

# Material Product Data Sheet

## 8 % Yttria Stabilized Zirconia Agglomerated and HOSP Powders

### Powder Products:

**Metco™ 204C-NS Premium, Metco 204NS-G Premium, Metco 204D, Metco 204E, Metco 204NS, Metco 204B-NS, Metco 204AF, Amdry™ 204NS-1, Metco 204C-NS, Metco 204F, Metco 204NS-G, Metco 204NS-AP, SPM 2000, SPM 2000-1**

### 1 Introduction

Yttria stabilized zirconia ( $8Y_2O_3-ZrO_2$ ) powders manufactured by Oerlikon Metco's HOSP™ process combine the advantages of pre-alloyed, fused and crushed powders together with the free flowing, consistent shape of spray dried powders.

Densification via the HOSP process ensures high deposit efficiency during the coating process, reducing application time and overspray waste. Powders are spheroidal with excellent flow, chemical homogeneity and structural stability. Compositions are manufactured from high purity raw materials, and produce coatings that provide long-lasting, reliable service.

Many of Oerlikon Metco's HOSP YSZ products are manufactured using very high purity, white materials (see section 2.1). Coatings of these products offer extended coating life through improved sintering resistance. It is the exceptional purity of these materials, with minimized levels of low-melting trace constituents that improves coating performance, even at temperatures significantly above 1200 °C (2200 °F).

#### 1.1 Typical Uses and Applications

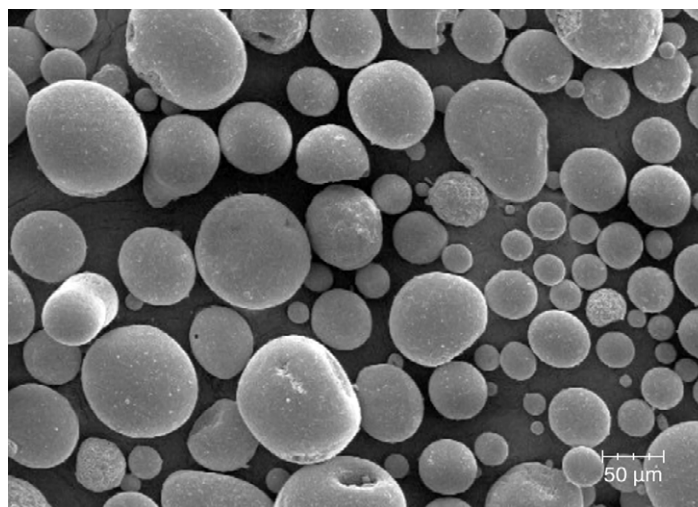
Usually used as a thermal spray coating for:

- Top coat (insulating layer) in a thermal barrier coating (TBC) system for industrial and flight gas turbine engine components such as combustion liners, transition pieces, afterburners, heat shields, turbine airfoils.
- Thermal protection at temperatures up to 900 °C (1650 °F) on metallic diesel and gasoline engine components such as cylinder heads, piston crowns, exhaust and intake valves, turbochargers.
- In general, these materials are used as the insulating layer in a two-part TBC system, consisting of a thermal sprayed bond coat and YSZ top coat. For some applications, they are used as intermediate layers between an oxidation-resistant bond coat and a more porous, low-K TBC system.

### Quick Facts

|                      |   |
|----------------------|---|
| Classification       | Ceramic, zirconia based   |
| Chemistry            | $ZrO_2 \cdot 8Y_2O_3$   |
| Manufacture          | Agglomerated & HOSP   |
| Morphology           | Spheroidal  |
| Apparent Density     | $2.3 \pm 0.2 \text{ g/cm}^3$  |
| Service Temperature* | High Purity Products: $\leq 1350 \text{ °C}$ (2460 °F)<br>Other Products $\leq 1250 \text{ °C}$ (2280 °F) |
| Melting point        | 2800 °C (5072 °F)   |
| Purpose              | Thermal protection  |
| Process              | Atmospheric Plasma Spray, ChamPro™ (LVPS, LPPS, VPS)  |

\* With suitable bond coat



Photomicrograph of a typical yttria-stabilized zirconium oxide material manufactured using Metco's HOSP process.

