

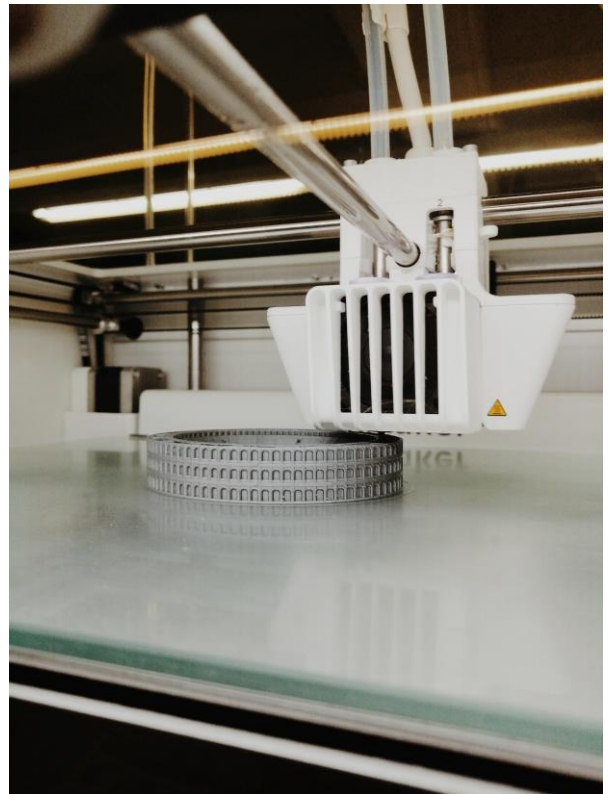
3D Metal – Maraging Steel Material Information

MS1(250) or (Maraging Steel) is used in DLMS (Direct Metal Laser Sintering) is a steel powder that has great strength combined with hardness.

MS1 can easily be machined after the 3D printing process.

Right off the metal printer MS1 is typically around a 33-37HRC (Rockwell hardness). It is machinable after the printing/building process and can be easily post-hardened up to 57-58 HRC.

Chemical Composition	
Element	Wt (%) Max/Min
Iron, Fe	Bal
Nickel, Ni	17 / 19
Cobalt, Co	8.5 / 9.5
Molybdenum, Mo	4.5 / 5.2
Titanium, Ti	0.6 / 0.8
Aluminum, Al	0.05 / 0.15
Carbon, C	0.0 / 0.03
Chromium, Cr	0.0 / 0.5
Cobalt, Co	0.0 / 0.5
Other	0.0 / 0.22



3D Metal – Maraging Steel Material Information

MS1 or (Maraging Steel

Superior properties, such as high ductility, high yield stress, good hardenability, good weldability, simple heat treatment without deformations, have led to a widespread application of maraging steels,

Thermal Properties	
Properties	Metric / Imperial
Thermal expansion co-efficient (@21-480°C/69.8-896°F)	10.1 $\mu\text{m}/\text{m}^\circ\text{C}$ 5.61 $\mu\text{in}/\text{in}^\circ\text{F}$
Thermal conductivity (20°C)	15 ± 0.8 W/mK 104 ± 0.6 BTU in/hr.ft ² .°F
Thermal conductivity (after age hardening)	813 J/kgK
Specific Heat capacity	450 ± 20 J/kg°C 0.108 ± 0.005 Btu/(lb °F)
Maximum Operating Temperature	400°C 750°F
Density	8.10 g/cm ³ 0.292 lb/in ³

3D Metal – Maraging Steel Material Information

Parts are typically printed and then machined. Clients like to complete the final machining once their part or insert is printed. This can speed up the delivery process depending on available machine type and time.

