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Cerakote™

CERAMIC HIGH TEMP COATINGS

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CERAKOTE™ Exhaust Coatings

The unique, ceramic-based formulation used in the entire line of Cerakote™ exhaust coatings enhances a number of physical characteristics. Cerakote™ exhaust coatings are durable, heat-resistant coatings with excellent long-term performance. Additionally, Cerakote™ ceramic exhaust coatings function as thermal barriers for thermally-sensitive applications. This report outlines the different high-temperature coatings available from Cerakote™ and discusses the properties inherent to each. The thermal barrier capability and chemical resistance of each coating was also studied, and the results of this study are published in this paper.

Background

Unlike other "ceramic" coatings, Cerakote™ is formulated from the molecular level. All Cerakote™ products begin with a liquid resin, and during the cure process, the resin forms a 3-D ceramic matrix. Additional property-enhancing materials are combined with the raw resin and trapped within the matrix. This technology creates a durable, heat resistant coating and makes Cerakote™ the premier exhaust coating available on the market today.

Cerakote™ offers four different types of high-temperature products. An outline of each of these coatings is shown below in table 1. As shown, Cerakote™ exhaust coatings are available in both ambient-cure and oven-cure systems. Each of the coatings may be used over a number of different substrates, including steel and aluminum. MC-Series is also commonly used over chrome plating, PVD surfaces, and some types of powder coating for additional protection and to prevent "rain-bowing" due to excessive heat. The average coating thickness ranges from 0.50-1.0 mil and can be used in areas of low tolerance. These coatings are also VOC-exempt in all 50 states and in the South Coast region of California.

Table 1. Characteristics of different high-temperature Cerakote™ exhaust coatings.

Type of Cerakote™	Cure Schedule	General Appearance
C-Series	Ambient cure; Dry to touch; 45 min	Various Satin Colors
MC-Series	Ambient Cure; Dry-to-touch; 45 min	Clear
W-Series	500°F, 1 hr	Chrome-like
V-Series	500°F, 1 hr	Various Satin Colors

Thermal Barrier Testing

Four different Cerakote™ products were tested to determine the potential of each as a thermal-barrier coating. These four coatings are shown in table 2 with their respective properties. Each of these coatings were used to coat a 3' long section of pipe. The pipes were manufactured of cold-rolled steel and had an inner diameter of 2". The pipes were cured according to the appropriate cure schedule and then horizontally mounted using 2 clamps spaced 6" from the center of each pipe. Three thermocouples, one in the center, one 3" from the inlet and one 3" from the outlet, were positioned on each pipe. Each thermocouple was held in place using a band clamp. A gas burner was attached to the inlet side of each pipe and the pipes were heated according to the following program:

Start condition: Ambient air at 100 SCFM
Ramp to 572°F in 1 minute, hold for 10 minutes
Ramp to 1112°F in 1 minute, hold for 10 minutes

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Ramp to 1706°F in 1 minute, hold for 10 minutes

The air flow rate was maintained at 100 SCFM for the duration of the test. The inlet gas temperature and the temperatures recorded by the 3 skin thermocouples were also monitored and recorded at 1 second intervals. The results of this test are illustrated in figure 1 and further explained in table 3. At temperatures below 572°F, C-7300 Black Velvet performed the best. Above 572°F V-171 Turbine Coat provided the most thermal protection. At 572°F, using C-7300 Black Velvet as a thermal barrier resulted in a 110°F drop in outer skin temperature. At 1112°F and 1706°F, V-171 Turbine Coat resulted in a 102°F and 185°F drop, respectively. Afterward, the pipes were examined in order to assess any deterioration in the physical or visual properties. C-186, C-7300, and V-171 maintained adhesion of 5B as well as color and gloss. W-207/W-350 showed a slight loss in adhesion and gloss. This can potentially be prevented by coating the inside of the pipe with V-171 turbine coat.

Table 2. Physical properties of four different Cerakote™ coatings tested for thermal barrier properties.

Type of Cerakote™	Adhesion ASTM D3359	Scratch Hardness/Hardness ASTM D3363	Impact ASTM 2794	Mandrel Bend ASTM D522
C-186 Piston Coat	5B	5h/9h	40/20 inch-lbs	4 mm at 180° rotation
C-7300 Black Velvet	5B	6h/7h	40/20 inch-lbs	2 mm at 180° rotation
W-207/W-350 Chromex/ Base Coat	5B	2b/9h	100/40 inch-lbs	0 mm at 180° rotation
V-171 Turbine Coat	4B	4h/5h	60/20 inch-lbs	1 mm at 180° rotation