## 2 Material Information

### 2.1 Chemical Composition

| Product               | ZrO <sub>2</sub> <sup>a</sup> | Y <sub>2</sub> O <sub>3</sub> | SiO <sub>2</sub><br>(max) | TiO <sub>2</sub><br>(max) | Al <sub>2</sub> O <sub>3</sub><br>(max) | Fe <sub>2</sub> O <sub>3</sub><br>(max) | Other<br>Oxides (max) | Monoclinic<br>Phase (max) |
|-----------------------|-------------------------------|-------------------------------|---------------------------|---------------------------|---|---|-----------------------|---------------------------|
| Metco 204C-NS Premium | Balance                       | 7.0 – 8.0                     | 0.05                      | 0.05                      | 0.05                                    | 0.05                                    | 0.5                   | 10                        |
| Metco 204NS-G Premium | Balance                       | 7.0 – 8.0                     | 0.05                      | 0.05                      | 0.05                                    | 0.05                                    | 0.5                   | 6                         |
| Metco 204D            | Balance                       | 7.0 – 8.0                     | 0.15                      | 0.15                      | 0.15                                    | 0.15                                    | 1.0                   | 10                        |
| Metco 204E            | Balance                       | 7.0 – 8.0                     | 0.15                      | 0.15                      | 0.15                                    | 0.15                                    | 1.0                   | 10                        |
| Metco 204NS           | Balance                       | 7.0 – 8.0                     | 0.3                       | 0.2                       | 0.2                                     | 0.2                                     | 1.0                   | 10                        |
| Metco 204B-NS         | Balance                       | 7.0 – 8.0                     | 0.3                       | 0.2                       | 0.2                                     | 0.2                                     | 1.0                   | ~ 10                      |
| Metco 204AF           | Balance                       | 7.0 – 8.0                     | 0.3                       | 0.2                       | 0.2                                     | 0.2                                     | 1.0                   | 10                        |
| Amdry 204NS-1         | Balance                       | 7.0 – 8.0                     | 0.7                       | 0.2                       | 0.2                                     | 0.2                                     | 1.0                   | 10                        |
| Metco 204C-NS         | Balance                       | 7.0 – 8.0                     | 0.7                       | 0.2                       | 0.2                                     | 0.2                                     | 1.0                   | ~ 10                      |
| Metco 204F            | Balance                       | 7.0 – 8.0                     | 0.7                       | 0.2                       | 0.2                                     | 0.2                                     | 1.0                   | ~ 6                       |
| Metco 204NS-G         | Balance                       | 7.0 – 8.0                     | 0.7                       | 0.2                       | 0.2                                     | 0.2                                     | 1.0                   | ~ 6                       |
| Metco 204NS-AP        |                               |                               |                           |                           | Proprietary                             |   |                       |                           |
| SPM 2000              |                               |                               |                           |                           | Proprietary                             |   |                       |                           |
| SPM 2000-1            |                               |                               |                           |                           | Proprietary                             |   |                       |                           |

