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Material Product Data Sheet
Nickel- and Cobalt-Based Self-Fluxing Alloy Powders for Thermal Spray

Powder Products:
Metco 11 series, Metco 12C, Metco 14E, Metco 15 series, Metco 16C-NS, Metco 18C, Diamalloy 2001, Metco 7010, Metco 1721A,

1 Introduction

Oerlikon Metco's portfolio of gas-atomized, self-fluxing alloys consists of nickel and cobalt based products with a proven track record for thermal spray applications.

These materials are fully alloyed powders with a spheroidal morphology for freely-flowing material feed during coating application. The gas-atomization process ensures a homogeneously alloyed and consistent product.

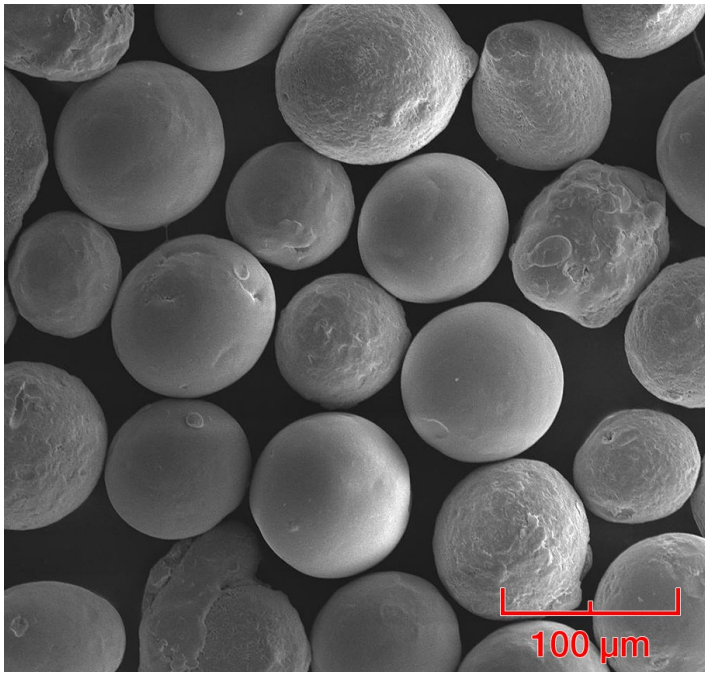
Products are available that can be applied using combustion powder Thermospray™, atmospheric plasma spray or HVOF.

1.1 Typical Uses and Applications

These alloys are used in a wide variety of industrial applications to provide enhanced wear and corrosion resistance. A select number of typical applications are:

- Oil industry sucker rods, slush pumps and gate valves
- Automotive valve seats, brake drums, rocker arms, cam followers, piston rings, cylinder liners, exhaust valve seats, dump valve plugs and seats, shifter forks
- Hot forming and extrusion dies
- Exhaust fans and dust collectors
- Hot crushing rolls and forging tools
- Buffing and polishing fixtures
- Concrete mixer screw conveyors
- Plug gages, lathe and grinder dead centers
- Tobacco grinding hammers
- Pump and valve seats and shafts
- Drum doctor blades
- Chip breakers
- Servomotor shafts
- Bond coat to improve adherence and oxidation resistance of a non-bonding thermal spray top coat

Quick Facts	
Classification	Self-fluxing alloy, nickel or cobalt based
Chemistry	Ni/Co Cr B Si C
Manufacture	Gas atomized
Morphology	Spheroidal
Service Temperature	≤ 750 °C (1380 °F)
Purpose	Wear and corrosion protection
Process	Combustion Powder Thermospray™, Atmospheric Plasma Spray, HVOF
Fusing Process	Manual torch, induction, furnace



Photomicrograph of a typical gas-atomized self-fluxing powder.

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2 Material Information

2.1 Chemical Composition

	Weight Percent (nominal)								
Product	**Ni**	**Co**	**Cr**	**B**	**Si**	**C**	**Fe**	**Cu**	**Mo**
Metco 11A	Bal.	–	15.0	3.0	4.5	0.65	3.5	–	–
Metco 11B	Bal.	–	15.0	3.0	4.5	0.65	3.5	–	–
Metco 11D	Bal.	–	15.0	3.0	4.5	0.65	3.5	–	–
Metco 12C	Bal.	–	7.5	1.7	3.5	0.25	2.5	–	–
Metco 14E	Bal.	–	11.0	2.2	3.7	0.5	2.75	–	–
Metco 15E	Bal.	–	17.0	3.5	4.0	1	4.0	–	–
Metco 15F	Bal.	–	17.0	3.5	4.0	1	4.0	–	–
Metco 16C-NS	Bal.	–	17.0	3.7	4.0	0.6	3.0	2.5	2.5
Metco 18C	27.0	40.0	18.0	3.0	3.5	0.2	2.5	–	6
Diamalloy 2001	Bal.	–	17.0	3.5	4.0	1	4.0	–	–
Metco 7010	Bal.	–	–	1.8	3.5	–	–	–	–
Metco 1721A	Bal	---	7.5	(report)	3.5	---	2.5	---	---

