Datasheet
Titanium alloys

Osprey® Ti-6Al-4V-ELI (Grade 23)

Osprey® Ti-6Al-4V-ELI (Grade 23) is a titanium grade alloyed with aluminium and vanadium, especially developed for Additive Manufacturing (according to ASTM F3001-14), as well as for HIP.

UNS
R56407

ASTM, AISI
F3001-14

EN Number
3.7165

SAE
AMS7015

Powder designed for

- Additive Manufacturing (AM)
- Hot Isostatic Pressing (HIP)
- Metal Injection Moulding (MIM)

Product description

Osprey® Ti-6Al-4V-ELI* (Grade 23) is a titanium grade alloyed with aluminium and vanadium, especially developed for Additive Manufacturing (according to ASTM F3001-14), as well as for Hot Isostatic Pressing (HIP).

The grade is characterized by high strength, very good corrosion resistance and low density. It is similar to Osprey® Ti-6Al-4V (Grade 5) but has a lower content of oxygen, nitrogen and iron, resulting in, for example, higher ductility. Osprey® Ti-6Al-4V-ELI (Grade 23) is typically used for medical implants as well as for aerospace and chemical processing applications.

Osprey® titanium powder is manufactured to the highest international quality management standards, for example, AS9100D (aerospace) and ISO 13485:2016 (medical).

*Extra low interstitials

Chemical composition (nominal), %

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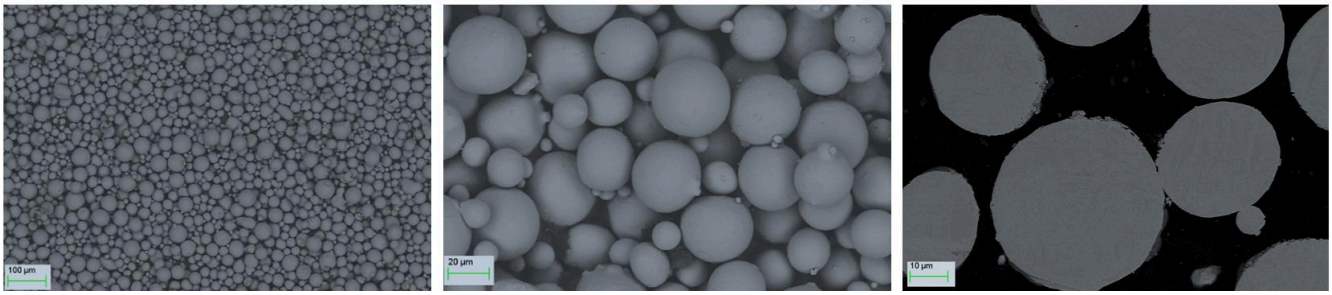
Ti	Bal.
Al	5.50-6.50
V	3.5-4.5
Fe	≤0.25
O	≤0.13
C	≤0.08
N	≤0.05
H	≤0.012
Y	≤0.005
Other, each	≤0.10
Other, all	≤0.40

