oerlikon
metco

Material Product Data Sheet
Pure Titanium and Titanium Alloy Powders

Powder Products:
Metco™ 4010 series, Metco 4012 series, Metco 4013 series, Metco 4015 series, Metco 4016 series, Metco 4023 series, Metco 4024 series, Metco 4027 series, Metco 4028 series, Metco 4030 series, Metco 4031 series, Metco 4032 series, Metco 4033 series

Quick Facts	
Classification	Titanium based
Chemical formula	Ti 99.5+ or Ti 6Al 4V
Manufacture	HDH (hydride-dehydride) or Atomization
Morphology	Angular, Porous / Blocky or Spherical
Apparent density	1.8 – 2.5 g/cm^3
Melting point	1649 (3000 °F)
Service Temperature	≤ 400 °C (750 °F)
Purpose	Corrosion resistance, biocompatibility
Process	ChamPro™ (LVPS, LPPS, VPS), Cold Spray, Laser Cladding / Laser Deposition (LC / LD), High Speed Laser Cladding (HS-LC), Metal Injection Molding (MIM), Hot Isostatic Pressing (HIP)

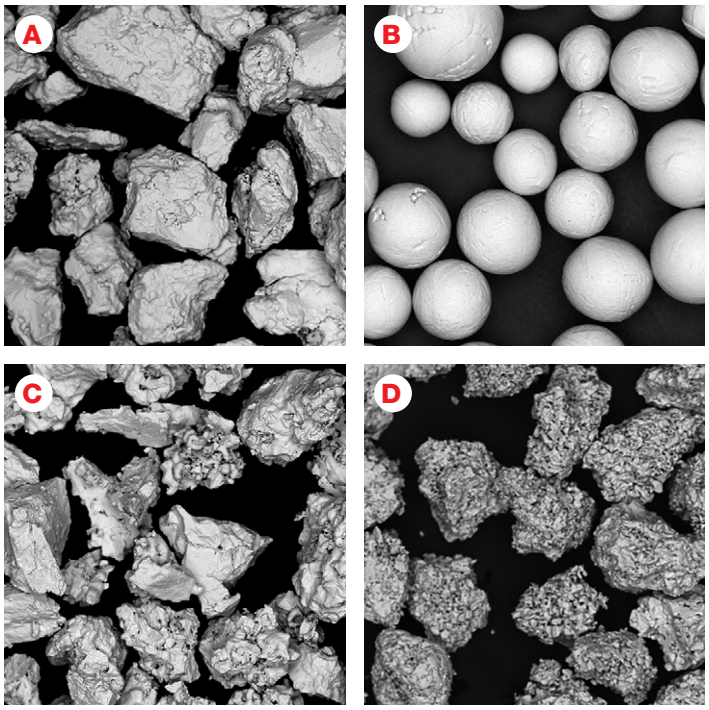
1 Introduction

Oerlikon Metco's titanium and titanium alloy powders produce coatings having a range of characteristics not found in any other thermal spray powder materials. The coatings are light in weight with high strength-to-weight ratio and resistant to most corrosives. Titanium readily combines with other metals to form useful alloys. Owing to these suitable mechanochemical properties, pure titanium and titanium alloy powders can be employed in a number of applications via chemical, powder metallurgy and thermal spray processes.

Thermal spray coatings of titanium-based materials are commonly used in medical applications where biologic compatibility is required. Additionally, these coatings may also be used as a potential bond coat for hydroxylapatite coatings that are often used as a top-coat on biomedical implants. Titanium powders may also be used to produce dense, corrosion resistant coatings. Titanium powders have strong affinity and reactivity with oxygen, hydrogen and nitrogen at high temperatures. Most of the thermal spray coatings from these powders are produced under controlled atmosphere conditions (low pressure or soft vacuum).

1.1 Typical Uses and Applications

- Biomedical applications (coatings on prosthetic implants)
- Corrosion resistant coatings
- Bond coat for hydroxylapatite coatings
- Metal injection molding applications
- Cold and hot isostatic pressing applications
- Repair of aerospace and automotive parts using LD / LD
- Cold spray applications



Typical powder morphologies. **A:** Powder from wrought raw material. **B:** Spherical powder. **C:** Powder from sponge (Kroll) raw material. **D:** Powder from sponge (Hunter) raw material.

