

# Material Product Data Sheet

## Chromium Carbide – Nickel Chromium Composite Powders

Thermal Spray Powder Products: Diamalloy 3006, Diamalloy 3007

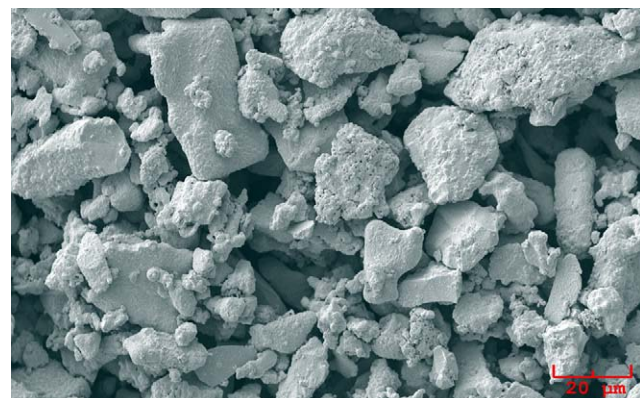
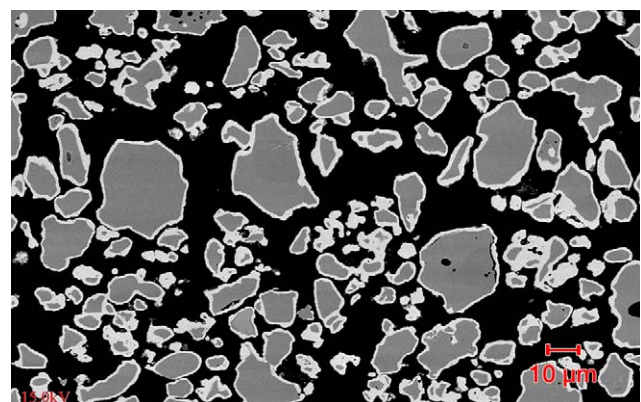
### 1 Introduction

Diamalloy 3006 and Diamalloy 3007 are chemically clad composites with each chromium carbide particle completely encapsulated in a nickel chromium shell.

The metal cladding minimizes decarburization and oxidation of the chromium carbide during the spray process and permits a more efficient deposition of the chromium carbide that contributes to exceptional wear resistance of the coating.

Chromium carbide Diamalloy powders are characterized by their ability to provide wear, oxidation and hot corrosion resistance at elevated temperatures. The addition of NiCr cladding improves corrosion properties. Higher NiCr content results in increased fracture toughness of the coatings.

Diamalloy 3006 and Diamalloy 3007 coatings are extremely dense. Coatings made from either of these materials exhibit exceptionally high bond strength of greater than 90 MPa (13,000 psi), indicating a superb combination of coating adhesion and cohesion.



SEM Cross-section photomicrograph of Diamalloy 3006 (top), SEM morphology of Diamalloy 3007 (bottom).

### 1.1 Typical Uses and Applications:

- Recommended for severe abrasive and erosive wear applications where tungsten carbide cannot be used at temperatures up to 870 °C (1600 °F).
- Diamalloy 3007 is used in industry for its fretting wear properties at elevated temperatures.
- Best performance of the coating is achieved using the HVOF spray process.

Quick Facts	
Classification	Cermet, chromium carbide based
Chemistry	Cr <sub>3</sub> C <sub>2</sub> - NiCr
Manufacture	Chemically clad
Morphology	Irregular
Apparent Density	2.3 – 2.4 g/cm <sup>3</sup>
Service Temperature	≤ 870 °C (1600 °F)
Purpose	Wear resistance
Process	HVOF

### 1.1 Typical Uses and Applications (continued):

#### Markets:

- Turbomachinery
- Petrochemical
- Alternative to hard chrome plating

#### Typical Components:

- Fuel rod mandrels
- Hot crushing rolls
- Forging tools
- Turbine exhaust struts
- Hot forming dies
- Turbine air seal rings

#### Typical Components (Diamalloy 3007 only):

- Turbine air seal spacers
- Turbine inner nozzle supports, stages 1 through 4
- Turbine engine exhaust flaps
- Knife edge seals
- Pump seals and liners
- Circulating fluidized bed combustors
- Valve stems
- Turbine baffle dampers

## 2 Material Information

### 2.1 Chemical Composition, Color and Apparent Density

Product	Phase Composition (wt %)		NiCr Composition (wt %)		Color	Apparent Density (g/cm <sup>3</sup> )
	Cr <sub>3</sub> C <sub>2</sub>	NiCr	Ni	Cr		
Diamalloy 3006	50	50	80	20	Gray	2.4
Diamalloy 3007	80	20	80	20	Gray	2.3

All reported values are nominal

### 2.2 Particle Size Distribution

Product	Nominal Range $\mu\text{m}$	Microtrac Analysis		
		D90	D50	D10
Diamalloy 3006	-45 +5.5	45 – 65	25 – 35	11 – 17
Diamalloy 3007	-45 +5.5	42 – 63	22 – 32	10 – 15

Particle size for upper size range using sieve analysis; lower size range analysis using laser diffraction (Microtrac).