<sup>a</sup> Maximum 2.5% HfO<sub>2</sub> included in this value

### 2.2 Additional Powder Characteristics

| Product               | Nominal Range $\mu\text{m}$ | D 90%     | D 50%   | D 10%   | Color       |
|-----------------------|-----------------------------|-----------|---------|---------|-------------|
| Metco 204C-NS Premium | -147 +45                    | 107 – 120 | 68 – 77 | 39 – 49 | White       |
| Metco 204NS-G Premium | -125 +11                    | 93 – 103  | 50 – 57 | 21 – 25 | White       |
| Metco 204D            | -90 +16                     | 85 – 99   | 47 – 57 | 20 – 30 | White       |
| Metco 204E            | -125 +45                    | 107 – 125 | 68 – 77 | 39 – 49 | White       |
| Metco 204NS           | -125 +11                    | 90 – 109  | 49 – 59 | 20 – 28 | White       |
| Metco 204B-NS         | -75 +45                     | 88 – 93   | 57 – 62 | 36 – 42 | White       |
| Metco 204AF           | -45 +15                     | 36 – 45   | 20 – 30 | 10 – 20 | White       |
| Amdry 204NS-1         | -125 +11                    | 90 – 109  | 49 – 59 | 20 – 28 | Off-White   |
| Metco 204C-NS         | -147 +45                    | 107 – 120 | 68 – 77 | 39 – 49 | Off-White   |
| Metco 204F            | -45 +15                     | 36 – 45   | 20 – 30 | 10 – 20 | Off-White   |
| Metco 204NS-G         | -125 +11                    | 93 – 103  | 50 – 57 | 21 – 25 | Off-White   |
| Metco 204NS-AP        |                             |           |         |         | Proprietary |
| SPM 2000              |                             |           |         |         | Proprietary |
| SPM 2000-1            |                             |           |         |         | Proprietary |

Particle size analysis by laser diffraction (Microtrac) in accordance with ASTM B822.

### 2.3 Key Selection Criteria

- Choose the product that meets the required customer material specification.
- Oerlikon Metco has many products in our portfolio that can meet a wide range of customer design criteria.
- Powders products with fine particle distributions typically produce dense coating microstructures, while materials with coarser distributions produce more porous coating microstructures.
- Products designated as Premium provide extended coating life as a result of high sintering resistance and low shrinkage. These materials can also be used in moderately higher temperature TBC applications. Coatings are the whitest in color of all TBC materials in the Metco YSZ portfolio of products.
- Metco 204D and Metco 204E offer excellent purity and performance. They can be used as cost-efficient alternatives for aerospace and power generation applications when customer specifications allow for such substitutions.
- Metco 204AF is designed to produce dense microstructures with smooth, as-sprayed surface textures.
- Amdry 204NS-1, Metco 204NS-G and Metco 204C-NS are slightly lower purity products. Coatings of these materials will be light cream in color, compared to coatings of other products in this datasheet, which will be white to near white.
- Metco 204F has a very fine particle size distribution that can produce coatings with dense or dense, vertically cracked microstructures when applied using atmospheric plasma spray equipment. Metco 204F can also be applied by the combustion powder Thermospray™ process, using a Metco 6P-II spray gun at low feed rates.
- SPM-designated products are proprietary and specifically designed to produce unique coating microstructures when applied with plasma equipment at high power.
- Metco 204NS-AP is also a proprietary product that has been tailored to produce coating having unique microstructures sprayed using very specific plasma coating conditions.

### 2.4 Related Products

- Coatings of 7 to 8% yttria stabilized zirconia exhibit better volume stability and can be used at higher service temperatures than magnesia- or calcia-stabilized materials, such as the Metco 201 and the Metco 210 families of materials.
- HOSP densified products exhibit higher coating deposit efficiencies than many competitive materials using alternative manufacturing technologies.
- HOSP densified products show better material feed characteristics than angular (fused and crushed) materials, such as Amdry 333.
- Coatings of 7 to 8% yttria stabilized zirconia have better thermal cyclic properties compared to coatings of fully stabilized products such as Metco 202NS.
- Coatings of these materials are somewhat more prone to chemical attack from sodium, sulfur and chlorine contaminants than ceria-stabilized materials (Metco 205NS).
- Coatings of these materials are less resistant to erosion and scuffing, and have a somewhat lower hot hardness than coatings of zirconia yttria titania (Metco 143), but can be used at higher service temperatures.
- When high coating porosities are required, agglomerated and sintered YSZ materials may be more appropriate. Metco 22xx series products are high purity agglomerated and sintered powders, equivalent to the HOSP products designated as Premium in this datasheet. Metco 23xx series have chemistries equivalent to today's industry standard for YSZ chemistries.
- Metco 6700 is a spray dried, flame-stabilized YSZ material that has a particle size distribution much finer than other Metco yttria-zirconia based materials. It is designed to be applied using the Metco ChamPro™ PS-PVD process, giving rise to dense coating structures, including segmented structures similar to EB-PVD.
- Oerlikon Metco also offers a complete portfolio of bond coat materials, including MCrAlY materials most often used as a bond coat for these thermal barrier materials..

