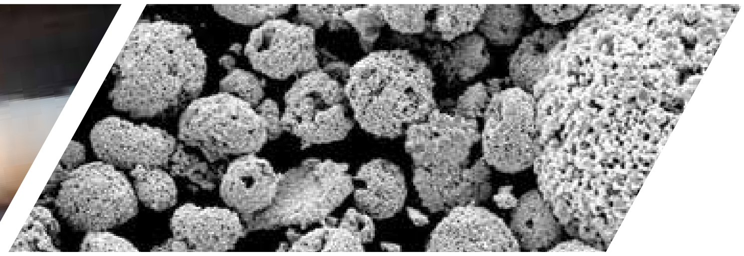
EXTREME COATINGS

Engineered Surfaces



Wear & Corrosion Resistant Coating Solutions for Injection Molding, Compound Mixing & Extrusion Machinery

Single Feedscrews • Twin Feedscrews • Mixing Rotors • Tip Assemblies

Extreme Coatings
Engineered Surfaces

A Global Leader in Thermal Spray Coating Solutions

Extreme Coatings is a global leader providing wear resistant coating solutions which are used for surface engineering in a variety of industries. Since 1996, we have been developing and deploying innovative, superior coating products and services to countries across the globe.

Our team offers an effective, solution-oriented approach which makes use of advanced thermal spray technology and proprietary coating formulations. The exceptional quality of our products has enabled them to become trade standards in the plastics and rubber industry for feedscrews, mixing rotors, tip assemblies and other processing parts.

Successful Solutions, Impressive Results

Extreme Coatings encapsulates complex industrial components, protecting them from wear and corrosion. By increasing wear resistance, service life is increased and performance is dramatically enhanced.

We use state-of-the-art HVOF thermal spray technology to apply wear and corrosion resistant coating formulas to the working surface of any size feedscrew or mixing rotor. Extreme Coatings is a world leader for Tungsten Carbide Coatings on injection molding feedscrews, extrusion feedscrews and compounding mixing rotors in the Plastic and Rubber Industry.

Our focus always remains on our customers' requirements, and is demonstrated by our dedication to the resources for developing effective, successful surface engineering solutions for specific industries and equipment.

Experience & Expertise

Our industry experience has afforded Extreme Coatings the opportunity to service over 25,000 parts, and our technological expertise has equipped us with ability to offer bottom-line solutions like no other company in the industry. Our proprietary technologies yield a finished product that offers greater value than most all other surface engineering solutions on the market.

This competitive advantage significantly lowers our customers' operating costs through extended service life and a reduction in machine downtime. We view each job as unique, and we take pride in offering a service model that is customized to fulfill individual client needs to advance their productivity.

Typical Components Protected to Maximize Value

Plastic & Rubber Industry

- Injection Molding Feedscrews
- Extrusion Feedscrews
- Continuous Mixing Rotors
- Non-Return Valve/Tip Assemblies
- Ultrasonic Horns
- Dies

Other Miscellaneous Items

- Conveyor Augers
- Pump Sleeves
- Hydraulic Shafts
- Heat Exchanger Tubes
- Fans

The Core of Our Solutions – What We Do

Extreme Coatings™ utilizes emerging thermal spray technologies to apply extremely wear and corrosion resistant protective coatings to any size injection molding or extrusion feedscrew. The technology produces crack free coatings with hardness values ranging from 30-70 Rc and thickness' from 005"-.040" (.13 – 1.01mm).