Physical Properties	
Properties	Metric / Imperial
Tensile strength	1158MPa / 168000psi [XYZ]
Yield strength (@strain 0.200 %, temperature 538°C/@strain 0.200 %, temperature 1000°F)	1056MPa / 153200psi [XYZ]
Bulk modulus (typical for steel)	140Gpa / 20300ksi
Shear modulus (estimated from elastic modulus)	73GPa / 10600ksi
Elastic modulus	190GPa / 27600ksi
Poisson's ratio	0.3
Elongation at break (in gage length of 4.5 times the square root of the area, @ 316°C/600 °F)	12% [XYZ]
Reduction of area (@427°C/800°F)	61.30%
Hardness (as grown)	34-36 HRC
Hardness - Heat treated	54-56 HRC
Shrink - age hardening	approx 0.08%
Density	8.10 g/cm ³ / 0.292 lb/in ³

3D Metal – Maraging Steel Material Information

Working with MS1. Some high lights are: up to 56HRC and 1,000,000 cycles.

Tooling Work Info Maraging Steel (MS1)	
Action	Technical Information
Annealing	Maraging 300 alloy steel can be annealed at 1038°C (1900°F) after cold working and then finally cooled in air.
Cold Working	Maraging 300 alloy steel can be cold worked by conventional methods.
Welding	Maraging 300 alloy steel can be welded by conventional methods.
Forging	Maraging 300 alloy steel can be forged as for stainless 304 alloy.
Forming	Conventional methods are used to readily form maraging 300 alloy steel that has good ductility.
Machinability	Maraging 300 alloy steel has good machinability characteristics. Consistent with tradisional tool steels.
Heat Treatment	Maraging 300 alloy steel cannot be heat treated for hardening except by aging.
Hot Working	Maraging 300 alloy steel can be hot worked in temperatures ranging 260 to 93°C (500 to 200°F). Age hardening takes place when this alloy steel is exposed to these temperatures for a long time.
Hardening	Maraging 300 alloy steel can be hardened by aging and cold working. *34-36HRC (as grown), Up to 54-56HRC after heat treat.
Aging	Maraging 300 alloy steel has high hardness and strength properties and is thus suitable for an aging heat treatment at 482°C (900°F). *Age hardening shrink is approximately 0.08%.
Surfaces	Can be coated, polished, grained etc.
Tooling Cycles	Typically lasts 1,000,000 cyles. (application dependent) *(ROI for inserts is typically 90days)
Applications	Industries Include: Tooling, Low & High Volume Parts, Die Casting, Tooling Inserts, Gauges & Fixtures, Gears, Dental Components, Surgical Implants, Aerospace, and much more

3D Metal – Maraging Steel Material Information

Printed parts and inserts typically take 3-7 business days depending on complexity.

Other Technical Data	
Typical Achievable Part Accuracy	
Small Parts (<80mm x 80mm)	approx. $\pm 20 \mu\text{m}$ approx. $\pm 0.8 \times 10^{-3}$ inch
Large Parts	approx. $\pm 50 \mu\text{m}$ approx. ± 0.002 inch
Age hardening shrinkage	approx 0.08%
Minimum wall thickness	approx. 0.3 - 0.4 mm approx. 0.012 - 0.016 inch
Surface Roughness (approx) (as manufactured)	
MS1 Surface (20 μm)	Ra 4 μm ; Rz 20 μm Ra 0.16×10^{-3} inch, Rz 0.78×10^{-3} inch
MS1 Surface (40 μm)	Ra 5 μm ; Rz 28 μm Ra 0.19×10^{-3} inch, Rz 1.10×10^{-3} inch
MS1 Surface (50 μm)	Ra 9 μm ; Rz 50 μm Ra 0.47×10^{-3} inch, Rz 2.36×10^{-3} inch
After Shot Peening	Ra 4 - 6.5 μm ; Rz 20 - 50 μm Ra $0.16 - 0.26 \times 10^{-3}$ inch Rz $0.78 - 1.97 \times 10^{-3}$ inch
After Polishing	Rz up to < 0.5 μm Rz up to < 0.02×10^{-3} inch (can be very finely polished)