conical Mandrel Bend	ATSM D522	1/4" Pass	18
19	Flexibility - Cylindrical Mandrel Bend	ASTM D522	Zero (0) - T	19
	ENVIRONMENTAL RESISTANCE	**TEST STANDARD**	**RESULTS**	
20	Controlled Xenon Arc-Lamp-Exposure Resistance: *4,000 hrs*	SAE J1960 ASTM G155	100% Gloss Retention 99% Gloss Retention	20
21	Fluorescent UV-Condensation Exposure: QUV 313 > 1,500 hrs	ASTM D4587	100% Gloss Retention	21
22	Water Immersion Resistance: *240 hrs @ 50°C / 122°F*	ISO 2812-2	Pass	22
23	Humidity Testing: @ 100% RH, 100°F / 37.8°C - 240 hrs	ASTM D1735-02	No loss of adhesion - No change	23
24	Corrosion Resistance: *PASS 240 hrs @ 50°C / 122°F*	JIS H8502	Pass	24
25	Salt Spray Fog: *6,360 hrs*	ASTM B117 / 2018	No corrosion points - Approved	25
26	Thermal Shock Test for Adhesion: *Heat: @ 100°F / 37.8°C for 3 hrs, Freeze for 3 hrs, Steam Blast for 30 Sec*	GM9525P	No loss of adhesion - No Change	26
	CHEMICAL RESISTANCE	**TEST STANDARD**	**RESULTS**	
27	Effect of Household Chemicals on Clear & Pigmented Coatings: *10% Sulfuric Acid*	ASTM D 1308	No effect	27
28	Effect of Household Chemicals on Clear & Pigmented Coatings: *10% Hydrochloric Acid*	ASTM D 1308	No effect	28
29	Effect of Household Chemicals on Clear & Pigmented Coatings: *10% Sodium Hydroxide*	ASTM D 1308	No effect	29
30	Effect of Household Chemicals on Clear & Pigmented Coatings: *10% Ammonium Hydroxide*	ASTM D 1308	No effect	30
31	Effect of Household Chemicals on Clear & Pigmented Coatings: *Isopropyl Alcohol*	ASTM D 1308	No effect	31
32	Effect of Household Chemicals on Clear & Pigmented Coatings: *Xylene*	ASTM D 1308	No effect	32
33	Immersion Testing of Industrial Protective Coatings: *Skydrol® 500Fluid*	ASTM D6943-A	No effect	33
34	Measuring MEK Resistance by Solvent Rubs: *1,500 Double Rubs*	ASTM D4752	No effect	34
	FIRE RESISTANCE	**TEST STANDARD**	**RESULTS**	
35	Fire Resistance Testing of Building Materials	ASTM E84 / BS476	Class1(Excellent)	35

TABLE 2

DMA (Dynamic Mechanical Analysis)

	SAMPLE PANEL TESTED	E' @ 23ºC/73.4ºF MPA	XLD (Kmols/cc)	Tg (ºC)	
36	Nano-Clear® (NCI)	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)

	SAMPLE PANEL TESTED	YOUNG'S MODULUS MPa	YIELD STRAIN %	YIELD STRESS MPa	STRESS @ BREAK %	STRAIN @ BREAK %	TOUGHNESS MPa	
37	Nano-Clear® (NCI)	1506	4.59	51.6	52.7	52.4	5.09	
38	95% *CI +/-	35	0.14	1.6	1.3	1.5	0.59	*Confidence Intervals based on 5 tests of this sample

Q. What is ***DMA***?
A. ***Dynamic Mechanical Analysis*** is performed by a *Dynamic Mechanical Analyzer.*

Q. What does a ***DMA*** do?
A. ***DMA*** measures the mechanical/rheological (crosslink density; XLD) properties of a material as a function of time, frequency, temperature, stress, and strain.
NOTE: The *Dynamic Mechanical Analyzer* used for **Table 2** tests, was a ***TA Instrument Q800*** unit.

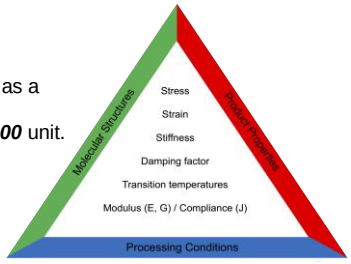


TABLE 3

TEST METHOD DETAILS	TEST STANDARD
The Japanese Industrial Standard is a quantitative antimicrobial surface test method that tests for antimicrobial activity and efficacy	non-GLP Modified JIS Z 2801Study