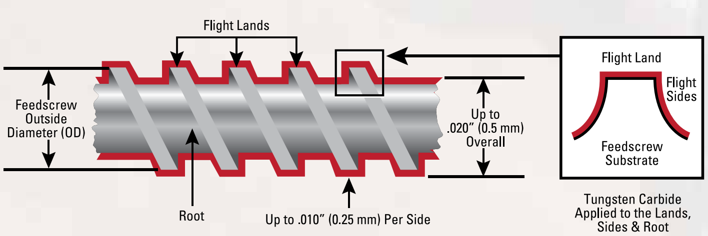
A: Our formulas ***B:*** HVOF thermal spray ***C:*** Extreme layer of protection

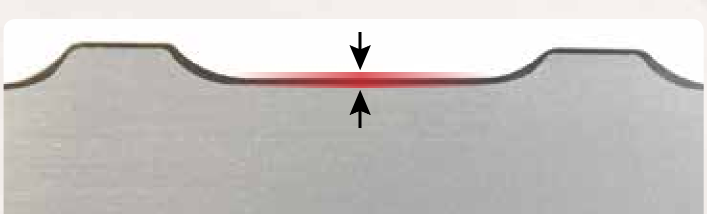
Our various and proprietary compositions of hard carbides, ceramics, and alloys are incorporated to achieve abrasion and corrosion resistant characteristics unmatched by conventional hardfacing alloys. This process completely eliminates the necessity for chrome plating, flame hardening, or nitriding, as the entire screw surface is encapsulated, including the root, flight sides and flight lands.

CarbideX Formula	Alloy Composition	Hardness
C1000	Formulation of Tungsten Carbide, Cobalt Matrix. ***Key Characteristics:*** *Ultimate abrasion resistance with moderate corrosion resistance*	*68-71 HRC
C1000Ni	Formulation of Tungsten Carbide, Nickel Matrix. ***Key Characteristic:*** *Ultimate abrasion and moderate to good corrosion resistance*	*68-71 HRC
C1000Cr	Formulation of Tungsten Carbide, Cobalt, Chrome Matrix. ***Key Characteristic:*** *Ultimate abrasion and good to excellent corrosion resistance*	*69-70 HRC
C4000	Formulation of Carbon, Chromium, Nickel Matrix. ***Key Characteristic:*** *Excellent corrosion and moderate abrasion resistance with high temperature performance*	*55-60 HRC
C9000	Formulation of Tungsten Carbide (micron & nanometer particles), Cobalt Matrix. ***Key Characteristic:*** *Excellent wear resistance and good corrosion resistance specially formulated for fine particle abrasion*	*68-71 HRC

** Hardness converted from Vickers/Knoop*

Full Encapsulation

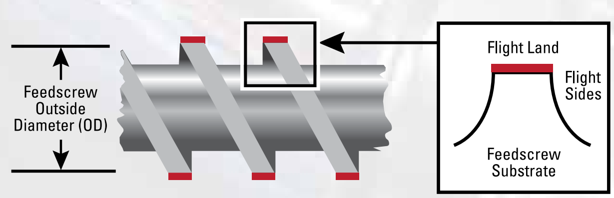




This cut away shows our coating layer uniformity

Other Protection Methods

In applications that do not require wear or corrosion protection in the roots and flight sides, we apply our coating to the flight land /O.D. only. The process involves masking the roots and flight sides to prevent the coating from adhering to those areas.



How We Do It - Our Process

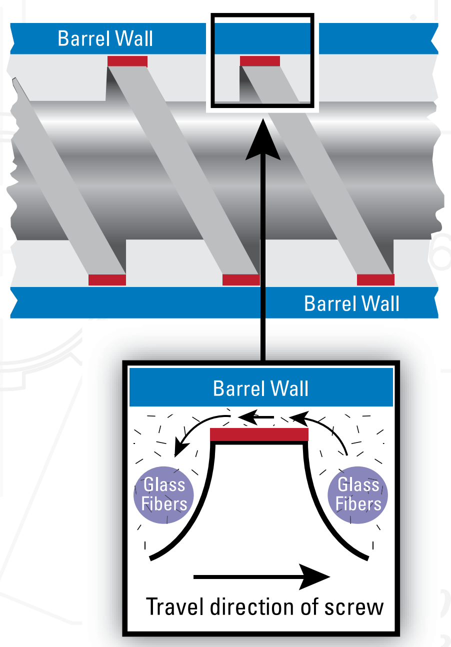
Key Points

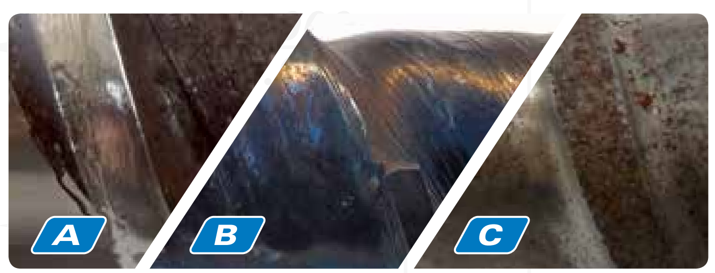
Our process has key elements to obtain the desired specifications and high quality standards:

- 100% QA inspection of received parts to confirm the pre-coating dimensions are correct, tool marks removed, coated area matches drawing, materials of construction, hardness and confirming formula match.
- QC Measurement of parts before and after each step ensures quality throughout the process to meet the desired coating specification.
- Precise control and calculation of the powder formula deposition rate based on the part and solution to reach desired machine part specification (+ 0/-.002" (.05mm).
- Methodical combination of rotation and traverse speed to control heat input and deposition rate of selected coating formulation to minimize internal stresses.
- Post coating heat straightening to meet industry/drawing requirements for TIR.
- Consistent monitoring of the polishing system to ensure product meets QC dimensional data desired to pass final inspection.

The Problem - Why We Do What We Do

A tight tolerance between the feedscrew and barrel of an injection molding machine or extruder is of vital importance to the production efficiency and the quality of the parts produced. An increase in the gap between the barrel and screws as little as .015" (.38mm) can cause excessive scrap and downtime. Additionally, changes (degradation) in the screw roots and flight sides dimension may cause similar problems.





A: Adhesion ***B:*** Abrasion ***C:*** Corrosion

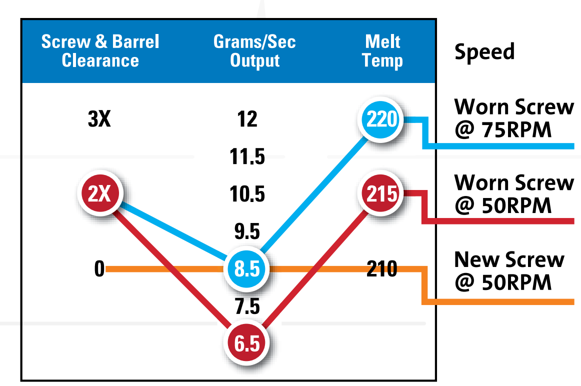
There are three primary modes of wear that cause processing problems in plastic injection molding machines and extruders

1. Adhesive wear (metal to metal) is caused as the feedscrew flight lands contact the barrel I.D.
2. Abrasive wear occurs when hard fillers such as fiberglass, titanium dioxide and calcium carbonate are compressed against the screw flight and barrel surfaces causing material removal.
3. Corrosion wear results from acids and other chemicals which attack the components surfaces. PVC and CPV for example, have gases that can permeate the surface. Corrosive wear is characterized by pitting which increases the coefficient of friction of the surface which may result in polymer sticking and degradation. The pits can also collect, melt, burn or degrade and result in black or burned particles in the parts.

Defining the Problems

Adjusting injection molding or extrusion machines to compensate for screw-barrel wear is common practice. These adjustments lead to excessive shear heat which can degrade sensitive polymers. Polymer residence time and time at temperature are important considerations when producing high tolerance parts. Maintaining a like-new tolerance between screw and barrel ensures that quality melt is produced at a consistent, predictable rate. An example below:

50mm GP Feedscrew Processing PS



- When the OEM tolerance between the screw and barrel is doubled, output decreases by 25% and melt temperature increases.
- To maintain output, screw speed is increased 50% resulting in higher melt temperature.

Results: Increased power consumption, potential for polymer degradation, decreased productivity and a reduction of the bottom line!