## 2.5 Customer Specifications

| Product               | Customer Specifications  |  |
|-----------------------|--|--|
| Metco 204C-NS Premium | GE A50A558 <sup>a</sup>  |  |
| Metco 204NS-G Premium | GE A50A557   | U. S. Military USAF 461204 (material only for top coat)  |
| Metco 204NS           | Avio 4800M/40<br>Canada Pratt & Whitney CPW 673<br>Chromalloy BZ-003 Type 52<br>GE A50TF278, CI B, 10042376<br>GE A50TF278, CI D<br>GE 1042376<br>GKN Aerospace PM 819-20<br>Hamilton Sundstrand ESR 1487<br>Honeywell EMS 57750, Type I, CI 1 | Honeywell M3966, Type II<br>Honeywell M3978<br>Pratt & Whitney PWA 1375<br>Siemens PD83336AA, Sec. 7.2 & 7.2.2<br>SiemensPD83336AB, Sec. 5.3 & 5.3.1<br>Siemens PD83336Z2, Sec. 7.3 & 7.3.2<br>Solar Turbines ES9-110B, Class A<br>U. S. Military SA-ALC 97P1271 |
| Metco 204B-NS         | Avio 4800M/38<br>GE A50TF204, CI B<br>GKN Aerospace PM 819-55<br>Honeywell 91547-52564 App. A Sec 1.3<br>Honeywell EMS 10479, Paragraph 8.3.2<br>Light Helicopter LHM 3314   | Rolls-Royce Corporation EMS 56722<br>Rolls-Royce OMAT 3/185A<br>Rolls-Royce plc MSRR 9507/46<br>Rolls-Royce plc RRMS 40000<br>Snecma DMR 33.098<br>Pratt & Whitney MC-2024   |
| Metco 204AF           | Pratt & Whitney PWA 36318  |  |
| Amdry 204NS-1         | Canada Pratt & Whitney CPW 673<br>Chromalloy BZ-003 Type 52<br>GE A50TF278, CI B<br>Hamilton Sundstrand ESR 1487<br>Honeywell EMS 57750, Type I, CI 1<br>Pratt & Whitney PWA 1375  | Siemens PD83336AA, Sec. 7.2 & 7.2.2<br>SiemensPD83336AB, Sec. 5.3 & 5.3.1<br>Siemens PD83336Z2, Sec. 7.3 & 7.3.2<br>Turbine Airfoil Coating and Repair TACR 05-366 Type 5 & 6<br>Turbine Airfoil Coating and Repair MS201-1                                      |
| Metco 204C-NS         | GE A50A558<br>GE A50TF278, CI A  | Power Systems Manufacturing LLC PSM-410-2 Appendix I   |
| Metco 204NS-G         | GE A50A557<br>GE A50TF278, CI B, F50TF50, CI B<br>GE A50TF278, CI C  | Siemens HTCT 650564<br>U. S. Military USAF 461206 (material only for intermediate coat)  |
| Metco 204NS-AP        | Alstom HMHD 658042, Except TiO 0.1%  |  |
| SPM 2000              | GE A50AG1<br>GE A50TF278, CI B   | GE A50TF278, CI D  |
| SPM 2000-1            | GE A50AG1, CI A  | GE A50TF278, CI B  |

<sup>a</sup> Fulfills requirements but not approved

### 3 Coating Information

#### 3.1 Key Thermal Spray Coating Information

| Specification                  | Typical Data   |
|--------------------------------|--|
| Recommended coating processes  | APS (Atmospheric Plasma Spray) or ChamPro™ (Controlled Atmosphere Plasma Spray)                                |
| Recommended bond coat          | Suitable high-temperature materials that are compatible with the substrate. MCrAlY bond-coats are recommended. |
| Typical porosity range         | 8 – 20%  |
| Thermal conductivity           | 0.8 – 1.3 W/mK   |
| Thermal expansion              | 10 x 10 <sup>-6</sup> /K<br>5.6 x 10 <sup>-6</sup> /°R   |
| Specific Heat                  | 450 ± 20 J/kgK   |
| Post finishing                 | Typically used as-sprayed. May be SiC or diamond ground  |
| Microstructure characteristics | Homogeneously porous and finely microcracked   |

#### 3.2 Coating Parameters

Please contact your Oerlikon Metco Account Representative for parameter availability. For specific coating application requirements, the services of Oerlikon Metco's Coating Solution Centers are available.