	Test Microorganism	Contact Time	Test Substrate	Replicate	CFU/Carrier	Average CFU/Carrier	Percent (%) Reduction Compared to 24 Hour Control	Log10 Reduction Compared to 24 Hour Control
39	*E. coli* ATCC 8739	Time Zero	Control Glass Substrate	1	3.30E+05	2.80E+05	N/A	N/A
				2	2.60E+05			
				3	2.50E+05			
40		24 Hours	Control Glass Substrate	1	3.70E+05	3.97+05	N/A	N/A
				2	3.80E+05			
				3	4.40E+05			
41	*S. aureus* ATCC 6538		Nano-Clear® NCI 4.0	1	1.63E+02	4.87E+02	99.9993%	5.59
				2	1.48E+02			
				3	1.15E+03			
42			Nano-Clear® NCI 5.0	1	3.03E+01	1.53E+01	99.99998%	6.87
				2	6.00E+00			
				3	9.50E+00			

TABLE 4

ANTI-ICE SCREENING

TEST SAMPLE INFO	T-PANEL (4" X 12") SUBSTRATE	NUMBER OF PANELS TESTED	SCOPE OF TESTING
Control	Aluminum	2	Contact angle - ice de-bond (shedding)
NCI +NCFP@5%	Aluminum	1	Contact angle - ice de-bond (shedding)
VX-SC	Aluminum	1	Contact angle - ice de-bond (shedding)
VX+SC+5% Fluoropolymer	Aluminum	2	Contact angle - ice de-bond (shedding)
NCI+NCIM@30%+NCFP@5%	Aluminum	2	Contact angle - ice de-bond (shedding)

ICE / FROST BUILD TESTING

1. Test sample panels were attached to the evap-cooler's fins along with thermo-couplers.
2. Freezer door propped open by .5" for an 1 hour.
3. Two pans of 40ºC tap water (500 grams) was added and the freezer door was then closed shut.
4. The closed freezer was run for 16 hours and monitored using a picolog with thermocouplers and a computer.
5. After 16 hours of run time the amount of ice/frost generated on the test panels was evaluated.

CONTACT ANGLE TEST RESULTS

	TEST SERIES 1	TEST SAMPLE INFO	CONTACT ANGLE
43		Control	43.12°
44		NCI +NCFP@5%	102.41°
45		VX-SC	103.15°
46		VX+SC+5% Fluoropolymer	98.535°
47		NCI+NCIM@30%+NCFP@5%	101.07°

ICE DE-BOND (SHEDDING) TEST RESULTS

	TEST SERIES 2	TEST SAMPLE INFO	ICE DE-BOND (SHEDDING) TIME IN SECONDS
48		Control	58s
49		NCI +NCFP@5%	32s
50		VX-SC	49s
51		VX+SC+5% Fluoropolymer	47s
52		NCI+NCIM@30%+NCFP@5%	40.5s

TABLE 5

SCRATCH TESTING PARAMETERS - ASTM D7027

SCRATCH MODE	MAX. LOAD (N)	SCRATCH LENGTH (MM)	SCRATCH SPEED (mm/sec)	LOADING RATE (N/min)	PRE/POST SCAN LOAD (N)	SCRATCH TRACKS PER SAMPLE	SCRATCH TIP TYPE	TIP MATERIAL	SCRATCH TIP RADIUS (µM)
Progressive	100	2	2	200	1	3	Sphero-conical	Diamond	20

TEST REQUIREMENTS

1. Room temperature micro-scratch experiment using a micro-scratch technique.
2. The goal is to study and compare coating adhesion, strength / scratch resistance of the coatings through progressive scratch tests.
3. The testing procedures follow a modified ASTM D7027 standard to scratch polymeric thin coatings with a diamond tip.

SYSTEM EMPLOYED FOR TESTING

1. An Anton Parr Revtest (Macro) Scratch System.
2. The system was calibrated on 04/30/2021.
3. A 100 µm radius diamond spherical tip was employed for the scratch measurements.
4. The system and the scratch tip were validated on a **TiN** reference sample before the experiments were conducted on the Assero supplied samples conducted as a blind test **(X vs Y)**

	COMPARISON OF CRITICAL LOADS OF FAILURE ROOM TEMPERATURE			LC1	OPTIC
	TEST 1 SAMPLES			DATA 1	DATA 2	STD DEV
53	X*	38.393	38.032	37.962	38.129	0.231
54	Y**	43.622	42.386	45.551	43.853	1.595

NOTE: X* (submitted sample) Nano-Clear® Gel-coated fiberglass *unsanded* pre-application

	COMPARISON OF CRITICAL LOADS OF FAILURE HEATED 8 HOURS @ 50ºC-COOLED OVERNIGHT				LC1	OPTIC
	TEST 2 SAMPLES	DATA 1	DATA 2	DATA 3	MEAN	STD DEV
55	X*	38.486	32.869	35.433	35.929	3.336
56	Y**	1.294	1.338	1.963	1.532	0.374

**Y (submitted sample) BASF DC92 *sanded* Gel-coated fibreglass pre-application

Why Micro-Scratch Testing?

"Data from the nano-scratch test also proved best for determining how well the coating responded to physical assault based on its crosslink density, the measure of how tightly the polymer components are bound together," *Sung said.