2 Material Information

2.1 Chemistry

Product	Nominal Chemical Composition (wt. %)														
	Ti	Al	V	Fe max	C max	H max	O max	N max	Cu max	Sn max	Y max	Si max	Cl max	Mg max	Na max
CP Ti Grade 1															
Metco 4012 series	Bal.	---	---	0.20	0.08	0.015	0.18	0.03	---	---	---	---	---	---	---
Metco 4023 series	Bal.	---	---	0.20	0.08	0.015	0.18	0.03	---	---	---	---	---	---	---
CP Ti Grade 2															
Metco 4013 series	Bal.	---	---	0.30	0.08	0.015	0.25	0.03	---	---	---	---	---	---	---
Metco 4024 series	Bal.	---	---	0.30	0.08	0.015	0.25	0.03	---	---	---	---	---	---	---
Metco 4027 series	Bal.	---	---	0.30	0.08	0.015	0.25	0.03	---	---	---	---	---	---	---
CP Ti Grade 4															
Metco 4010 series	Bal.	---	---	0.50	0.08	0.015	0.40	0.05	---	---	---	---	---	---	---
Metco 4015 series	Bal.	≤0.05	---	0.15	0.03	0.03	0.40	0.02	---	---	---	0.04	0.20	---	0.19
Metco 4016 series	Bal.	≤0.05	---	0.15	0.03	0.03	0.40	0.02	---	---	---	0.04	0.20	0.20	---
Metco 4028 series	Bal.	---	---	0.50	0.08	0.015	0.40	0.05	---	---	---	---	---	---	---
Ti 6Al 4V Grade 5															
Metco 4030 series	Bal.	5.50 – 6.75	3.50 – 4.50	0.30	0.08	0.015	0.20	0.05	0.10	0.10	0.005	---	---	---	---
Metco 4031 series	Bal.	5.50 – 6.75	3.50 – 4.50	0.30	0.08	0.015	0.20	0.05	0.10	0.10	0.005	---	---	---	---
Ti 6Al 4V Grade 23															
Metco 4032 series	Bal.	5.50 – 6.50	3.50 – 4.50	0.25	0.08	0.012	0.13	0.05	0.10	0.10	0.005	---	---	---	---
Metco 4033 series	Bal.	5.50 – 6.50	3.50 – 4.50	0.25	0.08	0.012	0.13	0.05	0.10	0.10	0.005	---	---	---	---

2.2 Particle Size Distribution, ASTM Grade, and Other Properties

Product	Nominal Particle Size Distribution [a]		Grade (ASTM)	Manufacturing Method [c]	Morphology
	µm	mesh (ASTM) [b]			
Metco 4012A	-106 +45	-140 +325	Grade 1	HDH – wrought	Angular / Blocky
Metco 4023B	-106 +45	-140 +325		Atomized	Spherical
Metco 4013A	-106 +45	-140 +325	Grade 2	HDH – wrought	Angular / Blocky
Metco 4024B	-106 +45	-140 +325		Atomized	Spherical
Metco 4027A	-25 +5	-500 mesh +5 µm			
Metco 4010E	-350 +200	-350 µm +200 µm	Grade 4	HDH – wrought	Angular / Blocky
Metco 4010D	-250 +90	-60 +170			
Metco 4010B	-180 +75	-80 +200			
Metco 4010A	-90 +22	-170 mesh +22 µm			
Metco 4010C	-45 +11	-325 mesh +11 µm			
Metco 4015A	-125 +75	-120 +200		HDH – Hunter sponge	Porous / Blocky
Metco 4015B	-75 +45	-200 +325			
Metco 4015C	-250 +150	-60 +100			
Metco 4015D	-180 +75	-80 +200			
Metco 4016A	-180 +75	-80 +200		HDH – Kroll sponge	Angular / Blocky
Metco 4016B	-125 +90	-120 +170			
Metco 4016C	-160 +45	-160 µm +325 mesh			
Metco 4016D	-45	-325			
Metco 4028A	-45	-325		Atomized	Spherical
Metco 4030A	-250 +150	-60 +100	Grade 5	HDH – wrought	Angular / Blocky
Metco 4030B	-180 +75	-80 +200			
Metco 4030C	-106 +45	-140 +325			
Metco 4031A	-106 +45	-140 +325		Atomized	Spherical
Metco 4031C	-53 +20	-270 mesh +20 µm			
Metco 4031B	-25 +5	-500 mesh +5 µm			
Metco 4032A	-106 +45	-140 +325	Grade 23	HDH – wrought	Angular / Blocky
Metco 4033A	-106 +45	-140 +325		Atomized	Spherical
Metco 4033C	-53 +20	-270 mesh +20 µm			