### 2.3 Key Selection Criteria

- With reduced NiCr content and higher hardness, Diamalloy 3007 makes a better coating for anti-fretting applications and for use in applications to replace hard chrome plating compared to Diamalloy 3006.
- The higher NiCr content of Diamalloy 3006 increases the coating fracture toughness compared to Diamalloy 3007.
- Diamalloy 3007 coatings produce higher macrohardness and microhardness with very low porosity and very high bond strength. These characteristics, combined with an exceptionally fine as-sprayed surface makes Diamalloy 3007 a premium product.
- Diamalloy 3007 may be used for many applications with no subsequent grinding as a result of its fine as-sprayed surface.

### 2.4 Related Products

- For better wear resistance at temperatures below 500 °C (930 °F) choose tungsten carbide based powders.
- For better abrasion and sliding wear, use powders that combine tungsten carbide with chromium carbide such as Woka 7502, Woka 7504 and Woka 7505.
- Use Metco 82VF-NS or Amdry 367 when a chromium carbide with a very low percentage of binder is preferred.
- Use Metco 70C-NS or Metco 70F-NS for applications that require pure chromium carbide coatings.
- When atmospheric plasma spray is preferred, chromium carbide powders to choose from include Amdry 367, Metco 70C-NS, Metco 81NS, Metco 81VF-NS, Metco 82VF-NS, Metco 430NS, Sulzer Metco 5265, and Sulzer Metco 5546NS.
- Metco 430NS can be sprayed using the combustion powder Thermospray™ process.
- Sulzer Metco 5241 can be used for hard chrome replacement when higher deposition efficiencies are required. Coatings of this material exhibit excellent erosion and oxidation properties with superior super-finished surfaces.
- Woka 7100 series [Cr<sub>3</sub>C<sub>2</sub>-20(Ni 20Cr)] and Woka 7200 series [Cr<sub>3</sub>C<sub>2</sub>-25(Ni 20Cr)] products can be used when agglomerated and sintered materials are preferred. These materials are available in many particle size distributions appropriate for a variety of HVOF spray guns.

### 2.5 Customer Specifications

Product	Customer Specification
Diamalloy 3007	GE B50A845, CI B Honeywell EMS 52544 Sec 1.3 Type IV Pratt & Whitney PWA 36332-1S Rolls-Royce plc MSRR 9507/71 Williams CWIMS 794

## 3 Coating Information

### 3.1 Key Thermal Spray Coating Characteristics

Specification <sup>(1)</sup>	Diamalloy 3006 <sup>(1)</sup>		Diamalloy 3007 <sup>(2)</sup>		
Recommended Process	High Velocity Oxy-Fuel (HVOF)		High Velocity Oxy-Fuel (HVOF)		
Recommended Bond Coat	Not required		Not required		
Bond Strength <sup>(3)</sup>	> 90 MPa	> 13000 psi	> 90 MPa	> 13000 psi	
Deposit Efficiency (approx.)	40 – 50 %		30 – 45 %		
Porosity	< 1 vol. %		< 1 vol. %		
Surface Roughness	as-sprayed machined	10 – 15 µm 0.1 – 0.2 µm	400 – 600 µin 4 – 6 µin	2.5 – 4 µm < 0.25 µm	100 – 170 µin < 10 µin
Post Finishing Technique	Grind		Use as-sprayed or grind		
Macrohardness approx.	85 HR15N	50 HRC <sup>(4)</sup>	92 – 93 HR15N	65 – 68 HRC <sup>(4)</sup>	
Microhardness	550 – 700 HV0.3		800 – 1150 HV0.3		
Thickness Limitation <sup>(5)</sup>	> 0.63 mm	> 0.025 in	> 0.63 mm	> 0.025 in	
Service Temperature max	870 °C	1600 °F	870 °C	1600 °F	

1) Properties reported for Diamalloy 3006 based on coatings applied using a Diamond Jet™ air-cooled HVOF spray gun.

2) Properties reported for Diamalloy 3007 based on coatings applied using a variety of spray guns as listed in Section 3.3.

3) In all cases, the tensile strength of the coatings exceeded the strength of the glue. Absolute tensile strengths are unknown.

4) Converted

5) Coating thickness limitations will depend on the application hardware and parameters used.

