Datasheet

Austenitic stainless steel

Osprey® 316L

Osprey® 316L is an austenitic chromium-nickel steel with minimum 2.0% molybdenum and a low carbon content. It has good corrosion resistance to most chemicals.

UNS

S31600, S31603

ASTM, AISI

316, 316L

EN Name

X 5 CrNiMo 17-12-2, X 2 CrNiMo 17-12-2

EN Number

1.4401, 1.4404

BS

316S14

AFNOR

Z3CND18-14-03

Powder designed for

Additive Manufacturing (AM)

Cold spray
Hot Isostatic Pressing (HIP)
Metal Injection Moulding (MIM)
Micro-MIM
Sintered metal filters and foams

Product description

Osprey® 316L is an austenitic chromium-nickel steel with minimum 2.0% molybdenum and a low carbon content. It has good corrosion resistance to most chemicals and a high creep strength at elevated temperatures. The low carbon content reduces the possibility of in vivo corrosion in medical applications.

Thismetal powder is manufactured by Inert Gas Atomization (IGA), producing a powder with a spherical morphology which provides good flow characteristics and high packing density. In addition, the powder has a low oxygen content and low impurity levels, resulting in a metallurgically clean product with enhanced mechanical performance.

Chemical composition (nominal), %

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Fe	Bal.
C	≤0.03
Cr	16.0-18.0
Ni	10.0-14.0
Mo	2.0-3.0
Si	≤1.0
Mn	≤2.0
S	≤0.03
P	≤0.045
Other	N ≤0.10

Powder characteristics and morphology

Powder for Additive Manufacturing

Osprey® metal powder for Additive Manufacturing is characterized by a spherical morphology and high packing density, which confer good flow properties. For powder bed processes these are essential when applying fresh powder layers to the bed to ensure uniform and consistent part build.

For blown powder processes, such as Direct Energy Deposition (DED), good flow ensures uniform build rates. Tight control of the particle size distribution also helps ensure good flowability. Low oxygen powders result in clean microstructures and low inclusion levels in the finished parts.

Powder for Cold spray

Osprey® metal powder for cold spray is characterized by a spherical morphology and good flow properties. Accurate control of the powder composition and particle size distribution ensure consistent performance both throughout a single batch as well as between different batches of the same alloy.

Powder for Hot Isostatic Pressing (HIP)

Osprey® HIP powder has a spherical morphology, resulting in high packing density. In addition, the powder has a low oxygen content and low impurity levels, resulting in a metallurgically clean product with enhanced mechanical performance.

Powder for Metal Injection Moulding (MIM)

Osprey® MIM powder has a spherical morphology, resulting in high packing density. This enables the manufacture of feedstocks with high powder loading, which not only minimizes binder costs but also reduces part shrinkage during debinding and sintering. Spherical powder also has excellent flow characteristics, resulting in reduced tool wear and consistent mould filling.

Osprey® MIM powder's low oxygen content allows better control of carbon and consistency during sintering. Low oxygen levels, together with high packing density, also facilitate faster sintering.

Powder for Micro-MIM

Osprey® Micro-MIM powder has a spherical morphology, resulting in high packing density. This enables the manufacture of feedstocks with high powder loading, which not only minimizes binder costs but also reduces part shrinkage during debinding and sintering. Spherical powder also has excellent flow characteristics, resulting in reduced tool wear and consistent mould filling.

Osprey® Micro-MIM powders' low oxygen content allows better control of carbon and consistency during sintering. Low oxygen, together with high packing density, also facilitates faster sintering