#### Recommended Atmospheric Plasma Spray Guns

Metco 9MB series

Metco 11MB

Metco 8MB

Metco F4 series

iPro™-90

Metco SM F-100 Connex

Metco SM F-220

TriplexPro™ series

SinplexPro™ series

## 4 Commercial Information

### 4.1 Ordering Information and Availability

| Product                     | Order No.          | Package Size                                       | Availability   | Distribution     |
|-----------------------------|--------------------|--|----------------|------------------|
| Metco 204C-NS Premium       | 1084635            | 12.5 lb (approx. 5.7 kg)                           | Stock          | Global           |
| Metco 204NS-G Premium       | 1084634            | 12.5 lb (approx. 5.7 kg)                           | Stock          | Global           |
| Metco 204D                  | 1097241            | 12.5 lb (approx. 5.7 kg)                           | Stock          | Global           |
| Metco 204E                  | 1097243            | 12.5 lb (approx. 5.7 kg)                           | Stock          | Global           |
| Metco 204NS                 | 1000577<br>1000591 | 5 lb (approx. 2.25 kg)<br>12.5 lb (approx. 5.7 kg) | Stock<br>Stock | Global<br>Global |
| Metco 204B-NS               | 1000590            | 5 lb (approx. 2.25 kg)                             | Stock          | Global           |
| Metco 204AF                 | 1050349            | 12.5 lb (approx. 5.7 kg)                           | Stock          | Global           |
| Amdry 204NS-1               | 1001585            | 12.5 lb (approx. 5.7 kg)                           | Stock          | Global           |
| Metco 204C-NS               | 1001593            | 12.5 lb (approx. 5.7 kg)                           | Stock          | Global           |
| Metco 204F                  | 1043121            | 12.5 lb (approx. 5.7 kg)                           | Stock          | Global           |
| Metco 204NS-G               | 1000800            | 12.5 lb (approx. 5.7 kg)                           | Stock          | Global           |
| Metco 204NS-AP <sup>a</sup> | 1037601            | 12.5 lb (approx. 5.7 kg)                           | Stock          | Global           |
| SPM 2000 <sup>a</sup>       | 1019245            | 12.5 lb (approx. 5.7 kg)                           | Stock          | Global           |
| SPM 2000-1 <sup>a</sup>     | 1029027            | 12.5 lb (approx. 5.7 kg)                           | Stock          | Global           |

<sup>a</sup> Available only to OEM qualified buyers

### 4.2 Handling Recommendations

- Store in the original container in a dry location.
- Tumble contents gently prior to use to prevent segregation.
- Open containers should be stored in a drying oven to prevent moisture pickup.

### 4.3 Safety Recommendations

See the applicable SDS (Safety Data Sheet) in the localized version applicable to the country where the material will be used. SDS are available from the Oerlikon web site at [www.oerlikon.com/metco](http://www.oerlikon.com/metco) (Resources – Safety Data Sheets).

| Product               | SDS No. |
|-----------------------|---------|
| Metco 204C-NS Premium | 50-149  |
| Metco 204NS-G Premium | 50-149  |
| Metco 204D            | 50-149  |
| Metco 204E            | 50-149  |
| Metco 204NS           | 50-149  |
| Metco 204B-NS         | 50-149  |
| Metco 204AF           | 50-1552 |
| Amdry 204NS-1         | 50-1552 |
| Metco 204C-NS         | 50-1552 |
| Metco 204F            | 50-1552 |
| Metco 204NS-G         | 50-1552 |
| Metco 204NS-AP        | 50-1552 |
| SPM 2000              | 50-819  |
| SPM 2000-1            | 50-819  |

Information is subject to change without prior notice.