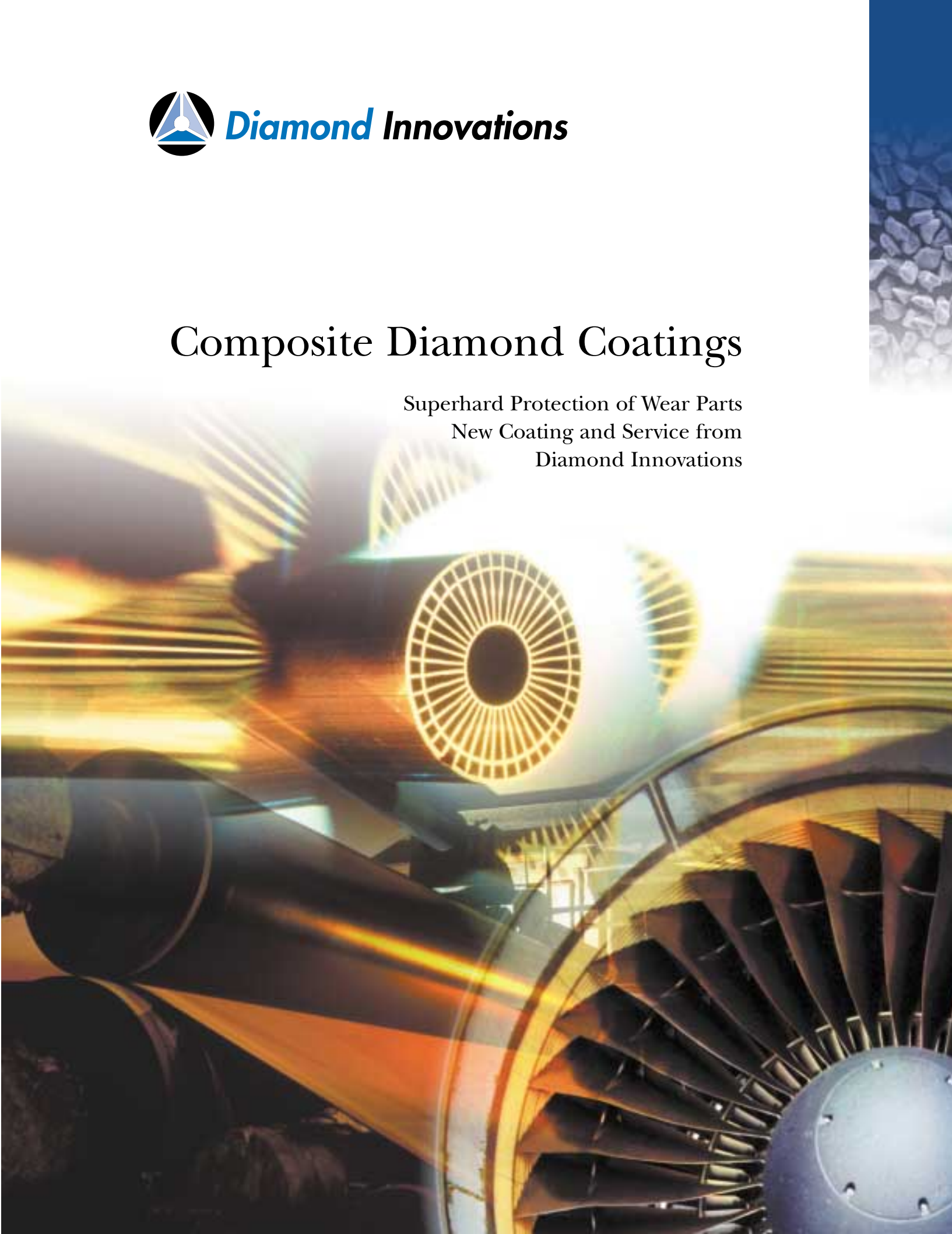




Composite Diamond Coatings

Superhard Protection of Wear Parts
New Coating and Service from
Diamond Innovations



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Genuine Man Made* Diamond Makes All the Difference

Composite Diamond Coating – CDC is a hard metal alloy with fine particles of Man Made* Diamond dispersed throughout the metal matrix. Diamond is the hardest material known and its incredible wear resistance has revolutionized a great number of technical key applications over time. The proprietary¹ process of Composite Diamond Coating offers a practical and economical opportunity, to provide the unique properties of diamond to the surface of wear parts and systems. In principle any part that is exposed to harmful and costly effects of various wear modes may benefit from a protective Composite Diamond Coating.