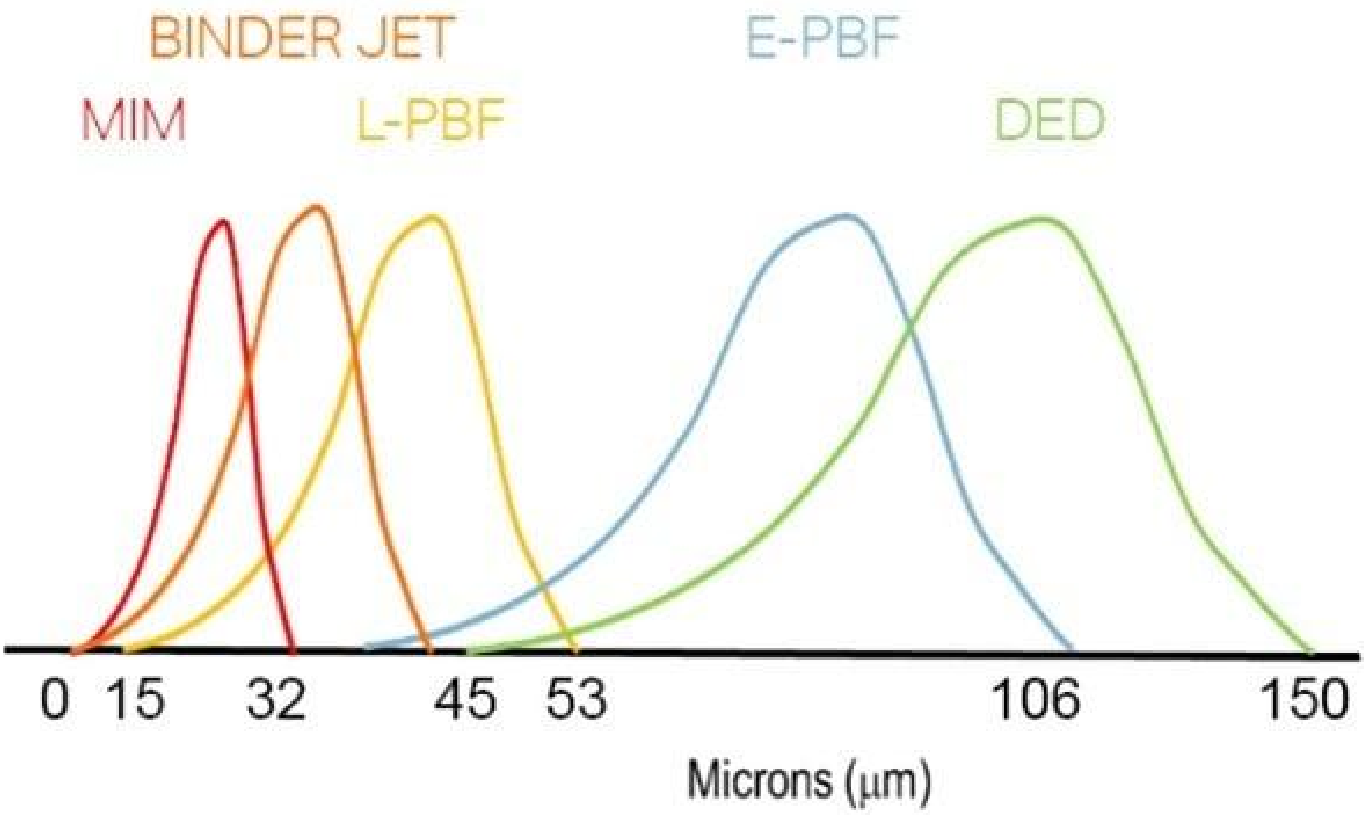
Powder for sintered metal filters and foams

Osprey® metal powder for sintered metal filters and foams is characterized by a spherical morphology, which results in excellent packing density during processing. Accurate control of the powder composition and particle size distribution ensure consistent performance both throughout a single batch as well as between different batches of the same alloy.

Particle size distribution

Powder for Additive Manufacturing

Osprey® metal powder for Additive Manufacturing is available in a wide range of particle size distributions that are tailored to the individual Additive Manufacturing systems. They can also be tailored to the particular requirements of the end application, both in terms of mechanical performance and surface finish.



Process technology	Size (µm)
Binder jetting	≤ 16, ≤ 22, ≤ 32, ≤ 38, ≤ 45
Laser - Powder Bed Fusion (L-PBF)	15 to 53 and 10 to 45
Electron beam - Powder Bed Fusion (E-PBF)	45 to 106
Direct Energy Deposition (DED)	53 to 150

Powder for Cold spray

Osprey® metal powder for Cold spray is available in a wide range of particle size distributions, from 5 µm to 45 µm. Our standard range of Cold spray powder includes the following particle size distributions:

20 to 45 µm

15 to 38 µm
10 to 32 µm
5 to 25 µm

Powder for Hot Isostatic Pressing (HIP)

Osprey® powder for Hot Isostatic Pressing (HIP) is available in a broad size range, typically <250 microns, resulting in a high packing density and tap density. Low oxygen levels, together with high packing density, also facilitate faster sintering.

Powder for Metal Injection Moulding (MIM)

Osprey® metal powder for Metal Injection Moulding (MIM) is available in a wide range of particle size distributions, from under 5 µm up to 38 µm. The table shows our standard particle size distributions for MIM powders.

Size (µm)	D10 (µm)	D50 (µm)	D90 (µm)
≤ 38	5.5	13.0	31.0
≤ 32	5.0	12.0	29.0
80% ≤ 22	4.5	11.5	27.0
90% ≤ 22	4.0	10.5	22.0
90% ≤ 16	3.5	8.0	16.0

- Particle size measurements performed using a Malvern laser particle size analyzer, typical D10, D50 and D90 provided.

Powder for Micro-MIM

Osprey® metal powder for Micro-Metal Injection Moulding (Micro-MIM) has the following typical particle size distributions:

	D10 (%)	D50 (%)	D90 (%)
90% – 10 µm	3.0	5.7	9.8
80% – 5 µm	1.9	3.4	6.0

*Particle size measurements performed using a Malvern laser particle size analyzer.

Tailor-made particle size distributions are available on request.Contact us to discuss your specific requirements.