2.2 Particle Size Distribution

Product	**Nominal Range µm**	**Manufacture**
Metco 11A	–53 +20	Gas Atomized
Metco 11B	–106 +45	Gas Atomized
Metco 11D	–150 +63	Gas Atomized
Metco 12C	–125 +53	Gas Atomized
Metco 14E	–125 +45	Gas Atomized
Metco 15E	–106 +45	Gas Atomized
Metco 15F	–53 +15[a]	Gas Atomized
Metco 16C-NS	–125 +53	Gas Atomized Blend
Metco 18C	–125 +53	Gas Atomized
Diamalloy 2001	–45 +15	Gas Atomized
Metco 7010	–180 +53	Gas Atomized
Metco 1721A	-125 +20	Gas Atomized

Upper particle size analysis using sieve in accordance with ASTM B214; lower size analysis using laser diffraction (Microtrac), unless noted
[a] Particle size analysis by laser diffraction (Microtrac).

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2.3 Recommended Process

Product	CPS	APS	HVOF
Metco 11A	✖	✖	●
Metco 11B	●	●	✖
Metco 11D	✖	●	✖
Metco 12C	●	●	✖
Metco 14E	●	●	✖
Metco 15E	●	●	✖
Metco 15F	✖	●	◖
Metco 16C-NS	●	●	✖
Metco 18C	●	●	✖
Diamalloy 2001	✖	◖	●
Metco 7010	●	●	✖
Metco 1721A	✖	●	✖

● = Recommended; ◖ = Acceptable; ✖ = Not Recommended
CPS = Combustion Powder Thermospray™; **APS** = Atmospheric Plasma Spray; **HVOF** = High Velocity Oxygen Fuel Spray;

2.4 Key Selection Criteria

- The selection of a particular alloy depends on several factors:
- Desired coating hardness
  - Spray process to be used (Combustion Powder, Atmospheric Plasma or HVOF)
  - Required wear and corrosion resistance for the application
  - Coating fluidity during the fusing process
  - Type of finish machining / grinding required for the fused coating
  - Susceptibility to cracking on hardenable steel substrates
  - Desired surface finish of the fused coating
- Metco 11 series products optimized to provide better wetting and fusing behavior. Deposits of these materials provide:
  - Excellent fusing behavior with reduced porosity levels
  - Better batch-to-batch material consistency as well as deposition results due to their tightly controlled chemistry.
  - Somewhat lower deposit hardness compared to the Metco 15 series, but less susceptible to cracking depending on the parameters used.
- Metco 12C is recommended where a hardness of HRC 35 is sufficient for wear resistance and where machinability of the coating is important.
- Metco 14E coatings, with a fused hardness of HRC 45 – 50, are harder than Metco 12C coatings and suitable where thick, wear resistant coatings are desired. In this respect, these are better than the harder Metco 15E coatings, which may be susceptible to cracking when applied as a thick coating on highly hardenable steels.
- Coatings of Metco 14E are not easily machined, but can be ground to a good finish.
- In general, the wear resistance of Metco 15E, Metco 15F, Metco 16C-NS and Metco 18C are very similar despite differences in coating hardness.
- Metco 15E coatings have a typical hardness of HRC 60 and produce dense, pore-free coatings with high wear resistance and corrosion resistance.
- Metco 15F coatings are similar in composition and hardness to that of Metco 15E coatings, but are suitable for thin coatings with better surface finish and superior thickness control.
- Metco 15E and Metco 15F produce smooth surfaces that require very little stock removal after fusing to get a clean surface.
- Metco 16C-NS coatings are similar to Metco 15E coatings, but have superior resistance to corrosion against a variety of acids and aqueous media. They can also be applied much thicker than Metco 15E coatings and offer better resistance to cracking. Metco 16C-NS is the best choice when coatings thicker than 1.5 mm (0.06 in) are required, or for thinner coatings on complex geometries. However, coatings of Metco 16C-NS may require more stock removal after fusing to get a smooth, clean surface
- Metco 18C, a cobalt-based material which is recommended for use on substrates that cause cracking issues such as alloyed steels, 400 series steels. It is recommended for plungers used to produce glass molds.