Expected Results of Our Solutions

- ***Tight tolerance of close tolerance system maintained***
- ***Cost per pound of kilogram/hour decreases***
- ***Screws last at least two times longer***
- ***Two to four times more production***
- ***Less preventive maintenance (DOWNTIME)***
- ***Barrel life is improved***
- ***Scrap rate decreases***
- ***Output remains consistent***
- ***Cycle times remain consistent***
- ***Polymer integrity maintained***

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Defining the Value

Production Efficiency Advantage Factor

Production efficiency suffers dramatically as the clearance between feedscrew and barrel increases. While sometimes difficult to determine, an estimate of the cost of production loss such as scrap or downtime will highlight the return on an investment in Extreme Coatings Product Solutions.

Quantifying the cost of inefficiency on a per machine, per month basis we define as the Production Efficiency Advantage Factor or PEAF. This value is typically a reduction in screw or barrel expense. Carbide encapsulation can postpone feedscrew wear better than any other technology available today.

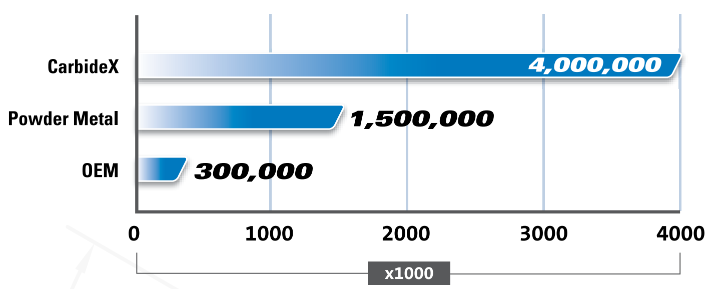
The Extreme Coatings industry specific approach makes our technology valuable through an understanding of the PEAF of a particular process.

PEAF Case Studies

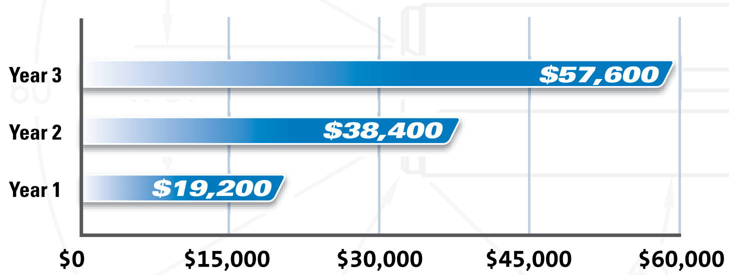
Injection Molding

A precision injection molder with 100 injection presses, 30 of which run glass filled Nylon, PBT and LCP materials, experiences process inconsistency with a small amount of wear. The small screws (25mm) make small precision parts on a fast cycle. Screws are replaced at .008”- .010” (.20 - .25mm) wear as component part quality and cycle time are impacted. CPM-9V tool steel feedscrews provide 1.5 million cycles while the carbide coated screws provide four (4) million cycles.
Annual Preventive Maintenance (P/M) includes feedscrew measurements every six months. Improved reliability and predictable wear from carbide coating has reduced semi-annual P/M’s to every 18 months or two (2) million cycles.

Injection Cycles



Injection P/M Savings



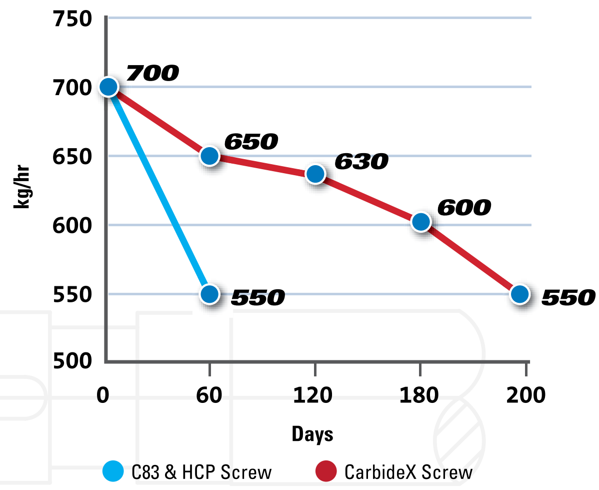
At $60/hr for skilled labor, 8 hrs to P/M a machine and two P/M operations per year this yields $960 in annual maintenance cost per machine. With 30 machines this is over $28,800 per year in direct labor cost that has been reduced to $9600 per 12 months (a $19,200 per 12 months savings). This savings does not include annual recovered machine downtime cost that equates to about 150,000 cycles of saleable product not produced.

