Datasheet
Maraging steel

Osprey® MAR-60

Osprey® MAR-60 is an ultra-high hardness maraging steel alloyed with cobalt, nickel and molybdenum. It is typically used for conformal-cooled mould tooling applications that require high levels of performance.

ASTM, AISI

13Ni400

EN Name

X 2 NiCoMo 13 15 10

Powder designed for

- Additive Manufacturing (AM)
- Metal Injection Moulding (MIM)

Product information

Osprey® MAR-60 is an ultra-high hardness maraging steel alloyed with cobalt, nickel and molybdenum. The alloy is typically used for conformal-cooled mould tooling applications that require high levels of performance, such as injection mold tools, extrusion tools, die casting dies, cores and core pins.

This metal 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.

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Chemical composition (nominal), %

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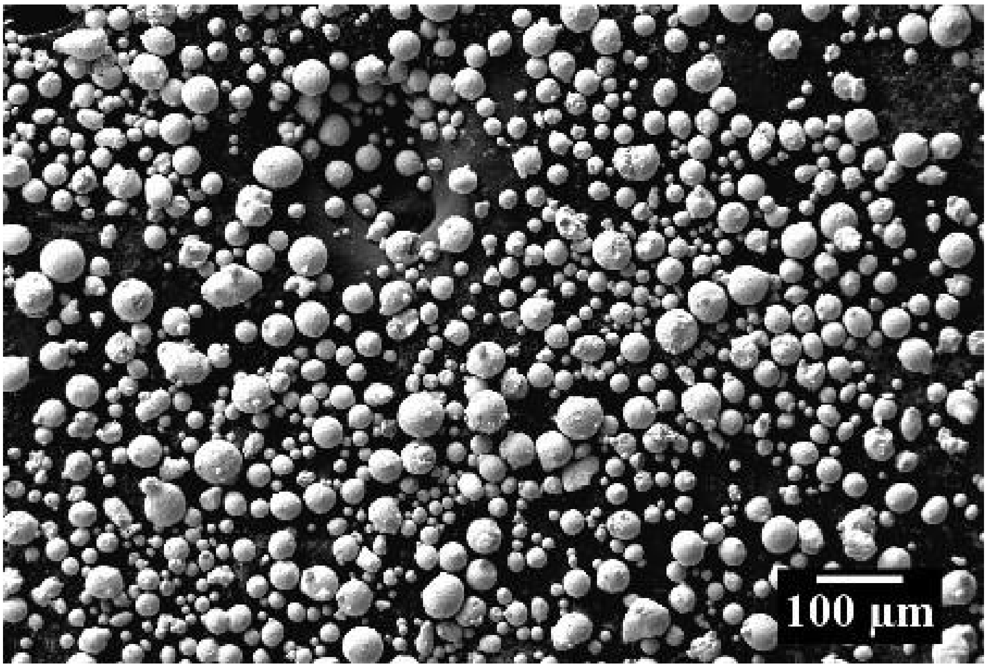
Fe	Bal.
C	≤0.03
Cr	≤0.3
Ni	13.0
Mo	10.0
Co	15.0
Ti	0.20
Al	0.01
Mn	≤0.1
Si	≤0.1
P	≤0.01
S	≤0.01
O	≤0.1
N	≤0.1