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2.4 Key Selection Criteria (continued)

- Diamalloy 2001 is similar to Metco 15E and Metco 15F in composition and properties, but is designed for application with the HVOF process. As-sprayed coatings of Diamalloy 2001 are generally smoother and denser, with very clean surfaces that exhibit lower shrinkage during fusing compared to coatings of Metco 15E and Metco 15F.
- Metco 7010 is a chromium-free alloy that can be used in applications requiring high toughness and ductility with very good fluidity and wetting behavior. It is useful for both mild corrosion applications and buildup of worn parts. It can be blended with tungsten carbide to provide a wear-resistant coating with a high toughness matrix for impact wear applications.

2.5 Related Products

- Oerlikon Metco also offers a number of self-fluxing alloys blended with tungsten carbide. The matrix of these materials are nickel-based, with hardness of the fused coatings similar to the materials in this datasheet. However, the carbide phase will offer additional hardness and wear resistance, with particular resistance to abrasion and fretting. These products include:

Metco 31C-NS
Metco 36C
Metco 32C
Woka 7701
Metco 34F
Woka 7702
Metco 34FP
Woka 7703

Tungsten carbide powders that can be blended with the self-fluxing alloys in this datasheet are also available.

2.6 Customer Specifications

Product	Customer Specification
Metco 16C-NS	Rolls-Royce plc MSRR 9507/7

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3 Coating Information

3.1 Key Thermal Spray Coating Characteristics

Product	Fused Hardness	Approx. Fusing Temperature		Approx. Shrink During Fusing
Metco 11A	HRC 56 to 62	1040 to 1060 °C	1904 to 1940 °F	10 to 15 %
Metco 11B	HRC 56 to 62	1040 to 1060 °C	1904 to 1940 °F	20 to 25 %
Metco 11D	HRC 56 to 62	1040 to 1060 °C	1904 to 1940 °F	20 to 25 %
Metco 12C	HRC 37 to 43	1095 to 1115 °C	2005 to 2039 °F	20 to 25 %
Metco 14E	HRC 47 to 53	1065 to 1095 °C	1949 to 2003 °F	20 to 25 %
Metco 15E	HRC 58 to 64	1035 to 1065 °C	1895 to 1949 °F	20 to 25 %
Metco 15F	HRC 58 to 64	1035 to 1065 °C	1895 to 1949 °F	10 to 15 %
Metco 16C-NS	HRC 58 to 64	1035 to 1065 °C	1895 to 1949 °F	20 to 25 %
Metco 18C	HRC 48 to 54	1100 to 1130 °C	2012 to 2066 °F	20 to 25 %
Diamalloy 2001	HRC 58 to 64	1035 to 1065 °C	1895 to 1949 °F	10 to 15 %
Metco 7010	HRC 25 to 30	1055 to 1085 °C	1931 to 1985 °F	20 to 25 %
Metco 1721A	HRC 35 to 40	1050 to 1070 °C	1922 to 1958 °F	20 to 25 %

Note: Data presented represents laboratory test conditions. There may be some lot-to-lot variation or variation as a result of processing.

3.2 Processing Notes

Spray and fuse coatings using Metco self-fluxing alloys can be applied to many iron, nickel and cobalt based alloy substrates. While some of them require no special precautions, others require special preheating or cooling procedures to avoid cracking problems. Some alloy substrates are not compatible for spray and fuse coatings

Generally, components constructed from most SAE steels with less than 0.25 % carbon content, 405-series stainless steels, 430-series stainless steels (maximum carbon content of 0.1 %) and several nickel and cobalt based high-temperature alloys can be used without any special precautions.

For components constructed from austenitic stainless steels and highly hardenable martensitic stainless steels, special precautions are necessary to avoid cracking. For example, 300-series austenitic stainless steels require a preheat of approximately 315 – 370 °C (600 – 700 °F) prior to spraying to alleviate high expansion problems.

SAE steels with a carbon content greater than 0.25 % also require a preheat of approximately 260 – 370 °C (500 – 700 °F).

For martensitic stainless steels where martensitic transformations cause thermal expansion mismatches, a preheat prior to spraying and fusing should be followed by an isothermal annealing to avoid cracking.

Some free-machining stainless steels and stainless steels with high aluminum and / or titanium content are not suitable substrates for self-fluxing alloy coatings.

3.3 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 Thermal Spray Guns		
Combustion Powder	**Atmospheric Plasma**	**HVOF**
Metco 5P-II	Metco 3MBM	DiamondJet 2700
Metco 6P-II series *	Metco 9MBM	WokaJet series
Metco 6PT series	Metco F4MB series	WokaStar series
	TriplexPro series	
	SinplexPro series	

* Extension modules for which a 6P-II spray gun is required

3.4 Fusing

These coatings can be fused using an acetylene torch, an induction heating coil or batch-processed in a furnace.

Torch Fusing:

Adjust the torch to a slightly reducing flame with an oxygen to acetylene ratio of 3:4.