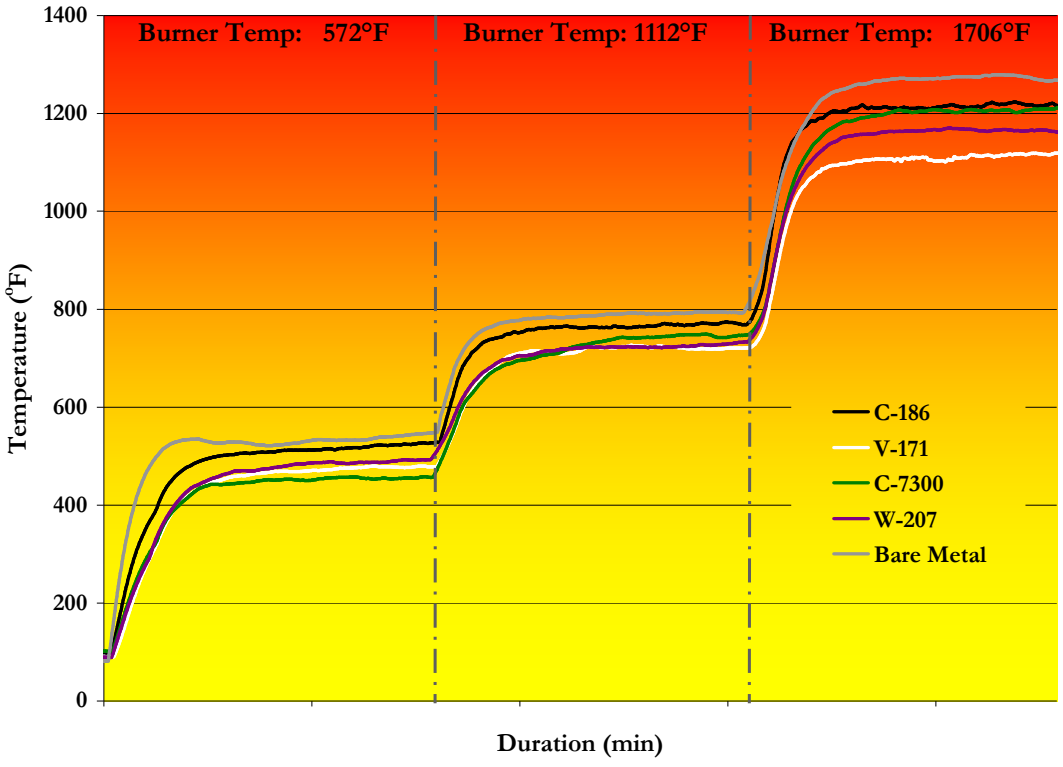

Figure 1. Outer skin temperature profile for 4 pipes coated with Cerakote™ and one uncoated, cold-rolled steel pipe over the temperature range ambient-1706°F.

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Table 3. Temperature difference on outer skin of Cerakote™-coated pipe as compared to bare metal pipe.

Cerakote™	Temperature Drop (°F) At 572°F	Temperature Drop (°F) At 1112°F	Temperature Drop (°F) At 1706°F
C-186 Piston Coat	48	55	81
C-7300 Black Velvet	110	77	91
W-207/W-350 Chromex/ Base Coat	77	90	135
V-171 Turbine Coat	88	102	185

Chemical Resistance

The ability of Cerakote™ exhaust coatings to resist chemical breakdown was tested by dipping coated panels into a series of solvents and allowed to sit for 24 hours. Afterward, the samples were removed, analyzed and assigned a rank depending on the resistance to each specific chemical. The results of this test are shown in table 4. The performance of Cerakote™ C-186, C-7300, and V-171 was classified as excellent for the solvent tests. This indicates that the coating was not affected following a 24-hour immersion in the solvents. CerakoteTM W-207/W-350 performed excellent in 9 of the solvents and performed fair to good in the remaining solvents.

Table 4. Chemical resistance of Cerakote™ C-186, C-7300, W-207/W-350, and V-171 to 13 different solvents

Solvent	Cerakote™ C-186	Cerakote™ C-7300	Cerakote™ W-207/W-350	Cerakote™ V-171
WD-40	★★★★	★★★★	★★★★	★★★★
Motor Oil	★★★★	★★★★	★★★★	★★★★
Lacquer Thinner	★★★★	★★★★	★★★	★★★★
Mineral Spirits	★★★★	★★★★	★★★★	★★★★
Methyl Ethyl Ketone	★★★★	★★★★	★★★	★★★★
Gasoline	★★★★	★★★★	★★★★	★★★★
Diesel	★★★★	★★★★	★★★★	★★★★
Graffiti Remover	★★★★	★★★★	★★	★★★★
Brake Cleaner	★★★★	★★★★	★★★★	★★★★
Denatured Alcohol	★★★★	★★★★	★★★★	★★★★
Paint Stripper	★★★★	★★★★	★★★★	★★★★
Acetone	★★★★	★★★★	★★★★	★★★★
Ammonia	★★★★	★★★★	★★★	★★★★

★★★★ = excellent chemical resistance ★★★ = good chemical resistance
★★ = fair chemical resistance ★ = poor chemical resistance

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