Extrusion

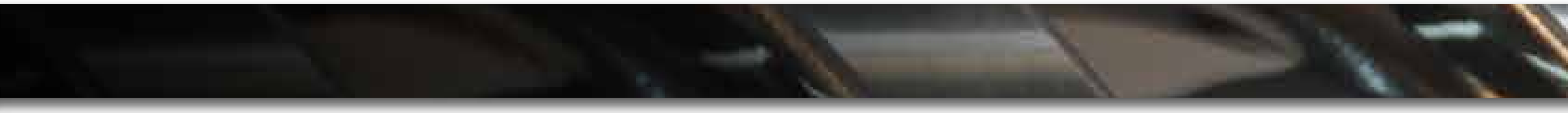
An extruder processing a highly filled (>80%) material repairs or replaces a feedscrew when output rate becomes uneconomical at about .030” (.76mm) of wear. With a hardfaced and chrome plated screw, this much wear occurred in 50-60 days. A tungsten carbide coated feedscrew was installed and processed for 210 days until it reached the same output rate reduction.

The carbide coated screw provided a three-fold increase in service life, however, this coated screw produced more than four times as much product as the previous HF/chrome feedscrew. A solid example of the value that minimizing wear can have on a close-tolerance system. This is a prime example of what we term PEAF!

Productivity Gain from Tungsten Carbide



Minimize Wear • Maximize Profit



Our Value Statements - What You Can Expect

Encapsulating a plastic injection molding or extrusion feedscrew with a wear and corrosion resistant tungsten or chromium carbide coating will reduce your average amortized monthly feedscrew costs by up to 50% regardless of the type of polymer being processed.

The high concentration of extremely hard tungsten or chromium carbides in our coatings provide protection against adhesive and abrasive wear resistance characteristics unmatched by common hardfacing alloys or tool steels. In most cases, you can expect an encapsulated feedscrew to last from two to five times longer than any other feedscrew on the market.

Less Wear = More Production + Constant Quality + Less Down Time + Improved profit

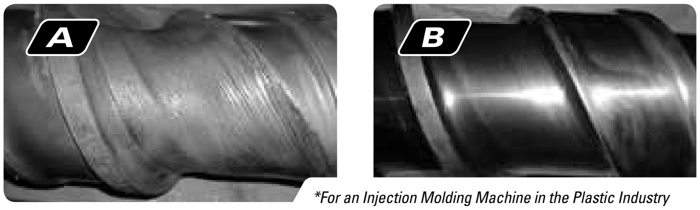
Product Performance – Customer Results

**Product for an Injection Molding Machine in the Plastic Industry*

- A: Is a standard powder metal Feedscrew after 6 months processing highly abrasive ceramic filled polymer.
- B: Is a CarbideX C9000 coated Feedscrew after 12 months in the same process with more life remaining.

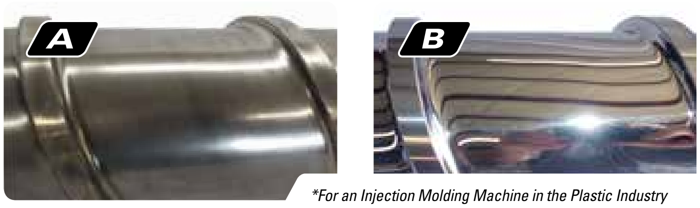
**For an Extruder Machine in the Plastic Industry*

- A: Is a Nitrided Steel Feedscrew processing PVC after 10 Months of processing.
- B: Is a CarbideX -CPR coated Feedscrew after 10 months in the same process with more life remaining.