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3.4 Fusing (continued)

Preheat the work evenly from a distance of approximately 100 – 125 mm (4 – 5 in), moving the flame back and forth over the surface to a temperature of approximately 315 – 540 °C (600 – 1000 °F). Do not heat small areas to a high local temperature as the coating may expand rapidly and separate from the substrate.

After preheating, move the torch to a distance of approximately 32 mm (1.25 in) to the workpiece. Avoid the coating edges. Oscillate the torch slightly as the fusing point is reached. The coating will exhibit a glossy 'shine' when it fuses. Do not overheat or the coating may sag or run.

After fusing, cool the part slowly to avoid cracking of the coating. One way to cool slowly is to bury the part in vermiculite in a metal container.

Furnace Fusing:

While controlled atmosphere furnaces are recommended, precise atmosphere control is not essential. Avoid oxidizing atmospheres, particularly on large and heavy components that require extended furnace cycles. Therefore a hydrogen or Exogas reducing atmosphere is recommended.

Ramp the furnace temperatures to the recommended fusing temperature as fast as possible while avoiding distortion of the workpiece. Hold at temperature a sufficient time to complete fusing. Excessive time at the fusing temperature will result in diffusion of the coating, which may reduce coating hardness and corrosion resistance.

To cool, ramp down slowly to avoid part distortion and cracking of the coating. Quenching is not recommended.

Induction Fusing:

Use of induction coils to fuse these coat is a very good production fusing method, particularly for shafts, bushings and glass mold plungers. Use coils properly sized for the part to be fused.

3.5 Recommended Finishing Method

Adjust to low stock removal rates when grinding or machining. Where grinding is recommended, use 30 – 60 grit for rough grinding and 60 – 120 grit for finish grinding.

In some cases, customers have reported good success machining with boron-nitrided tools as an alternative to grinding for those coatings where grinding is recommended.

Product	Finishing Method
Metco 11A	Grinding, diamond
Metco 11B	Grinding, diamond
Metco 11D	Grinding, diamond
Metco 12C	Machining, carbide-tool
Metco 14E	Grinding, diamond (preferred) or green SiC
Metco 15E	Grinding, diamond (preferred) or green SiC
Metco 15F	Grinding, diamond (preferred) or green SiC
Metco 16C-NS	Grinding, diamond (preferred) or green SiC
Metco 18C	Grinding, diamond (preferred) or green SiC
Diamalloy 2001	Grinding, diamond (preferred) or green SiC
Metco 7010	Grinding, diamond (preferred) or green SiC
Metco 1721A	Machining, carbide-tool

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4 Commercial Information

4.1 Ordering Information and Availability

Product	Order No.	Package Size	Availability	Distribution
Metco 11A	1301201	5 kg (approx. 11 lb)	Stock	Global
Metco 11B	1301203	5 kg (approx. 11 lb)	Stock	Global
Metco 11D	1301206	5 kg (approx. 11 lb)	Stock	Global
Metco 12C	1002519	5 kg (approx. 11 lb)	Stock	Global
Metco 14E	1051112	10 lb (approx. 4.5 kg)	Stock	Global
Metco 15E	1051113	10 lb (approx. 4.5 kg)	Stock	Global
Metco 15F	1051117	10 lb (approx. 4.5 kg)	Stock	Global
Metco 16C-NS	1029071	10 lb (approx. 4.5 kg)	Stock	Global
Metco 18C	1000053	5 lb (approx. 2.25 kg)	Special Order	Global
Diamalloy 2001	1000787	5 lb (approx. 2.25 kg)	Stock	Global
Metco 7010 [a]	1083802	10 lb (approx. 4.5 kg)	Stock	Global
Metco 1721A	1308774	10 lb (approx. 4.5 kg)	Stock	Global

[a] When purchasing this product from an Oerlikon Metco facility in Germany, an authorized German export license (BAFA) is required. Please contact your Oerlikon Metco Account Representative or Customer Service for more information.

4.2 Handling Recommendations

- Store in the original container in a dry location.
- Carefully tumble contents prior to use to prevent segregation, but avoid breakdown of friable components.
- Open containers should be stored in a drying oven at temperatures to prevent moisture pickup. Avoid prolonged storage at elevated temperatures.

4.3 Safety Recommendations

See the correct SDS (Safety Data Sheet) for the product of interest localized for the country where the material will be used. SDS are available from the Oerlikon web site at www.oerlikon.com/metco (Resources – Safety Data Sheets).

Product	SDS No.
Metco 11A	50-2324
Metco 11B	50-2324
Metco 11D	50-2324
Metco 12C	50-100
Metco 14E	50-101
Metco 15E	50-413
Metco 15F	50-413
Metco 16C-NS	50-102
Metco 18C	50-103
Diamalloy 2001	50-413
Metco 7010	50-1039
Metco 1721A	50-2701

Information is subject to change without prior notice.

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