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SULZER METCO
The Coatings Company™

Metco® 204NS Yttria Stabilized Zirconia Powder

Technical Bulletin #10-311

Metco® 204NS Yttria Stabilized Zirconia Powder

Metco 204NS is a spherical, free flowing, partially stabilized, 7-8 percent yttria zirconia powder manufactured by Metco. During the manufacturing process, zirconia and yttria react to form a solid solution ceramic having a cubic and tetragonal structure with minor amounts of the monoclinic phase. Metco 204NS provides several advantages over conventional crushed angular or spray dried oven composite powders including:

- *Excellent flowability
- *Chemical homogeneity
- *Structural stability (there is no flame stabilization required as is necessary with Metco 202NS)
- *High purity due to absence of contamination from crushing operations
- *Uniform particle melting

Metco 204NS produces excellent high temperature thermal barrier coatings resistant to thermal cycling stresses and strains.

Metco 204NS is expected to be superior to Metco 210NS in these categories, because of its 7-8 percent yttria content. The yttria stabilizing component tends to remain longer in solid solution at elevated temperatures and does not migrate from this structure to form the destructive monoclinic phase.

Metco 204NS can be sprayed with the Metco Type 7MB, 9MB and 10MB Plasma Spray Equipment using argon/hydrogen or nitrogen/hydrogen as the plasma gases or the Metco Type 11MB and MBN Plasma Spray Equipment using argon/hydrogen as the plasma gases.

Specification Conformance

Metco 204NS meets the requirements of Pratt & Whitney Aircraft Specification PWA 1375.

Applications

Coatings of Metco 204NS are recommended for the following applications:

Coating No.	Coating Function	Typical Applications
P204NS-10 P204NS-11	Thermal barrier	Aircraft Engine Burner Cans, Turbine Combustors and Air foils

Powder Characteristics

Typical Composition:	ZirconiumOxide	92%
	YttriumOxide	8%
Typical Size Range:	-140 mesh +10 microns	
	-106 +10 microns	
Melting Point:	2480°C (4500°F)	

Typical Physical Properties of the Coatings

	P204NS-10	P204NS-11
Texture, As-Sprayed (microinches aa):	450-600	450-600
	(microns aa):	11-15
As-Ground (100 grit SiC):	10-15	10-15
	(microns aa):	.2-.4
Macrohardness: (R_{15N} converted):	R _c 30 ±5	R _c 35 ±5
Cross Sectional Hardness: (DPH 300)	400	400
Density (g/cc):	5.4	5.1
Porosity (volume):	5	9
Coating Weight (lb/ft²/0.001")	.028	.027
	(kg/m ² /0.1mm)	.54
Bond Strength, Low Carbon Steel		
	Metcolite C Grit Blast, (psi)	3000
(MPa)	21	21

Maximum Service Temperature

The recommended maximum service temperature is 1010°C (1850°F).

Surface Preparation

Clean substrate, severe oxidation must be removed, grit blasting is recommended.

Refer to Volume II or Volume III of the Metco Flame Spray Handbook for basic methods of surface preparation.

Note: Aluminum or magnesium substrates should be grit blasted with chilled iron grit at a pressure that will not permit the grit to become entrapped in the substrate. If Metcolite (aluminum oxide) is used, do not blast over 30 psi (2.07 bar). This recommendation is made to reduce the potential for grit and dust entrapment in the substrate which could reduce the coating bond strength.

The use of a bond coat, such as Metco 443, is recommended.

Spraying

To produce optimum Metco 204NS coatings, the spray parameters recommended in this bulletin must be followed.

Substrate Preheat Temperature: Normal 90-120°C (200-250°F).

Note: Magnesium substrates should **never** be preheated. The surface oxidizes too rapidly. This oxidation will interfere with the bond strength of the sprayed coating.

Aluminum substrates should only be preheated to 65-95°C (150-200°F), if the preheating can be done indirectly (i.e: from the back or side, but never on the surface to be sprayed), to eliminate the formation of surface oxides. Oven preheating is not recommended because the surface to be sprayed will be heated directly. If indirect heating cannot be done, then the substrate should not be preheated.

Substrate Temperature During Spraying: Normal 175°C (350°F) Maximum

Typical Application Rate: .025mm (.001") Per Pass, Maximum

To obtain the best coating, it is important to maintain a traverse rate above 0.66 m/sec (130 ft/min) to insure an application rate of less than 0.25mm (0.001") per pass and to utilize sufficient substrate cooling to maintain the substrate temperature below 175°C (350°F). This is to minimize local overheating with subsequent internal stress levels leading to delamination and cracking.