Mechanical properties

Typical mechanical properties of material produced by Laser - Powder Bed Fusion (L-PBF) and binder jetting. The mechanical properties of Osprey® 316L differ based on the Additive Manufacturing (AM) process, where L-PBF material in the as-built condition offers increased tensile strength, but a lower elongation compared to binder jetting material, which has comparable mechanical properties to Metal Injection Moulding (MIM).

The mechanical properties presented are based on a standard L-PBF process with an increased layer thickness at 60 μm, which provides an efficient build speed. Similarly, the binder jetting process provides a high-productivity AM process to produce large components, compared to MIM, for a wide range of applications based on Osprey® 316L powder.

The mechanical properties presented are based on material printed by a commercially available binder jetting process, incorporating debinding and sintering. Osprey® 316L powder is based on a fine 90% less than 22 μm size distribution, which is identical to powder used in MIM. The provided data is based on material sintered, in hydrogen, over a range of temperatures from 1,310–1,410°C (2,390–2,570°F), with optimum temperature at 1,390°C (2,534°F), which typically produces material with low levels of porosity (<1%).

Metric units

Condition	Direction	Yield strength ($R_{p0.2}$), MPa	Tensile strength (R_m), MPa	E-modulus, MPa1)	Elongation (A), %	Hardness, HV
L-BPF, as built	Horizontal	573 +/−4	695 +/−1	196 +/−10	35 +/−1	200 +/−10
L-BPF, as built	Vertical	507 +/−3	645 +/−2	196 +/−9	42 +/−1	221 +/−5
Binder jetting, as sintered	-	200 +/−5	500 +/−15	160 +/−20	60 +/−3	130 +/−40

Imperial units

Condition	Direction	Yield strength (R	Tensile strength (R	E-modulus, ksi1)	Elongation (A), %	Hardness, HV

Condition	Direction	p0.2), ksi	m), ksi	E-modulus, ksi1)	Elongation (A), %	Hardness, HV
L-BPF, as built	Horizontal	84 +/−0.6	101 +/−0.1	28.4 +/−1.5	35 +/−1	200 +/−10
L-BPF, as built	Vertical	74 +/−0.4	94 +/−0.3	28.6 +/−1.3	42 +/−1	221 +/−5
Binder jetting, as sintered	-	29 +/−0.7	73 +/−2.2	23.2 +/−2.9	60 +/−3	130 +/−40

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Physical properties

Wrought material, typical values

Density	7.99 g/cm3 (0.29 lb/in3)
Thermal conductivity	16.2 W/mK
Coefficient of thermal expansion*	16 10-6K-1
Melting range	1,371–1,399 °C (2,500–2,550 °F)

*In the range of 0–100°C (32–212°F)

Corrosion resistance

General corrosion

Osprey® 316L has good resistance to:

Organic acids at high concentrations and temperatures, with the exception of formic acid and acids with corrosive contaminants
Inorganic acids, e.g. phosphoric acid, at moderate concentrations and temperatures, and sulfuric acid below 20% at moderate temperatures. The steel can also be used in sulfuric acid of concentrations above 90% at low temperature

Salt solutions, e.g. sulfates, sulfides and sulfites

Intergranular corrosion

Osprey® has a low carbon content and therefore better resistance to intergranular corrosion than other steels of type ASTM 316.

Pitting and crevice corrosion

Resistance of these types of corrosion improves with molybdenum content. Osprey® 316L has substantially higher resistance to attack than steels of type ASTM 304.

Stress corrosion cracking

Austenitic steels are susceptible to stress corrosion cracking. Stress corrosion cracking may occur if the steel is simultaneously exposed to the following:

Tensile stresses
Certain solutions, particularly those containing chlorides
Temperatures above 60°C (140°F)

Such service conditions should therefore be avoided. Conditions when plants are shut down must also be considered, as the condensates which are then formed can develop a chloride content that leads to both stress corrosion cracking (SCC) and pitting.

Gas corrosion

Osprey® 316L can be used in:

Air up to 850 °C (1,560 °F)
Steam up to 750 °C (1,380 °F)

In flue gases containing sulphur, the corrosion resistance is reduced. In such environments Sandvik 316L can be used at temperatures up to 600–750 °C (1,110–1,380 °F) depending on service conditions. Factors to consider are
whether the atmosphere is oxidizing or reducing, i.e., the oxygen content, and whether impurities such as sodium and vanadium are present.

Testing

All Osprey® metal powders are supplied with a certificate of analysis containing information on the chemical composition and particle size distribution. Information on other powder characteristics is available upon request.

Packaging

A wide range of packaging options is available, from 5kgs plastic bottles to 250kg metal drums.

5 kg (11 lbs) Plastic bottles
6 kg (13 lbs) Plastic bottles
10 kg (22 lbs) Plastic bottles
20 kg (44 lbs) Metal cans
100 kg (220 lbs) Steel drums
150 kg (330 lbs) Steel drums
250 kg (551 lbs) Steel drums
All packaging materials are suitable for air, sea and road freight.

Contact us for more information and to discuss your packaging requirements.

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