Many metals or alloys can be enhanced by Composite Diamond Coating. The most common materials coated are steels and aluminum alloys. Copper, brass, bronze and stainless steel can also be treated with CDC. In fact any part that wears out frequently may benefit from Composite Diamond Coating. Because of the chemical method of deposition, CDC covers all surfaces of parts, regardless of geometry, with perfect uniformity. Outstanding wear life and enhanced reliability guarantees a significantly extended use of the CDC coated parts. CDC can be chemically removed and replaced with a fresh coating. The result is a part as good as new, without manufacturing cost for a replacement part. These benefits, combined with the unmatched hardness and wear resistance of diamond, make CDC a cost effective and environmentally friendly alternative to other processes such as electroplating, hardening or thermal spraying.

Composite Diamond Coating for Wear Parts and Systems from the No.1 Diamond Expert

Diamond Innovations provides Composite Diamond Coatings that allow you to save money on overall system costs. Diamond Innovations' coating service is able to deliver reliable, Six Sigma controlled CDC coatings quickly and in large quantities.

Our specialists will also gladly evaluate the possibilities of applying CDC on any new material submitted, that is subject to abrasion, erosion, or other damaging wear environments. Utilizing the unmatched wear resistance of diamond may also enable you to transform lower cost substrate materials into economically interesting wear resistant alternatives. Our laboratories offer you access to the vast knowledge of a market leader for innovative material solutions.

Features and Benefits of Composite Diamond Coating

- Diamond hardness surpasses all other materials
- Perfect uniformity even on most complex part geometries
- Not limited to line-of-sight applications
- Excellent mechanical properties
- Extremely strong adhesion to most metals
- Smooth and polishable surfaces
- Extended life of base part – coating can be stripped and replated
- Environmentally friendly – no chrome, over 40% less metal in matrix
- Vast savings potential through coating of less costly substrates for material substitution

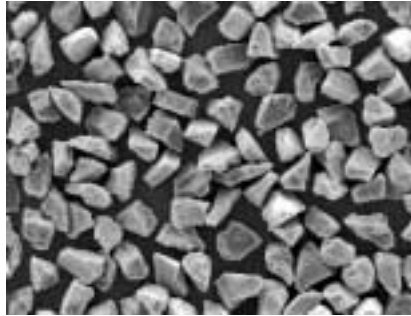
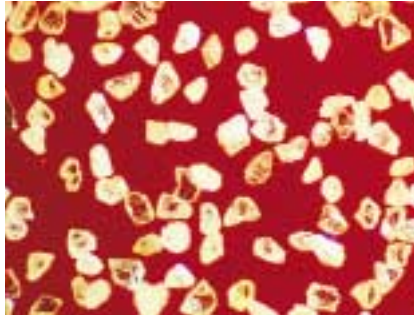
Properties of Selected Ultra-Hard Materials

	Density [g/cm ³]	Hardness Knoop	Compressive Strength [GPa]	Coefficient of Thermal Expansion [mm/mm/°C x 10 ⁻⁶]	Thermal Conductivity [W/m K]
Diamond (C)	3.52	10,000	10.0	4.8	2,100
Cubic Boron Nitride (CBN)	3.48	4,500	7.0	5.6	1,400
Boron Carbide (B₄C)	2.60	3,200	4.6	3.1	90
Silicon Carbide (SiC)	3.21	2,700	1.3	4.5	42
Aluminum Oxide (Al₂O₃)	3.92	2,100	3.0	8.6	33
Tungsten Carbide (WC-Co, 6%)	15.00	1,700	5.4	4.5	105

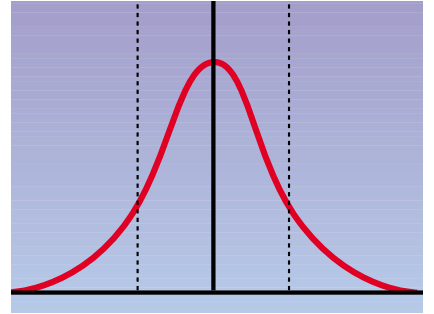
Man Made Diamonds - Key for Purity and Consistency

Tightly controlled diamond characteristics significantly enhance the quality of CDC. As the diamond particles interact with the reactive coating matrix, the purity of the diamond must be exceptional. To insure optimal density and fine surface quality, the diamond must be tightly sized and shaped. Excellent control of our diamond products are key for this consistency.

