

Introduction

Advancements in camouflage and signature management technologies significantly improved soldier survivability. Signature management technology employed in combat uniforms and tactical vehicle paints, substantially reduced detection by enemy combatants in both day and night operations. While significant improvements have been made to help the warfighter avoid detection, little has been done to reduce the non-firing signatures of individual and crew-served weapon systems, accessories and mounts.

Traditional flat, black surface treatments such as phosphate, anodize, black oxide, and other processes in use today offer no visual, near-infrared, or thermal signature management capability. The lack of these important capabilities leaves warfighters vulnerable to detection thereby placing them at risk during day and night combat operations.



Figure 1. Black surface treatments do not provide either visual or near-IR signature management.

Technology Offering

Recognizing the need to improve weapon system signature management capabilities, NIC Industries, Inc. leveraged its proven civilian Commercial Off-The-Shelf (COTS) ceramic-based firearm coating, marketed under the trade name Cerakote™ and developed a second generation material, known as Cerakote™ Gen II. This next generation coating was developed specifically for military small arms and crew-served weapon applications where a capability is needed to manage the visual and near-infrared signature while at the same time enhancing durability, reliability and maintainability.

In addition to the signature management capability, Cerakote™ Gen II offers superior wear and corrosion resistance under the wide variety of adverse environmental conditions likely to be encountered in all theaters of operation. An added feature of Cerakote™ is that it can be applied to a variety of material substrates. This unique feature allows the coating to be applied to legacy and newly manufactured weapon systems, as well as accessories, and mounts.

Visual Signature

The Cerakote™ GEN II family of coatings offers the user visual signature camouflage that can be manufactured to custom color standards (i.e FedStd, Pantone, etc). For operations conducted during normal daylight hours, signature management is accomplished through the application of an unlimited array of camouflage colors and patterns. Some of these different camouflage options are shown in Figure 2.



Figure 2. A wide range of colors and patterns are available for visual signature management.

Infrared Signature Management

Most weapon systems in use today do not employ non-firing signature management technology. Consequently, soldiers are vulnerable to detection, particularly during combat operations conducted at night. A comparison of two (2) different weapon systems is shown in Figure 3. The upper picture shows a set of M4 carbines, one coated with Cerakote™ GEN II, the other with the standard flat black surface treatment that has been in use for decades. When viewed through GEN III night vision the Cerakote™ GEN II coated weapons, held in the soldier's left hand, mimics the NIR reflectivity of the natural background environment and the soldier's ACU. The standard surface treatment does not provide this capability.



Figure 3. near-Infrared (NIR) signature is managed by emulating the background reflectivity. The weapons on the right are coated with Cerakote™ GEN II.

For night operations weapon signature management is accomplished by the built-in NIR reflective characteristics of the coating. Cerakote™ GEN II which is designed to conform to the NIR reflectivity standards outlined in MIL-DTL-44436. Figure 4

shows the NIR of a standard black surface treatment when compared to the Cerakote™ GEN II coating. The standard surface treatment (lower red line) has a low NIR reflectivity whereas the NIR signature of Cerakote™ GEN II (middle green line) lies within the NIR reflectivity limits as given according to MIL-DTL-44436. This allows the coated object to blend in well with the surrounding background. The n-IR signature of Cerakote™ can also be custom matched to the operator's environment.

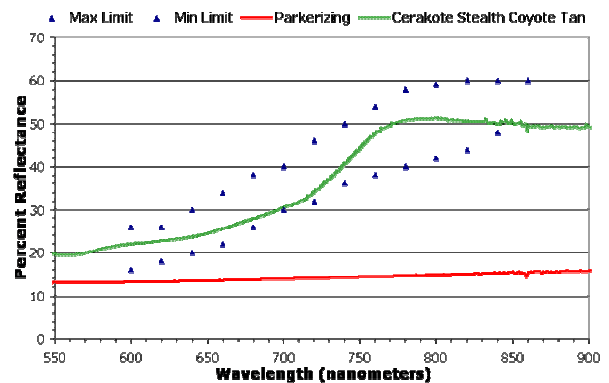


Figure 4. The n-IR signature of Cerakote™ GEN II is designed to mimic the NIR reflectivity of ACUs as outlined in MIL-DTL-44436.

Surface Protection

When compared to traditional surface treatments such as chrome plate, phosphate, anodize, carburize, nitride, bluing, parkerizing, etc, the Cerakote™ has a number of improved capabilities in the areas of corrosion protection, wear resistance, adhesion, and lubricity. Table 1 summarizes the performance characteristics of Cerakote™ using industry-accepted ASTM test protocols.

As can be seen in Figures 6 through 8, Cerakote™ provides superior protection against corrosion, abrasion, and impact. Cerakote™ withstands 3000hrs of continuous exposure to 5% salt spray. Traditional surface treatments typically fail near 96 hours of salt spray exposure (figure 6). The coating is also wear resistant and designed to withstand 5200 Taber Abrasion test cycles for each 0.001 inch of applied thickness. The Cerakote™ family of coatings are flexible, (figure 8) and adhere well to



Reduced Weapons Visual-IR Signature Detection

Liquid Ceramic Coatings for Optimum Performance and Reduced Weapons Signature

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ferrous and non-ferrous metals, as well as non-metals. This material can also be used as a dry-film lubricant by decreasing the coefficient of friction by up to 80% when compared to metal-on-metal interactions. These properties result in decreased system wear and increased service life for the weapon.

Adhesion (ASTM D3359)	5B
Hardness/ Scratch resist (ASTM D33636)	9h/6h
Coefficient of Friction (ASTM G133)	80% less than stainless steel on stainless steel
Corrosion Resistance (ASTM B117)	3000 hrs (see Figure 6)
Wear Resistance (ASTM D4060)	5200 wear cycles per mil (see Figure 7)
Impact Resistance (ASTM 2794)	direct/indirect: 160/160 in-lb (Figure 8)
Mandrel Bend (ASTM 522)	180° rotation; 1/4" mandrel (see Figure 8)

Table 1. Cerakote™ provides outstanding performance over a wide range of test conditions.



Figure 6. Cerakote™ is corrosion resistant and can withstand 3000 hrs of continuous 5% salt spray.

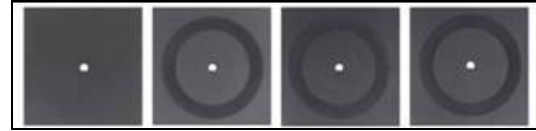


Figure 7. Taber abrasion testing results demonstrate the coating's capability to substantially increase durability.



Figure 8. Unparalleled impact resistance assures increased durability while tight bend radii demonstrate good adhesion properties.

Summary and Conclusion

Cerakote™ is an innovative next generation signature management weapon system coating material that will increase soldier survivability through the management of the weapon system's non-firing visual signature to avoid detection. In addition, longer weapons system service life and lower maintenance costs will be provided by the coating's outstanding wear, abrasion and corrosion resistance. Lastly, environmentally friendly application processes will eliminate the dangerous use of hazardous chemical surface treatments processes that are now used for corrosion protection.