Powder characteristics and morphology

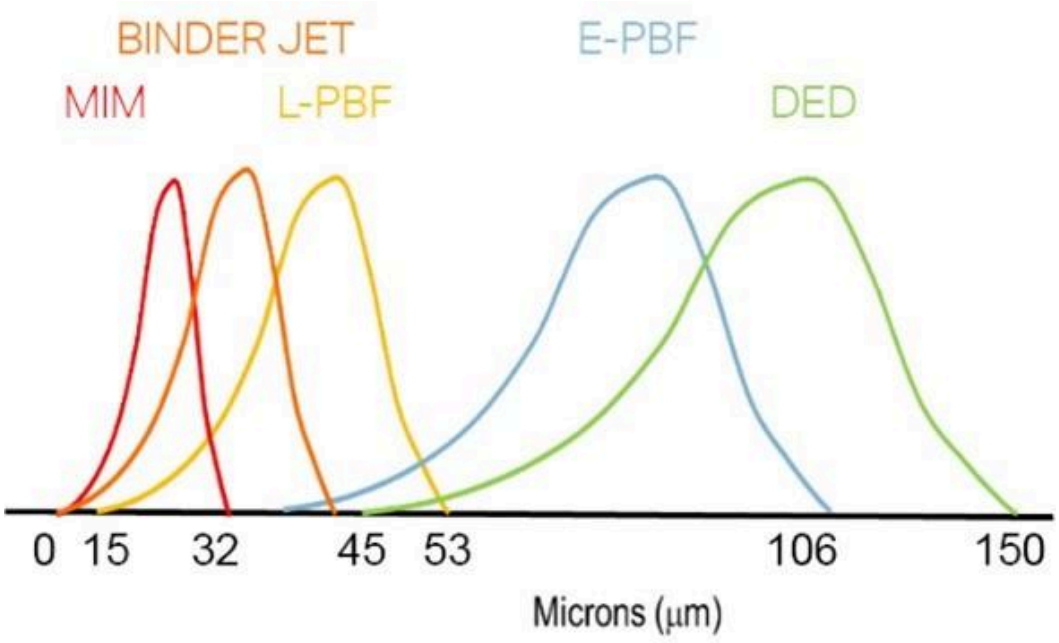


SEM micrographs of -63 +20 µm powder with a spherical morphology (HS Circularity 0.95), smooth surface and low level of powder satellites (magnifications x100 and x250) and a section through the powder (magnification x1000), with no visible internal porosity.

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.



Typical particle size distributions for Additive Manufacturing.

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 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)

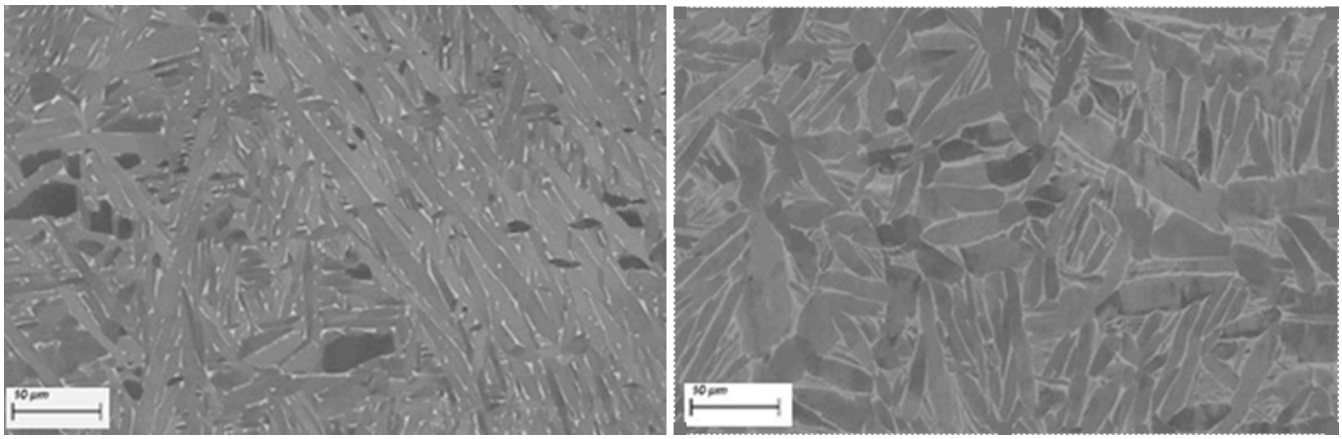
Osprey® metal powder for Metal Injection Moulding (MIM) is available in a wide range of particle size distributions, from under 5 µm up to 38 µm. The table shows our standard particle size distributions for MIM powders.

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.