It is important to maintain the correct spray distances and spray rate to produce the desired coating at the proper deposition rate. Excessively long spray distances and/or high spray rates generally reduce coating density and deposit efficiency. Excessively close spray distances and/or low spray rates may produce an overly dense coating and lead to possible delamination and cracking.

Finishing

Coating of Metco 204NS are best finished by grinding. Excellent finishes have been obtained utilizing 100 grit silicon carbide or 120 grit diamond wheels. Wet grinding is recommended over dry grinding.

Cylindrical Grinding

Wheel No.:	5C100-H10-VSC or MD120-N100-B
Wheel Speed:	1675-1980 m/min (5550-6500 ft/min)
Surface Work Speed:	20-30 m/min (70-100 ft/min)
Traverse, Roughing:	30 cm/min (12 in/min)
Finishing:	10-15 cm/min (4-6 in/min)

Surface Grinding

Wheel No.:	5C100-H10-VSC or MD120-N100-B
Wheel Speed:	1675-1980 m/min (5500-6500 ft/min)
Surface Work Speed:	120-180 m/min (400-600 ft/min)
Crossfeed, Roughing:	.76 mm .030 in.
Finishing:	.25 mm .010 in.

Safety Measures

Flame spraying is a completely safe process when performed in accordance with “Metco’s Safety Measures”. Familiarize yourself with local safety regulations before starting spraying operations. **DO NOT** operate your spraying equipment or use the spray material supplied before you have thoroughly read the Metco Instruction Manual.

Disregarding These Instructions May Be Dangerous To Your Health.

System Parameters Plasma Spray

	Set #1 Ar/H ₂	Set #2 N ₂ /H ₂	Set #3 Ar/H ₂	Set #4 N ₂ /H ₂
Spray Gun:				
Type:	7MB/9MB/10MB	7MB/9MB/10MB	7MB/9MB/10MB	7MB/9MB/10MB
Nozzle:	GH/732/830	G/730/820	GH/732/830	G/730/820
Powder Port:	#2	#2	#2	#2
Insulator:	7M 50/9MB 50/ 10MB 50	7M 55/9MB 55/ 10MB 55	7M 50/9MB 50/ 10MB 50	7m 55/9mb 55/ 10MB 55

Gas:				
Pressure -Primary, psi:	100	50	100	50
bar:	6.9	3.4	6.9	3.4
Secondary, psi:	50	50	50	50
bar:	3.4	3.4	3.4	3.4
Flow - Primary:	80	75	80	75
Secondary: (Note 1)	15	15	15	15

Power:				
Unit:	6MR/7MR/8MR	6MR/7MR/8MR	6MR/7MR/8MR	6MR/7MR/8MR
Arc Amps:	600	500	600	500
Arc Volts:	64-70	74-80	64-70	74-80

Powder Feed:				
Unit:	3MP/4MP (Note2)	3MP/4MP (Note2)	3MP/4MP (Note2)	3MP/4MP (Note2)
Meter Wheel:	S/-	S/-	S/-	S/-
RPM: (Note 3)	18/-	18/-	31/-	31/-
Feed Rate Indicator Setting:	-/55	-/45	-/105	-/80
Carrier Gas Flow:	37	37	37	37

Spraying:				
Spray Distance, inches:	2.5	2.5	2.5	2.5
mm:	64	64	64	64
Spray Rate, lb/hr:		6	6	12 12
kg/hr:	2.7	2.7	5.4	5.4
Coverage, ft ² /hr/.001":	135	135	180	270
m ² /hr/0.1mm:	3.2	3.2	4.2	6.4
Powder Required, lb/ft ² .001":	.044	.044	.067	.045
kg/m ² /0.1mm:	.85	.85	1.29	.86
Deposit Efficiency, %: (Note 4)	65	65	40	60
Deposition Rate, lb/hr:	3.9	3.9	4.8	7.2
kg/hr:	1.7	1.7	2.1	3.2

Notes:

1. The secondary gas flow shown in the chart may be adjusted as much as ±5 points, if necessary, to obtain voltage within the range shown; EXCEPT THAT the secondary gas flow may **not** be reduced

- zero and hydrogen flow may **not** exceed 25. If the required voltage is not obtained with the preliminary gas flow adjustment, check the equipment for a worn nozzle, a worn electrode, or a gas leak between the flowmeter and the gun. If there is no gas leak, and the nozzle and electrode are not badly worn, further adjustment does not result in a flow of zero or a hydrogen flow exceeding 25.
2. Use Powder Port Shaft "A". Use black 9 ft. powder feed hose. Use 25 psi (1.7 bar) vibrator air pressure.
 3. Use as a starting point. Adjust as necessary to obtain spray rate shown.
 4. Deposit efficiencies are approximate and have been rounded off for easy calculation. Spray rates and deposit efficiencies shown were obtained by skilled operators with all equipment in first-class condition.