[a] Analysis of particle size 45 µm (325 mesh) and above via sieve; analysis of particle size less than 45 µm (325 mesh) via wet laser diffraction
[b] Unless noted
[c] HDH – wrought: Hydride-dehydride process from wrought raw materials; HDH – sponge: Hydride-dehydride process from sponge raw material

2.3 Key Selection Criteria

- Use coarser pure titanium powders such as Metco 4010E, Metco 4010D or Metco 4010B and titanium alloy powders such as Metco 4030A or Metco 4030B to produce coatings with very high surface roughness and porosity. These types of coatings are often desirable for biomedical implant applications because the porous structure is believed to promote bone growth onto the implants.
- Use fine powders such as Metco 4010C to produce relatively smooth and dense coatings. These types of coatings may be suitable for applications requiring corrosion resistance.
- Grade 4 and Grade 5 titanium powders are recommended for use in biomedical applications.
- For some biomedical applications, layers of both the fine and the coarse powders may be applied serving different functions.
- Metco 4015 A through D are highly porous Ti sponge powders and free from any elongated (needle like) particles. These types of powders can not only be used for thermal spray coatings, but can also be used for cold spray.
- Metco 4016A and Metco 4016B are sponge products which are less dense and exhibit porosity in the powder particles. These types of powders can not only be used for thermal spray coatings, but can also be used to form parts using HIP (Hot Isostatic Pressing).
- HDH powder products are less expensive than atomized powder products.
- Atomized products are comprised of dense powder particles that are highly spreadable. These products will also give the best results for processes that require a high packing density to achieve high loading, such as MIM.

2.4 Recommended Processes

The table below indicates recommended use for each product; however, for specific applications, customers can choose to use the products for other processes.

Product	ChamPro	Cold Spray	LC / LD	HS-LC	MIM	HIP
Metco 4010A	✓					
Metco 4010B	✓					
Metco 4010C	✓	✓		✓		
Metco 4010D	✓					
Metco 4010E	✓					
Metco 4012A	✓		✓			
Metco 4013A	✓		✓			
Metco 4015A	✓	✓				
Metco 4015B	✓	✓				
Metco 4015C	✓					
Metco 4015D	✓					
Metco 4016A	✓					
Metco 4016B	✓					
Metco 4016C	✓					✓
Metco 4016D	✓	✓		✓	✓	✓
Metco 4023B			✓			✓
Metco 4024B			✓			✓
Metco 4027A		✓		✓	✓	
Metco 4028A		✓		✓	✓	
Metco 4030A	✓					
Metco 4030B	✓					
Metco 4030C	✓					
Metco 4031A			✓			✓
Metco 4031B		✓			✓	
Metco 4031C		✓	✓	✓	✓	
Metco 4032A	✓		✓			
Metco 4033A			✓			✓
Metco 4033C		✓	✓	✓	✓	

2.6 Specifications

Product	Specification
CP Ti Grade 1	
Metco 4012 series	ASTM B348 (chemistry only)
Metco 4023 series	
CP Ti Grade 2	
Metco 4013 series	ASTM B348 (chemistry only)
Metco 4024 series	
Metco 4027 series	
CP Ti Grade 4	
Metco 4010 series	ASTM F1580
Metco 4015 series	
Metco 4016 series	
Metco 4028 series	
Ti 6Al 4V Grade 5	
Metco 4030 series	ASTM F1580 SAE International AMS 4998
Metco 4031series	
Ti 6Al 4V Grade 23	
Metco 4032 series	ASTM F136 (chemistry only)
Metco 4033 series	

3 Coating Information

3.1 Key Thermal Spray Coating Information

Application in inert or vacuum atmospheres are recommended to prevent excessive fuming and oxidation that can have an undesirable affect the coating microstructure and properties and to avoid hazardous conditions.