- Tight mean size control
- Controlled standard deviation
- Very good oversize control
- Clean diamond surfaces



Diamond Size Distribution

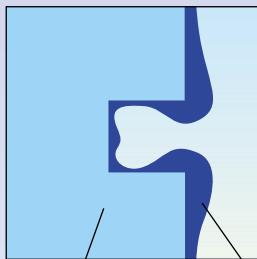
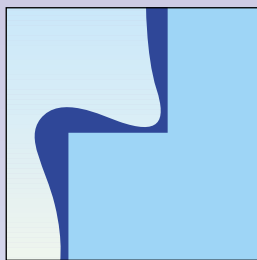


Uniformity Regardless of Work Piece Geometry

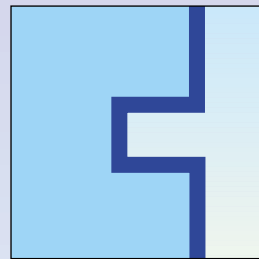
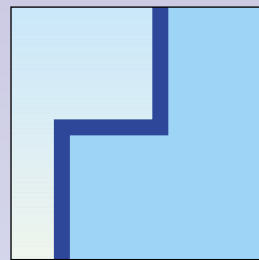
Composite Diamond Coating is applied with absolutely perfect uniformity to all surfaces of the work piece. Unlike other coating processes, there is no build up on edges, corners, inner diameters or any other given part of the surface. CDC can be applied with the same unmatched uniformity to the most complex geometries. Recesses, holes or inner diameters, there is just no “line of sight” requirement for CDC.



Non-conforming layers do not retain shape or detail of substrate



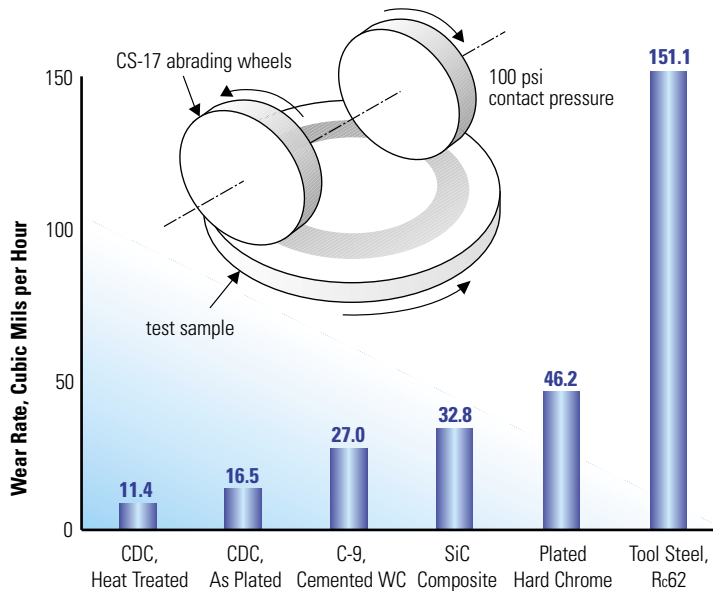
Conforming coating retains intricate details



Wear Resistance Second to None

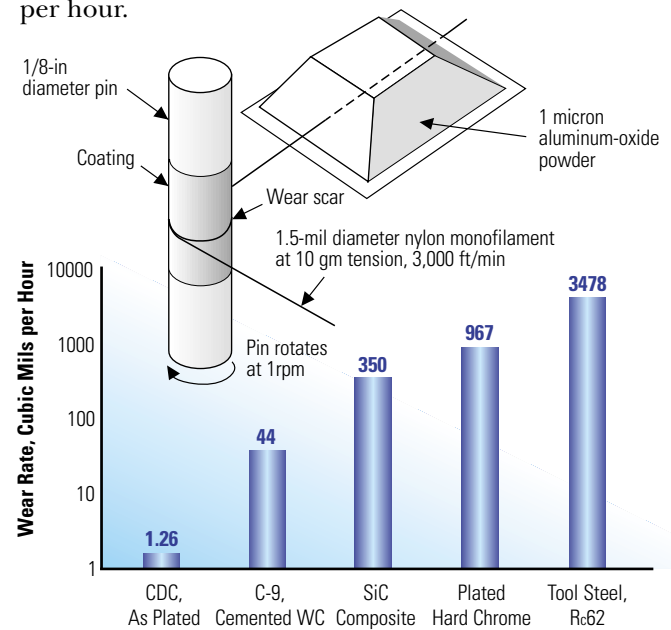
The Taber Abrasive Wear Test

Two rotating abrasive wheels turn over a coated panel. Wear is measured as the weight loss of the panels following a specified number of rotating cycles. The lower the wear index, the lower the wear to the coating.



