



December 19, 2006

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We have completed 4,000 hour weatherometer (WOM) testing of your Vecdor clearcoat. It was compared to PPG's CeramiClear product and an OEM clearcoat from DuPont. In all categories tested, the Vecdor product performed better than or equivalent to the PPG and DuPont products. Vecdor performed exceptionally well after 4,000 hours of WOM exposure. Refer to Table 3 for detailed test results.

Table 1 details the clearcoats that were tested along with their physical properties. All tests were performed on the Vecdor and PPG clearcoats (A & B) and some additional tests were performed on the DuPont OEM clearcoat (C).

**Table 1: Clearcoats**

<b>Sample</b>	<b>A</b>	<b>B</b>	<b>C</b>
<b>Clearcoat</b>	<b>Vecdor</b>	<b>D8126/D8226 CeramiClear</b>	<b>Acrylic Silane</b>
<b>Manufacturer</b>	<b>Nanovere Technologies</b>	<b>PPG Industries</b>	<b>DuPont</b>
% Non-Volatile (Weight)	62%	---	
% Non-Volatile (Volume)	---	49.8%	
Volatile Organic Content less Exempts	Solvents are VOC Exempt	2.01 lbs/gal	
Mix Ratio (by Volume)	1 : 1	2 : 1	
Potlife @ 68 °F / 20 °F	1 hour	1 hour	
Recommended Dry Film Thickness	2 - 3 mils	2 - 2.5 mils	
<u>Dry Times:</u>			
Dust-Free @ 68-72 °F	30 minutes	30 minutes	
Dry-to-Handle @ 68-72 °F	4 hours	4 hours	
Dry-to-Handle @ 150 °F	30 minutes	30 minutes	

Clearcoats A and B were mixed according to their directions and applied to coated steel panels, within 15 minutes of mixing, using wire wound applicator method. They were allowed to flash off for 3 – 5 minutes prior to baking for 30 minutes at 150°F. They were aged for 24 hours under ambient conditions prior to testing. Total clearcoat thickness for both clearcoats was 1.9 – 2.1 mils. Table 2 details the test panels that were prepared.

**Table 2: Test Panels**

<b>Panel ID</b>	<b>A</b>	<b>B</b>	<b>C</b>
Clearcoat	Vecdor	D8126/D8226 CeramiClear	RK8010A DuPont
Basecoat Code	542AC301 White	542AC301 White	542AC301 White
Primer	None	None	None
E-Coat	ED6060	ED6060	ED6060
Pretreatment	B952 P60 DIW: Unpolish	B952 P60 DIW: Unpolish	B952 P60 DIW: Unpolish
Substrate	Cold Rolled Steel	Cold Rolled Steel	Cold Rolled Steel
ACT Labs Product ID No.	APR45582	APR45582	APR44364

Panels were tested for appearance, mechanical and durability properties similar to those required of BMW. Descriptions of test methods can be found at the end of this report.

The Vecdor clearcoat showed superior cold temperature chip resistance, direct and reverse impact resistance compared to the CeramiClear and OEM clearcoats. It showed slightly more haze than the CeramiClear product. Both Vecdor and CeramiClear showed no breakthrough of clearcoat after exposure to 100 liters of sand via the Falling Sand Abrasion Test. The OEM clearcoat failed after 100 liters.

The initial 20° gloss of the OEM clearcoat was slightly higher than the other clearcoats, but the Vecdor clearcoat (A) showed the best gloss retention (100%) after 4,000 hours of WOM exposure. It had similar color change than the DuPont OEM and PPG CeramiClear clearcoats. The CeramiClear showed better gloss retention than the control with little color change. Table 3 details the test results.

Please call me should you have questions or comments at (810)750-0040. Thank you for the opportunity to perform the above work for Nanovere Technologies, Inc.

We look forward to working with you in the future.