3.2 Cold Spray Applications

Highly porous and very low density titanium powders can be used to produce cold spray coatings with extremely low internal coating porosity.

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.

4 Commercial Information

4.1 Ordering Information and Availability

Product	Order No.	Package Size	Availability	Distribution
Metco 4010A	1098594	1.5 kg (approx. 3.3 lb)	Stock	Global
Metco 4010B	1101154	1.5 kg (approx. 3.3 lb)	Stock	Global
Metco 4010C	1101155	1.5 kg (approx. 3.3 lb)	Stock	Global
Metco 4010D	1101156	1.5 kg (approx. 3.3 lb)	Stock	Global
Metco 4010E	1096845	1.5 kg (approx. 3.3 lb)	Stock	Global
Metco 4012A	1101157	1.5 kg (approx. 3.3 lb)	Stock	Global
Metco 4013A	1101158	1.5 kg (approx. 3.3 lb)	Stock	Global
Metco 4015A	1303041	1.0 kg (approx. 2.2 lb)	Stock	Global
Metco 4015B	1303043	1.0 kg (approx. 2.2 lb)	Stock	Global
Metco 4015C	1303045	1.0 kg (approx. 2.2 lb)	Stock	Global
Metco 4015D	1303046	1.0 kg (approx. 2.2 lb)	Stock	Global
Metco 4016A	1060305	1.5 kg (approx. 3.3 lb)	Stock	Global
Metco 4016B	1072415	1.5 kg (approx. 3.3 lb)	Stock	Global
Metco 4016C	1302026	1.5 kg (approx. 3.3 lb)	Stock	Global
Metco 4016D	1302025	1.5 kg (approx. 3.3 lb)	Stock	Global
Metco 4023B	1101162	2.5 kg (approx. 5.5 lb)	Stock	Global
Metco 4024B	1101163	2.5 kg (approx. 5.5 lb)	Stock	Global
Metco 4027A	1101169	2.5 kg (approx. 5.5 lb)	Stock	Global
Metco 4028A	1101170	2.5 kg (approx. 5.5 lb)	Stock	Global
Metco 4030A	1099885	10 lb (approx 4.5 kg)	Stock	Global
Metco 4030B	1099886	10 lb (approx 4.5 kg)	Stock	Global
Metco 4030C	1101159	1.5 kg (approx. 3.3 lb)	Stock	Global
Metco 4031A	1101164	2.5 kg (approx. 5.5 lb)	Stock	Global
Metco 4031B	1101165	2.5 kg (approx. 5.5 lb)	Stock	Global
Metco 4031C	1101166	2.5 kg (approx. 5.5 lb)	Stock	Global
Metco 4032A	1101160	1.5 kg (approx. 3.3 lb)	Stock	Global
Metco 4033A	1101167	2.5 kg (approx. 5.5 lb)	Stock	Global
Metco 4033C	1101168	2.5 kg (approx. 5.5 lb)	Stock	Global

4.2 Handling Recommendations

- Store in the original container in a dry location.
- Open containers should be stored in a drying oven below 38°C (100 °F) to prevent moisture pickup.
- Tumble contents prior to use to prevent material segregation.

4.3 Safety Recommendations

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

Product	SDS No.
Metco 4010A	50-2241
Metco 4010B	50-2246
Metco 4010C	50-2241
Metco 4010D	50-2246
Metco 4010E	50-2246
Metco 4012A	50-2241
Metco 4013A	50-2241
Metco 4015A	50-2303
Metco 4015B	50-2303
Metco 4015C	50-2303
Metco 4015D	50-2303
Metco 4016A	50-2246
Metco 4016B	50-2246
Metco 4016C	50-2241
Metco 4016D	50-2241
Metco 4023B	50-2241
Metco 4024B	50-2241
Metco 4027A	50-2241
Metco 4028A	50-2241
Metco 4030A	50-1078
Metco 4030B	50-1078
Metco 4030C	50-1078
Metco 4031A	50-1078
Metco 4031B	50-2149
Metco 4031C	50-2149
Metco 4032A	50-1078
Metco 4033A	50-1078
Metco 4033C	50-2149

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