"With this molecular-level understanding, clearcoat formulas can be improved so that they yield materials dense enough to be scratch resistant and resilient but not so hard that they cannot be worked with easily."

"The researchers concluded that to get the truest evaluation of clearcoat performance, the nano-, micro- and macro-scratch tests should be conducted in conjunction with the current industry standard methods." ***Li-Piin Sung *NIST* research Physicist**

NCI SuperCARC™

TABLE 6

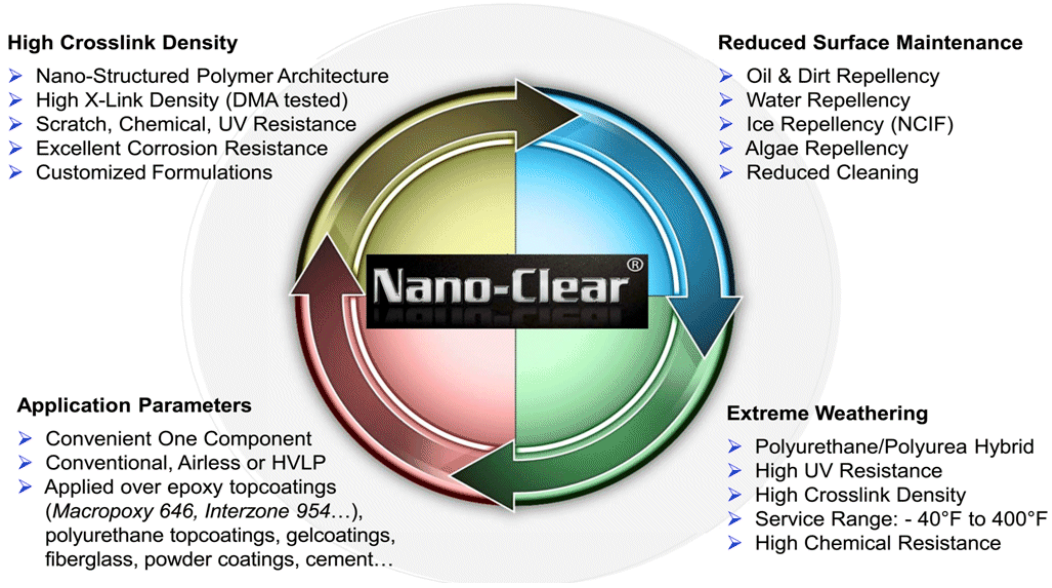
	TEST METHOD DETAILS			
	OPTICAL PROPERTIES	**TEST STANDARD**	**CONVENTIONAL CARC RESULTS**	**NCI SuperCARC (NCI +MAT) RESULTS**
57	Specular Gloss: *@ 20º - 60º - 85*	ASTM D534	0.7 - 3.6 - 7.4	0.6 - 1.3 - 7.8
58	Calculating color differences from instrumentally color measured color coordinates: *L-, a-, b-*	ASTM D2244	66.66 - 6.02 - 20.71	66.66 - 6.02 - 20.71
59	Measurement of spectral absorptance, reflectance, and transmittance: *IR signature*	ASTM E-903	PASS	PASS
	PHYSICAL PROPERTIES	**TEST STANDARD**	**CONVENTIONAL CARC RESULTS**	**NCI SuperCARC (NCI +MAT) RESULTS**
60	Rating Adhesion by Tape Test	ASTM D3359	5B	5B
61	Rating Film Hardness by Pencil Test	ASTM D3363	2B	>6H
	CHEMICAL AND PHYSICAL DAMAGE RESISTANCE	**TEST STANDARD**	**CONVENTIONAL CARC RESULTS**	**NCI SuperCARC (NCI +MAT) RESULTS**
62	Acid Spot Resistance	MIL-DTL-53039E Sec 4.6.24	No Effect	No Effect
	MEK Resistance	ASTM D4752		
63	Double rubs to substrate		>200	>1,500
64	Double rubs to start of coating Dissolution		20	>1,500
	Water Immersion Testing:	MIL-DTL-53039 Sec 4.6.24		
65	Visual Observation		No Effect	No Effect
66	Pencil Hardness		4B	>6H
67	Adhesion		5B	5B

INTRODUCING A NEW APPROACH TO CARC

"The effectiveness of US military forces is highly dependent on the readiness (and safety) of the equipment and vehicles they use. Spray-applied coatings are used for many types of equipment, components and vehicles including aircraft, ground vehicles, water-borne vessels and ordnance. Improved.....quality therefore results in reduced cost and readiness."
Lea Ann Schellhorn, Iowa Waste Reduction Center, Cedar Fall - Spray Technique Analysis and Research for Defense (STAR4D)

STAR4D Est. 2003

Multi-Functional Nanocoatings with Remarkable Properties



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Assero On Top™ NCI
3D-9™ Technologies
Engineered For Sustainability
LOW Volatile Organic Compounds (VOCs) contribute to atmospheric pollution.