Yarn Line Abrasive Wear Test

An abrasive yarn under constant tension is drawn across a material sample at a constant speed and force against a rotating test piece. Results are measured in material removal over time as cubic millimeter (mm^3) per hour.



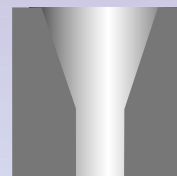
CDC Opens Huge Savings Potential Through Innovative Work Piece Options

Given the unique properties of CDC, many customers are able to change the base material of their parts to one that is less expensive, lighter, or easier to manufacture, thereby creating additional cost savings.

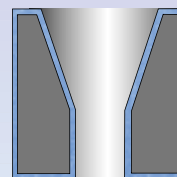
CDC Successfully Replaces

- Functional hard chrome plating
- Thermal spray coatings – no grinding or machining of over-coating
- Carburizing, nitriding and boriding of steel parts
- Anodizing of aluminum

Material Replacement Example




High Cost
Solid Tungsten Carbide
or Ceramic Spray Nozzle



Low Cost
Steel or Aluminum
Spray Nozzle
with CDC Coating

Composite Diamond Coatings – Product Service Guide Lines

	CDC-2	CDC-8	Nano CDC
Substrate	Steel, Aluminum Stainless Steel, Cast Iron Copper Alloys	Steel, Aluminum Stainless Steel, Cast Iron Copper Alloys	Steel, Aluminum Stainless Steel, Cast Iron Copper Alloys
Essentially any metal or alloy can be enhanced by CDC. New and innovative substrate materials can be evaluated at our applications laboratory upon request.			
CDC Thickness	up to 250 µm up to 0.010 inch	up to 250 µm up to 0.010 inch	25 µm 0.001 inch
Thickness is applied to a tolerance of +/- 3 µm - (0.000118 inch)			
Diamond Size	2 µm	5 to 10 µm	up to 250 nanometers
Diamond Concentration	30 Vol%	40 Vol%	up to 20 Vol%
Standard diamond concentration serves well in most applications. Higher or lower densities produced as needed.			
Heat Treatment	Recommended up to 750°F / 350°C	Recommended up to 750°F / 350°C	Recommended up to 750°F / 350°C
Provides improved adhesion of the coating, greater hardness of the matrix and maximum wear resistance. Other temperatures can be implemented for specific applications.			
Masking	As required	As required	As required
With view to the greatest economy and expediency of the coating process, it is often less expensive and faster to coat non-critical areas than to mask them off. If masking is mandatory, determine critical areas where coating should not be applied.			
Surface Finish	As plated. Surface finish generally matches that of the base material	As plated. Surface finish generally matches that of the base material	As plated. Surface finish generally matches that of the base material. May eliminate post-finishing
			
Finishing options:	Light sandblasting, polishing or tumbling	Light sandblasting, polishing or tumbling	Light sandblasting, polishing, or tumbling possible (exhibits more lubricating properties)
If an especially rough surface is desired, larger particles of up to 10 microns can be used in the diamond coating. As a preferred alternative, the substrate should be roughened before coating. CDC is able to preserve the exact roughness profile.			
Appearance	Attractive matte gray Shiny metallic when polished	Attractive matte gray Shiny metallic when polished	Shiny gray color
Surface may become polished upon initial use. Does not diminish quality of coating. Coating color cannot be changed. It can however be subsequently coated with other materials if a different appearance is desired.			



Friendly to the Environment Plus Savings in Waste Treatment Cost

- No chrome used in process
- Over 40% less metal compared to conventional coatings
- Diamond particles replace chemicals in metal matrix
- Less release of metal into the environment through
 - ▶ thinner layers
 - ▶ longer part life
 - ▶ less re-coating
 - ▶ no over-plating

Order Example

- **Description of part**
- **Overall size of the part and the area to be coated**
- **Base material**
- **Amount of masking or fixturing required**
- **Type of coating required**
- **Heat treatment required**
- **Post finishing required**
- **Number of parts**

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