**For an Injection Molding Machine in the Plastic Industry*

- A: Is a 105mm Feedscrew after 3 months processing 40% GF (Glass Filled) Nylon.
- B: Is a 105mm CarbideX C1000 coated Feedscrew after 10 months processing 40% GF (Glass Filled) Nylon with more life remaining.



**For an Injection Molding Machine in the Plastic Industry*

- A: A CarbideX C4000 coated 150mm Feedscrew that has been in operation 95 months processing CPVC and various materials. Prior to this first coating the customers chrome plated screws lasted only 6 months on this unique application.
- B: Is the refurbished 150mm Feedscrew striped, coated and polished to a <4 RA ui for super value and extended life and performance.

**For a Compounding-Mixing Machine in the Plastic & Rubber Industry*

- A: Is a Chrome Plated (HCP) Mixing Rotor after 12 months processing.
- B: Is the same Mixing Rotor that has been stripped, repaired and coated with CarbideX – CPR then polished to a mirror finish. These parts last 30–36 months on average and can be refurbished multiple times.

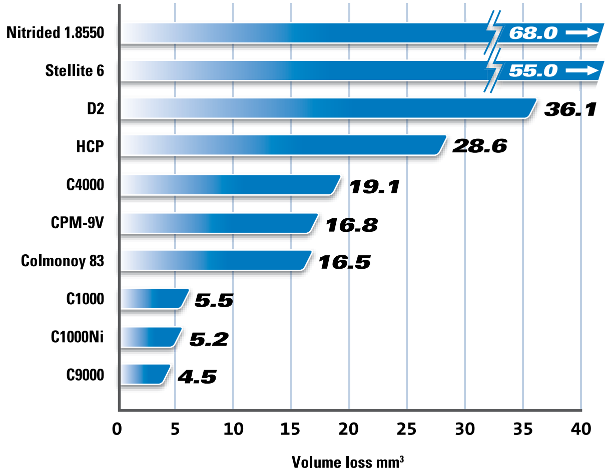
Testing & Validation

ASTM G65 A – Sliding Abrasion Charts

The ASTM G65 test simulates sliding abrasion conditions under moderate pressure, using dry sand metered between a rubber wheel and a block coupon of the material being evaluated. The test allows comparison of wear-resistant materials by their volume loss in cubic millimeters, with materials of higher wear resistance showing lower volume loss.

Test Conditions

Tested for 6000 revolutions at a load of 30 lb. (13.6 kg) using a 9 inch (229mm) diameter rubber wheel and dry sand.



Coating or Alloy	Description /Composistion	HRC Rc	Volume Loss mm3
C9000	Formulation - Nano Tungsten Carbide, Cobalt	68-71	4.5
C1000Ni	Formulation - Tungsten Carbide, Nickel Matrix	68-71	5.2
C1000	Formulation - Tungsten Carbide, Cobalt	68-71	5.5
Colmonoy 83	Ni/Cr/B/WC	48	16.5
CPM-9V	Iron-Chrome-Vanadium-Moly	54-56	16.8
C4000	Formulation - Chrome Carbide, Chromium, Nickel	55-60	19.1
HCP	Hard Chrome Plating	68-72	28.6
D2	Chrome Carbide Tool Steel	58-60	36.1
Stellite 6	Co/Cr/W	40	55
Nitrided 1.8550	Nitrided Nitralloy Steel	70	68