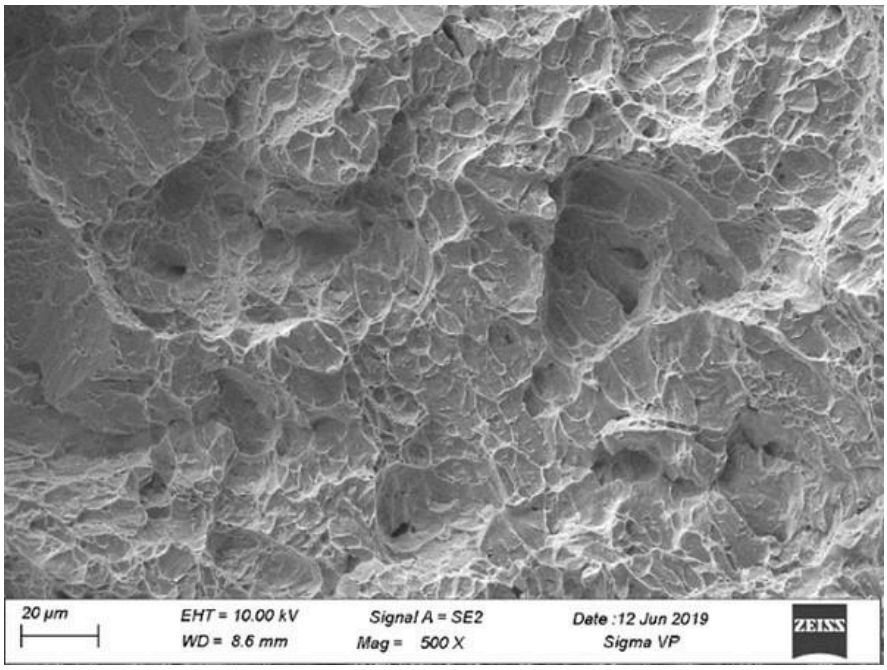
Tailor-made particle size distributions are available on request. Contact us to discuss your specific requirements.

Microstructure

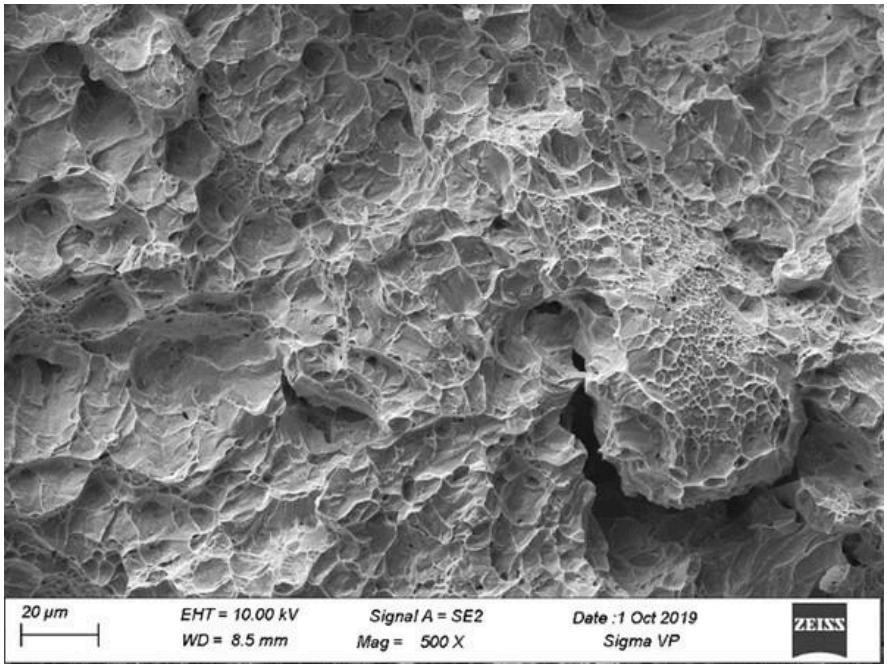


SEM micrographs of Osprey® TI-6AL-4V-ELI (Grade 23) Laser - Powder Bed Fusion (L-PBF) material in a heat-treated condition (solution annealed at 850 °C/1,562 °F for 2h in argon) on the left, featuring a fine lamellar and dense microstructure is identified which originates from the decomposition of martensitic α' as expected; showing a phase transformation that gave rise to a coarser structure consisting of a α phase matrix (grey) and an interlamellar β phase (bright).

