OSPREY® CO-FREE MARAGING STEEL FOR ADDITIVE MANUFACTURING

DATASHEET

GENERAL DESCRIPTION

Maraging steels are a class of high strength and hardness martensitic steels which can be welded without preheating, either in annealed or heat-treated condition. Maraging steels are therefore employed as tool steels in the mold- and die-making industry, and for high-performance parts, e.g. in the aerospace industry. Maraging steels are characterized by very low carbon content favoring dimensional stability, and the presence of substitutional alloying elements such as Mo, Ti, and Al which trigger age hardening in Fe-Ni martensite by the precipitation of nanosized intermetallic particles (e.g., Ni_3Ti, Ni_3Mo, NiAl, and Fe_7Mo_6). The martensitic microstructure of maraging steels is achieved through high nickel content as compared to most tool steels, which instead achieve their martensitic microstructure through a relatively high amount of carbon in the alloy composition. Given the Co price fluctuations, uncertainties associated with the supply sources and the health issues related to Co usage, Co free alternatives to 18Ni300 are of great interest. Sandvik has successfully developed a new maraging steel free of Co, using the very latest metallurgical modelling systems, with reduced amount of Ni and an addition of Cr, to obtain a nearly fully martensitic microstructure already in As-Built condition. Thus, the material can be directly aged to achieve levels of material performances including strength, hardness and toughness comparable to the conventional 18Ni300 maraging steel.

CHEMICAL COMPOSITION

Chemical composition (nominal), wt%

Fe	Ni	Mo	Cr	Ti	Si	Mn	Al	Co	P	S	C
Balance	9.5	4.5	4.0	<1.0	≤0.5	≤0.5	<0.3	<0.1	≤0.03	≤0.03	≤0.06

*Typical levels for Inert Gas Atomized (IGA) powder

POWDER SIZE DISTRIBUTION

Available in a range of customized powder sizes suitable for different applications and AM platforms.

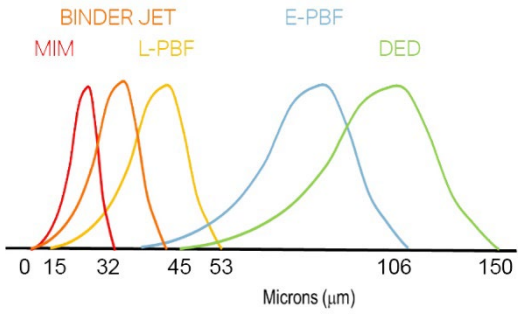
Metal Injection Moulding
<32 µm, <22 µm, <16 µm, <10 µm, <5 µm

Binder Jet
<45 µm, <38 µm, <22 µm, <16 µm

Laser Powder Bed Fusion (L-PBF)
e.g. 53 to 15 µm, and 45 to 20 µm

Electron Beam Powder Bed Fusion (E-PBF)
106 to 45 µm

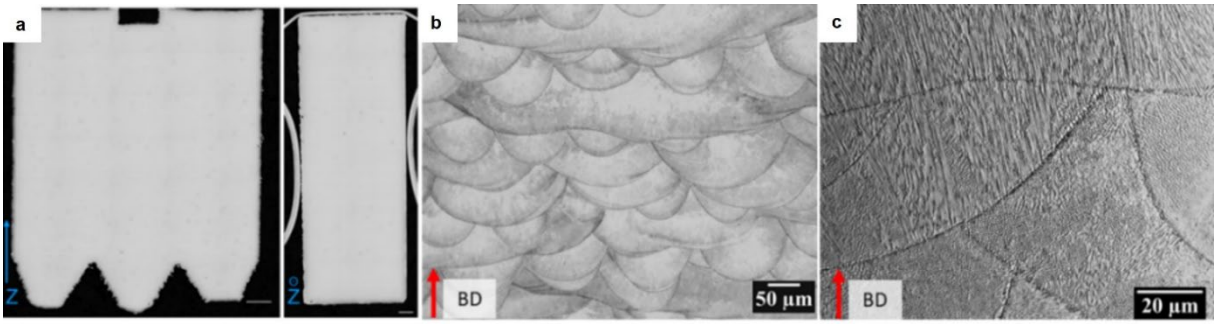
Direct Energy Deposition (DED)
150 to 53 µm and 90 to 45 µm



Other powder size range distributions are available by request.