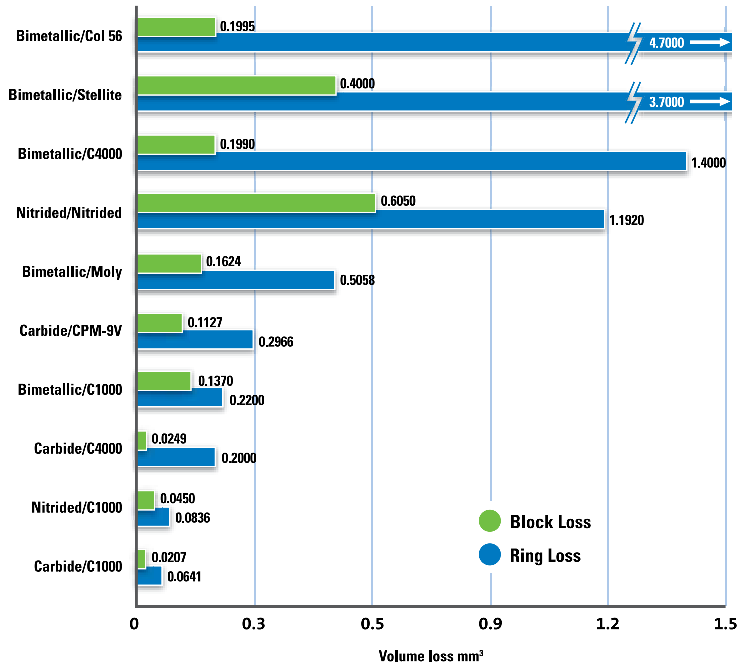
Formulations: Our CarbideX Products

ASTM G77 – Adhesive Wear Test

The ASTM G77 test determines the resistance of materials to metal-to-metal sliding wear. Utilizing a block-on-ring testing machine to rank pairs of materials according to their sliding-wear compatibility characteristics, this test replicates “adhesive, metal-to-metal” wear. Results are reported as volume loss in cubic millimeters for both the block and the ring. Materials of higher wear resistance have lower volume loss. Friction coefficients may also be established during this test.

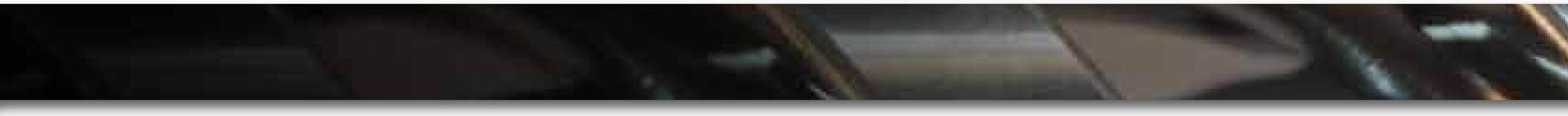
Test Conditions

Tested on 3000 meter slide length. Fixed load and stepped load to COF seizure. Mineral oil lubricant used, 30,000 revolutions, 300 RPM and 300 pounds of force.



Stationary Block	Block Loss	Ring Loss	Rotating Ring
BiMetallic (FeCr)	0.1370	0.2200	C1000
BiMetallic (FeCr)	0.1624	0.5058	Moly
BiMetallic (FeCr)	0.1990	1.4000	C4000
BiMetallic (FeCr)	0.4000	3.7000	Stellite
BiMetallic (FeCr)	0.1995	4.7000	Colmony 56
Carbide (WC)	0.0207	0.0641	C1000
Carbide (WC)	0.0249	0.2000	C4000
Carbide (WC)	0.1127	0.2966	CPM-9V
Nitrided Steel	0.045	0.0836	C1000
Nitrided Steel	0.605	1.192	Nitrided Steel
	Volume loss mm³		

*Note: This test was mainly done to compare a misconception that a hard coated feedscrew (Ring) in contact with a softer barrel liner (Block) will cause premature wear to the barrel. This test clearly shows that our tungsten coatings do not wear a barrel faster than any other alloys commonly used for wear resistance and actually can increase the barrel life.