Sincerely,  
*Debora L. Hense*  
 Consultant

**Table 3: Detailed Test Results**

Sample	A	B	C
<b>Clearcoat</b>	<b>Vecdor</b>	<b>CeramiClear</b>	<b>Acrylic Silane</b>
<b>Manufacturer</b>	<b>Nanovere</b>	<b>PPG</b>	<b>DuPont</b>
<b>Cure Schedule</b>	<b>30' @ 150°F</b>	<b>30' @ 150°F</b>	<b>OEM</b>
<b>Clearcoat DFT (mils)</b>	<b>2.0 +/- 0.1</b>	<b>2.0 +/- 0.1</b>	<b>2.0 +/- 0.1</b>
<u>Scrape Adhesion per ASTM D2197</u>			
Scratch	0.25 Kg	0.10 Kg	
Gouge	> 11 Kg	> 11 Kg	
<u>Chip Resistance Per ASTM D3170 *</u>			
Room Temperature (23°C)	7A	6A	6A
Cold Temperature (-29°C)	7B	5B	5B
<u>Falling Sand Abrasion per ASTM D968 (100 Liters)</u>			
	Pass	Pass	Fail
<u>Impact Resistance per ASTM D2794 at -18°C</u>			
Direct (inch-pounds)	50P / 60F	30P / 40F	40 P / 50F
Reverse (inch-pounds)	20F / 10P	5F	5F
<u>Humidity Resistance per ASTM D4585</u>			
500 Hours - Blistering per ASTM D714	No Effect	No Effect	No Effect
500 Hours - Appearance	No Effect	No Effect	No Effect
<u>Transmission &amp; Haze per ASTM D1003</u>			
Haze (%)	1.29	1.09	
Total Luminous Transmittance (%)	89.18	89.91	
Diffuse Transmittance (%)	1.15	0.98	
<u>WOM Resistance per SAE J1960</u>			
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	<b>100%</b>	<b>95%</b>	<b>92%</b>
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	

## **DESCRIPTION OF TEST METHODS**

*Chip Resistance* – Per ASTM D3170. This method covers the determination of the resistance of coatings to chipping damage by stones or other flying objects. One pint of standardized road gravel (~ 1/2” diameter) was projected by means of controlled air blast (70 +/- 5 psi) at the panels. One set was tested under ambient conditions and another set tested at -29°C +/- 2°C. After gravel blast, tape is applied and removed from the surfaces. The panels are rated using visual standards in the test method. They are summarized below:

<u>Rating</u>	<u>No. of Chips</u>	<u>Chip Size</u>
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	

*Delta E ( $\Delta E$ )* – Per SAE J1545. This method measures the color of the exposed samples and the color of the unexposed samples and calculates a color difference ( $\Delta E$ ) by the square root of the sum of the squares of the delta L\*, a\* and b\* values obtained from the color measurements.

*Falling Sand Abrasion* – Per ASTM D968 Method A. This method covers the determination of the resistance of organic coatings to abrasion produced by abrasive sand falling onto coatings applied to a plane, rigid surface. A specified amount of sand was allowed to fall from a specified height through a guide tube onto the panels until a minimum of 4mm area of clearcoat was removed. This is the end point.

*Gloss* – Per ASTM D523. This method covers the measurement of specular gloss of non-metallic specimens for glossmeter geometries 20°, 60° and 85°.

*Humidity Resistance* – Exposure per ASTM D4585. This practice covers basic principles and operating procedures for testing water resistance of coatings using controlled condensation. A vapor temperature of 60oC was maintained for the duration of testing. Immediately upon removal from the humidity chamber, the panels were observed for defects including blisters, blushing, color change, rust, water spots, etc. If no defects were observed, the panels were rated as PASS.

*Impact Resistance* – Per ASTM D2794. This method covers a procedure for rapidly deforming by impact a coating film and its substrate. A standard weight is dropped a distance so as to strike an indenter that deforms the coating and the substrate. The indentation can be either an intrusion (direct impact) or extrusion (reverse impact). Films generally fail by cracking. The results are reported as the maximum number of inch-pounds of force applied to the coating and substrate at which the coating does not crack (P for pass) or when the coating cracks (F for fail).

*Scrape Adhesion* – Per ASTM D2197. This method covers the determination of the adhesion of organic coatings when applied to smooth, flat (planar) panel surfaces. The adhesion is determined by pushing the panels beneath a rounded stylus or loop that is loaded in increasing amounts until the coating is removed from the substrate surface. Two measurements were recorded, the first the load at which marring of the surface was observed, and the second the load at which the clearcoat was removed by the stylus.

*Transmission & Haze* – Per ASTM D1003. This method covers the evaluation of specific light-transmitting and wide-angle-light-scattering properties of the planar sections of materials. The clearcoats were drawn down over glass panels, cured and measured.

*Weatherometer Resistance* – Exposure per SAE J1960. This method covers the practices and procedures for the simulated weathering of coated panels.