LASER POWDER BED FUSION (-53 +15µm)

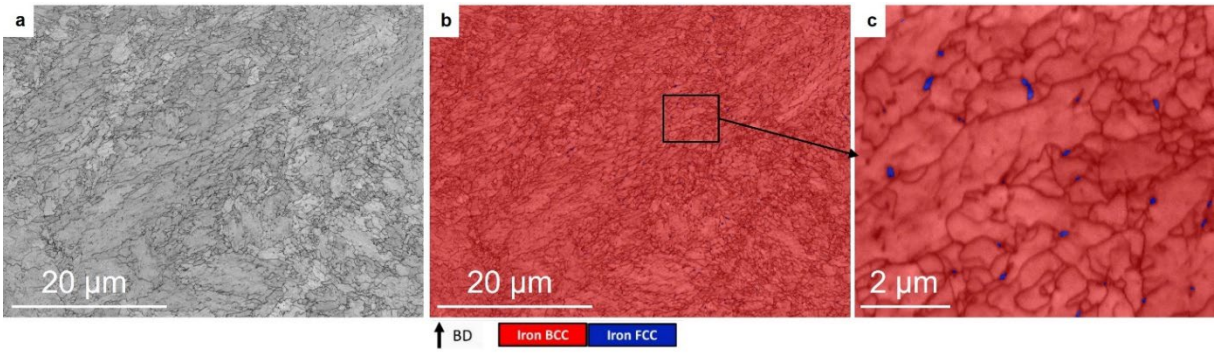
Samples were printed in an EOS M290 and a relative density over 99.9% was achieved (Image analysis).



LOM micrographs, a) a low magnification profile of the cross-section along build direction and normal to build direction, b) chemically etched cross-section showing traces of the melt pools, c) higher magnification micrograph showing the ultrafine cellular/dendritic solidification structure.

MICROSTRUCTURE

The EBSD analysis results confirm that the volume fraction of retained austenite (blue areas) is negligible in the as-built condition and the microstructure is essentially martensitic (red areas). This provides a suitable condition for direct ageing of the essentially martensitic as-built microstructure without the need for prior solution annealing.



As-Built sample: a) SEM micrograph of Osprey® Co-free maraging steel, b-c) EBSD analysis results, phase maps overlaid on band contrast images, low magnification scan higher magnification scan, respectively, showing the position of retained austenite.

MECHANICAL PROPERTIES

Typical mechanical properties of Osprey® Co-free maraging steel powder built via L-PBF in as-built and directly aged conditions, evaluated at room temperature.

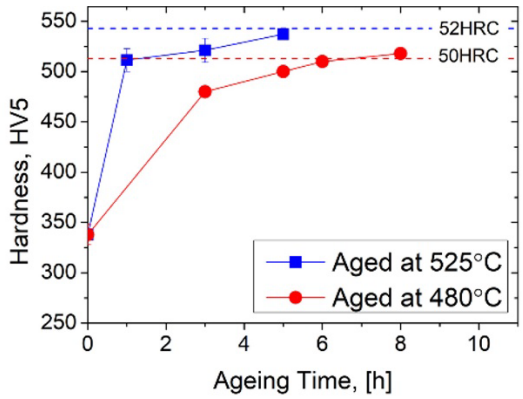
Metric units

Direction	Ageing temperature	Ageing time	Proof strength	Tensile strength	Elongation	Area reduction	Hardness	Impact toughness
			Rp0.2	Rm	ALO15			S (CVN)
	°C	h	MPa	MPa	%	%	HRC	J
Osprey® Co-free maraging (V)	As built	NA	1075	1095	19	74	35	190
Osprey® Co-free maraging (V)	480	8.0	1550	1620	10	52	50-51	8
Osprey® Co-free maraging (H)	480	8.0	1700	1730	10.3	52	50-51	14

Imperial units

Direction	Ageing temperature	Ageing time	Proof strength	Tensile strength	Elongation	Area reduction	Hardness	Impact toughness
			$Rp_{0.2}$	R_m	$A_{LO}15$			S (CVN)
	°C	h	MPa	MPa	%	%	HRC	J
Osprey® Co-free maraging (V)	As built	NA	156	159	19	74	35	140
Osprey® Co-free maraging (V)	896	8.0	225	235	10	52	50-51	6
Osprey® Co-free maraging (H)	896	8.0	247	251	10.3	52	50-51	10

AGEING CURVES



Hardness after ageing at 480°C and 525°C vs. time for samples directly aged.