System Parameters Plasma Spray

	Set #5 Ar/H ₂	Set #6 Ar/H ₂
Spray Gun:		
Type:	MBN	MBN
Nozzle:	MBN 432	MBN 432
Powder Port:	#2	#2
Gas Distribution Ring:	MBN 65	MBN 65
Gas:		
Pressure - Primary, psi:	100	100
bar:	6.9	6.9
Secondary, psi:	50	50
bar:	3.4	3.4
Flow - Primary:	80	80
Secondary: (Note 1)	15	15
Power:		
Unit:	MRN	MRN
Arc Amps:	500	500
Arc Volts:	65-70	65-70
Powder Feed:		
Unit: (Note 2)	4MP	4MP
Feed Rate Indicator Setting: (Note 3)	75	140
Vibrator Air Pressure, psi:25	25	
bar:	1.7	1.7
Carrier Gas Flow:	37	37
Spraying:		
Spray Distance, inches:	2.5	2.5
mm:	64	64
Spray Rate, lb/hr:	6	12
kg/hr:	2.7	5.4
Coverage, ft ² /hr/.001":	140	182
m ² /hr/0.1mm:	3.3	4.3

Powder Required, lb/ft ² /.001":		.043	.066
kg/m ² /0.1mm:	.83	1.27	
Deposit Efficiency, %: (Note 4)	65	40	
Deposition Rate, lb/hr:	3.9	4.8	
kg/hr:	1.7	2.2	

Notes:

1. The secondary gas flow shown in the chart may be adjusted as much as ±5 points, if necessary, to obtain voltage within the range shown; except hydrogen flow may **not** exceed 25. If the required voltage is not obtained with this preliminary gas flow adjustment, check the equipment for a worn nozzle, a worn electrode, or a gas leak between the flow meter and the gun. If there is no gas leak, and the nozzle and electrode are not badly worn, further adjustment of the secondary gas flow, up to an additional ±5 points, is permissible, if this second adjustment does not result in a flow of zero or a hydrogen flow exceeding 25. If the required voltage is not then obtained, replace the worn parts.
2. Use black 9 foot powder feed hose unless otherwise noted. Use powder port shaft A.
3. With the Type 4MP powder feed unit, feed rates are given as starting points. Adjust to obtain rate shown. Carrier flow should not be changed.
4. Deposit efficiencies are approximate and have been rounded off for easy calculation. Spray rates and deposit efficiencies shown were obtained by skilled operators with all the equipment in first-class condition.

System Parameters Plasma Spray

	Ar/H ₂
Spray Gun:	
Type: (Note 1)	11MB
Nozzle:	11MB 112
Air Cooled Cover,	Yes
psi:	20
bar:	1.4
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Gas:	
Pressure - Primary, psi:	75
bar:	5.2
Secondary, psi:	50
bar:	3.4
Flow - Primary:	65
Secondary:	40% (Note 2)
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Power:	
Unit:	6MR/7MR/8MR
Arc Amps:	500
Arc. Volts:	30-35
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Powder Feed:	
Unit:	3MP/4MP (Note 3)
Meter Wheel:	S/-
RPM: (Note 4)	20/-

Feed Rate Indicator Setting: -/130
 Air Vibrator, psi: 15/25
 bar: 1.0/1.7

Spraying: (Note 5)

Spray Distance, Inch: 0.5-2.0
 mm: 13-50
 Spray Rate, lb/hr: 3
 kg/hr: 1.4
 Deposit Efficiency %: (Note 6) 75 at 0.5", 65 at 2.0"

Notes:

1. Use 20 psi (1.4 bar) gun cooling air.
2. Use Low Capacity Hydrogen Flowmeter Tube and Float Assembly, Cat. No. 7MC 375.
3. Use Powder Port Shaft "B" and black 9 ft. powder feed hose.
4. Use as a starting point. Adjust as necessary to obtain spray rate shown.
5. Deposition rates per pass are very critical, especially at spray distances less than 25 mm (1"), and should **not** exceed .03mm (.001") per pass.
6. Spray rates and deposit efficiencies shown were obtained by skilled operators with all equipment in first-class condition.

Producing Recommended Coatings

Coating No.:	P210-10	P210-11
Surface Preparation:	Apply Coating P443-10 as Bond Coat.	Apply coating P443-10 as Bond Coat
Spraying:	Use Parameter Set #1, #2, or #5	Use Parameter Set #3, #4, or #6
Finishing:	Grind	Grind

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