Powder characteristics and morphology

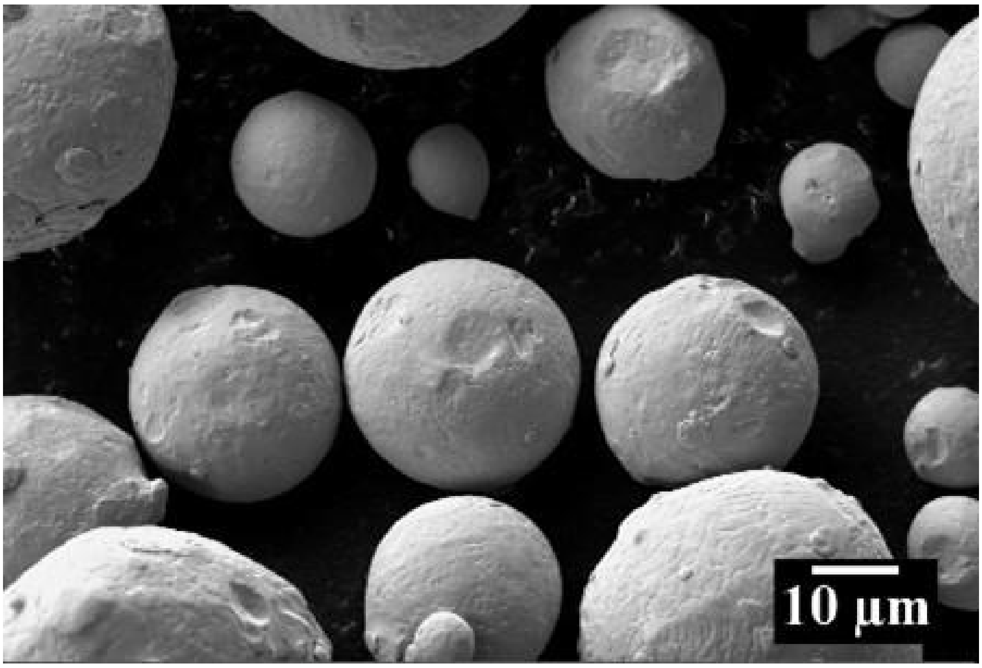
Powder for Additive Manufacturing

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.

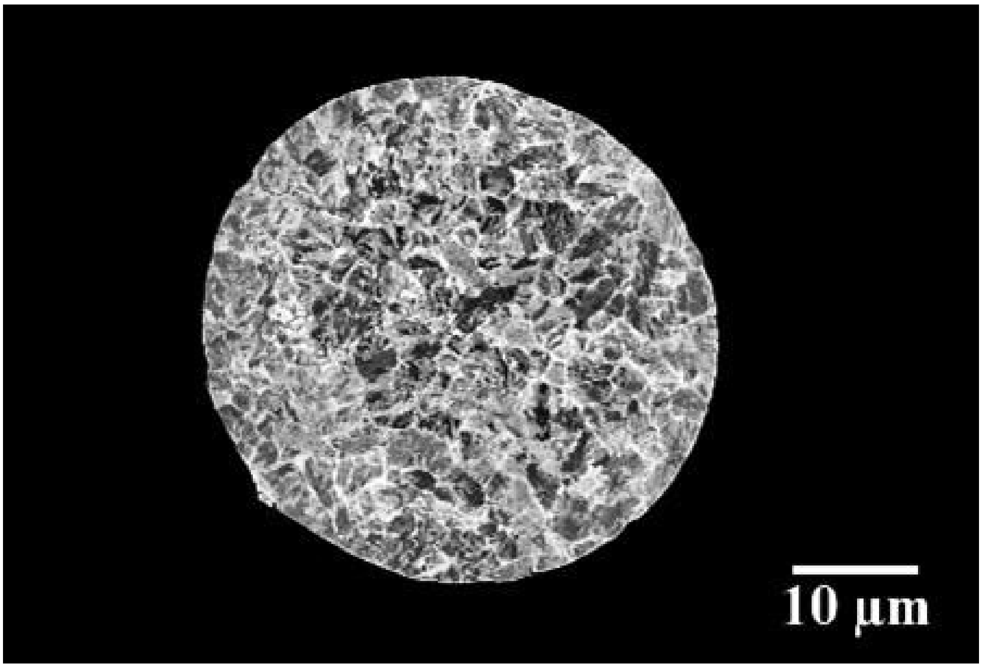
For blown powder processes, such as Direct Energy Deposition (DED), good flow ensures uniform build rates. Tight control of the particle size distribution also helps ensure good flowability. Low oxygen powders result in clean microstructures and low inclusion levels in the finished parts.



SEM micrograph of -53 +15 µm powder with spherical morphology



SEM micrograph of -53 +15 µm powder with smooth surface and low level of powder satellites



Micrograph of of -53 +15 µm powder in cross section, in back-scatted electron mode, highlighting the fine cellular structure

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.