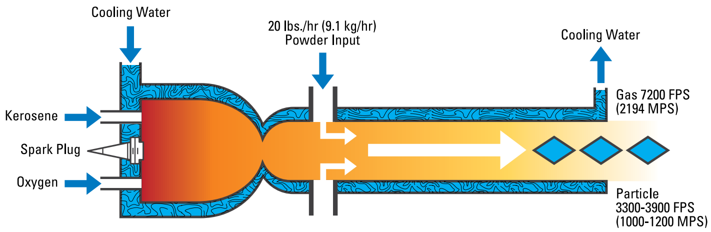


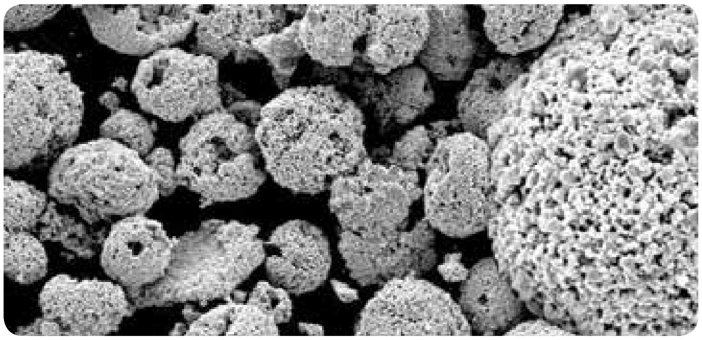
Innovation & Technology

HVOF Thermal Spray Technology

HVOF (High Velocity Oxygen Fuel) thermal spray technology allows us to apply coatings with extremely low porosity and high bond strength. A mixture of fuel and oxygen are combusted within a thermal spray gun producing temperatures near 6000ºF (3300ºC).

Powder particles are injected into the high-pressure gas stream created by the combustion and accelerate down the barrel of the spray gun at several times the speed of sound. At these speeds and temperature conditions, semi-molten particles adhere to the substrate with superior bond strength – exceeding 10,000 PSI. During coating application, the product rotates methodically in front of the HVOF thermal spray gun until the coating builds to the specified thickness. This process creates the strongest bond and highest hardness value as compared to any other thermal spray process.





Other Coating Solutions

Carboride • Niboride • Flame Spray

Coating Formulas for Ultimate Effectiveness

Our coating formulations have been designed for optimal effectiveness with our thermal spray application processes. Our winning CarbideX coating formulations combine tungsten carbide and carefully selected alloys or metals to provide the most economical wear solution available. By producing coating materials from micro and sub-micron raw material we assure high bond strength with uniform conformance to the most-complicated shapes and surfaces. We constantly test new formulations for a growing range of products and applications that result in even greater toughness, consistency and performance enhancement.

The CARBIDEX® Advantage

CarbideX Formula	Alloy Composition	Hardness
C1000	Formulation of Tungsten Carbide, Cobalt Matrix ***Key Characteristics:*** *Ultimate abrasion resistance with moderate corrosion resistance*	68-71 HRC
C1000Ni	Formulation of Tungsten Carbide, Nickel Matrix ***Key Characteristic:*** *Ultimate abrasion and moderate to good corrosion resistance*	68-71 HRC
C1000-17	Formulation of Tungsten Carbide, Cobalt Matrix ***Key Characteristic:*** *Ultimate abrasion and moderate corrosion resistance with ductility*	66-68 HRC
C1000Cr	Formulation of Tungsten Carbide, Cobalt, Chrome Matrix ***Key Characteristic:*** *Ultimate abrasion and good to excellent corrosion resistance*	69-70 HRC
C4000	Formulation of Carbon, Chromium, Nickel Matrix ***Key Characteristic:*** *Excellent corrosion and moderate abrasion resistance with high temperature performance*	55-60 HRC
C5000 (CPR)	Proprietary Formulation of Carbides within a Nickel Chrome Cobalt Matrix ***Key Characteristic:*** *Moderate wear, extreme corrosion, economical*	58-62 HRC
C6000	Proprietary Formulation of Carbides within a Nickel Chrome Cobalt Matrix ***Key Characteristics:*** *Moderate wear, moderate corrosion, very economical*	58-62 HRC
C9000	Formulation of Tungsten Carbide (micron & nanometer particles), Cobalt Matrix ***Key Characteristic:*** *Excellent wear resistance and good corrosion resistance specially formulated for fine particle abrasion*	68-71 HRC

Research & Development

At Extreme Coatings, our mission is to continually research and develop new technologies that benefit our clients in every industry we service. Our goal is to remain the experts in the field of metallurgy and set the bar in engineered surface solutions. Our proprietary coating formulas protect and extend the service life of your most valuable parts, saving you money and impacting your bottom line.

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EXTREME COATINGS
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