The difference in microstructure for vertical and horizontal builds is not significant. The mechanical properties of heat-treated L-PBF material are provided below. The microstructure, shown on the right, for L-PBF material after Hot Isostatic Pressing (HIP), which results in a coarsening of the grain size. The mechanical properties of HIP material are similar to that of the heat-treated material with an improvement in impact toughness, especially in the vertical direction.



SEM micrograph of Osprey® TI-6AL-4V-ELI (Grade 23) Laser - Powder Bed Fusion (L-PBF) material in a heat-treated condition, featuring ductile fracture surface.



SEM micrograph of Osprey® TI-6AL-4V-ELI (Grade 23) Hot Isostatic Pressing (HIP) material, featuring ductile fracture surface.

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Mechanical properties

Typical mechanical properties of material produced by Laser - Powder Bed Fusion (L-PBF) after solution annealing at 850°C/1,562°F for 2h, followed by air cooling and a combination of solution annealing with Hot Isostatic Pressing (HIP) at 920°C/1,688°F for 2h with a pressure of 100 MPa/ 14.5 ksi, followed by furnace cooling.

Condition	Direction	Yield strength (Rp0.2), MPa	Tensile strength (Rm), MPa	E-modulus, GPa	Elongation (A), %	Impact toughness, J
As built	Horizontal	957 +/−7	1,076 +/−6	119 +/−2	14.4 +/−0.6	23 +/−0.5
As built	Vertical	997 +/−6	1,094 +/−4	122 +/−2	15.5 +/−0.5	22 +/−0.9
HIP	Horizontal	906 +/−2	1,014 +/−1	125 +/−3	17.7 +/−0.8	23 +/−0.7
HIP	Vertical	915 +/−8	1,015 +/−4	126 +/−3	17.2 +/−0.4	23 +/−0.8

Condition	Direction	Yield strength (Rp0.2), ksi	Tensile strength (Rm), ksi	E-modulus, ksi	Elongation (A), %	Impact toughness, ft/ lb
As built	Horizontal	139 +/−1	156 +/−1	17,260 +/− 290	14.4 +/−0.6	17.0 +/−0.4
As built	Vertical	145 +/−1	159 +/−1	17,695 +/− 290	15.5 +/−0.5	16.2 +/−0.7
HIP	Horizontal	131 +/−1	147 +/−1	18,130 +/− 435	17.7 +/−0.8	17.0 +/−0.5
HIP	Vertical	133 +/−1	147 +/−1	18,275 +/− 435	17.2 +/−0.4	18.4 +/−0.6

Hardness

Typical Vickers Hardness (HV) levels (ASTM E92, ISO 6507-1, JIS Z2244, GB/T 4340.1) as well as HRC values of Osprey® TI-6AL-4V-ELI (Grade 23) material in the Laser - Powder Bed Fusion (L-PBF) heat-treated condition.

Condition	Direction	HV	HRC
Heat treated	Horizontal	344 +/−4	34
Heat treated	Vertical	346 +/−4	34
HIP	Horizontal	329 +/−4	32
HIP	Vertical	329 +/−4	32

Surface roughness

Typical surface roughness (Ra), of Osprey® TI-6AL-4V-ELI (Grade 23) in the Laser - Powder Bed

Fusion (L-PBF) heat-treated condition.

Direction	Roughness (RA), µm
Horizontal	8.4 +/−0.9
Vertical	9.0 +/−0.2

High cycle fatigue at 350MPa, of Osprey® TI-6AL-4V-ELI (Grade 23) in the L-PBF heat-treated condition, at different build orientations and surface roughness conditions.

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.