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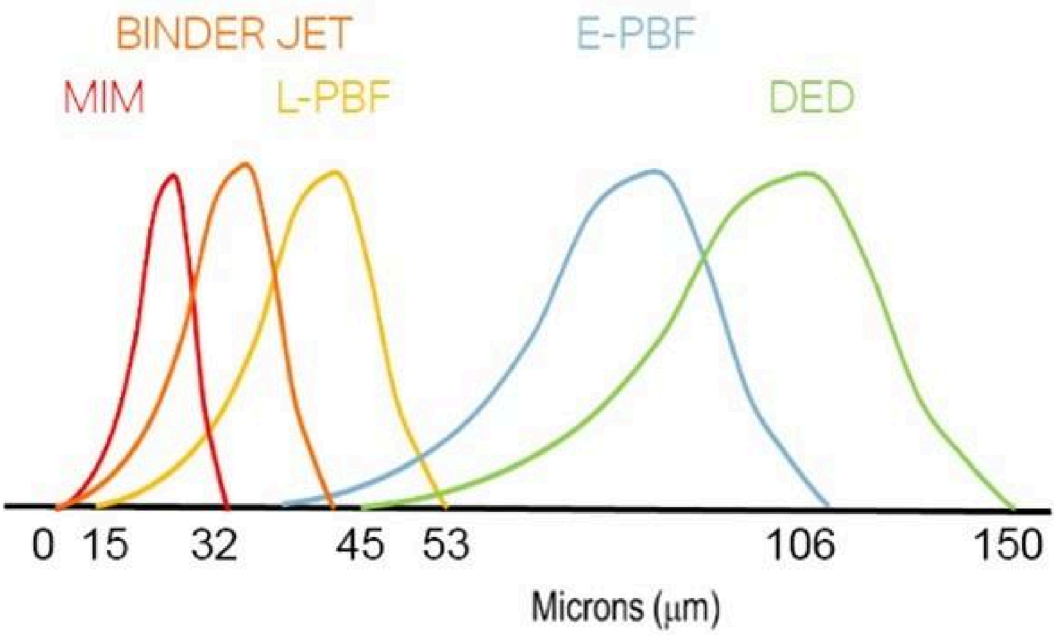
Particle size distribution

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 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.

Mechanical properties

Typical mechanical properties of material produced by Laser - Powder Bed Fusion (L-PBF) in as-built condition, evaluated at room temperature.

Direction	Yield strength (Rp0.2), MPa	Tensile strength (Rm), MPa	E-modulus, GPa	Elongation (A), %	Area reduction (Z), %
Horizontal	1,279	1,423	204	16.8	58
Vertical	1301	1,405	190	16.9	53

Direction	Yield strength (Rp0.2), ksi	Tensile strength (Rm), ksi	E-modulus, ksi1)	Elongation (A), %	Area reduction (Z), %
Horizontal	185	206	30	16.8	58
Vertical	189	204	28	16.9	53

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Typical mechanical properties of material produced by Laser - Powder Bed Fusion (L-PBF) in heat-treated condition (aged 480°C/896°F for 6 h).

Direction	Yield strength (Rp0.2), MPa	Tensile strength (Rm), MPa	E-modulus, GPa	Elongation (A), %	Area reduction (Z), %
Horizontal	2,477	2,640	212	1.8	6
Vertical	2,310	2,470	197	1.8	6

Direction	Yield strength (Rp0.2), ksi	Tensile strength (Rm), ksi	E-modulus, ksi1)	Elongation (A), %	Area reduction (Z), %
Horizontal	360	382	31	1.8	6
Vertical	335	358	29	1.8	6

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Hardness

Typical Vicker's Hardness levels (ASTM E92, ISO 6507-1, JIS Z2244, GB/T 4340.1) as well as HRC values (ASTM E18, ISO 6508-1, JIS Z2245, GB/T 230) in the Laser - Powder Bed Fusion (L-PBF) as-built and heat-treated conditions.

Condition	Direction	HV	HRC
As built	Horizontal	390	41
As built	Vertical	390	41
Heat treated	Horizontal	770	60

About maraging steels

Maraging steels are a class of ultra-high strength, high hardness and high toughness steels which can be welded without preheating either in annealed (easy to machine) or heat-treated condition. These properties make them ideal candidates for the Laser - Powder Bed Fusion (L-PBF) process to manufacture parts with complex geometries for demanding applications which require an excellent combination of strength, toughness, and thermal stability.

The strengthening mechanisms in this type of steel differ from those in classical carbon steels where martensitic, bainitic or pearlitic phases are formed on cooling and tempering is employed to control carbide precipitation. Less than 50% of the overall contribution to strengthening is provided by the extremely tough Fe-Ni martensite, while aging of this martensite, containing Mo, Al, Ti and Co in supersaturated solid solution, provides additional strengthening by precipitation of nanosized intermetallic particles in the martensitic matrix.

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 are available, from 1 kg (2.2 lb) to 200 kg (440 lb)*.

Contact our team who can support you with selecting the right packaging for your product and application.

*Some packaging options may not be available for all products due to international shipping regulations.

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