

MATERIAL DATA SHEET



Nickel Alloy HX is a nickel-chromium-iron-molybdenum alloy in fine powder form. While the wrought and cast versions of the alloy generally are solution annealed, the laser sintered version has a high strength and good elongation already in the as-built condition. Solution annealing of the laser sintered material will homogenize the micro-structure, relax internal stresses and increase the elongation, while slightly decreasing the strength.

This type of alloy is characterized by having high strength and oxidation resistance also at elevated temperatures, and is often used up to 1200 °C. Therefore its applications can be found in aerospace technology, gas turbine parts, etc. Standard laser processing parameters results in full melting of the entire geometry, typically with 20 µm layer thickness.

Parts built from Nickel-Alloy HX can be heat treated and material properties can be varied within specified range. In both as-built and solution heat treated states the parts can be machined, spark-eroded, welded, micro shot-peened, polished, and coated if required. Unexposed powder can be reused.

GENERAL PROCESS DATA

Typical achievable part accuracy ^[1] - <i>small parts</i>	approx. ± 40 - 60 µm (± 0.0016 - 0.0024 inch)
- <i>large parts</i>	approx. ± 0.2 %
Minimum wall thickness ^[2]	typ. 0.3 - 0.4 mm (0.012 - 0.016 inch)
Surface roughness ^[3] - <i>after shot-peening</i>	Ra 3 - 8 µm; Rz 13 - 40 µm Ra 0.12 - 0.31 x 10 ⁻³ inch Rz 0.51 - 1.56 x 10 ⁻³ inch
- <i>after polishing</i>	Rz up to < 0.5 µm Rz up to < 0.02 x 10 ⁻³ inch <i>(can be very finely polished)</i>
Volume rate ^[4]	2 mm ³ /s [7.2 cm ³ /h] 0.44 in ³ /h



MATERIAL DATA SHEET

PHYSICAL & CHEMICAL PROPERTIES OF PARTS

Material composition	Ni (Rest)	C (≤ 0.1 wt-%)	Se (≤ 0.005 wt-%)
	Cr (20.5 - 23.0 wt-%)	Si (≤ 1.0 wt-%)	Cu (≤ 0.5 wt-%)
	Fe (17.0 - 20.0 wt-%)	Mn (≤ 1.0 wt-%)	Al (≤ 0.5 wt-%)
	Mo (8.0 - 10.0 wt-%)	S (≤ 0.03 wt-%)	Ti (≤ 0.15 wt-%)
	W (0.2 - 1.0 wt-%)	P (≤ 0.04 wt-%)	
	Co (0.5 - 2.5 wt-%)	B (≤ 0.01 wt-%)	
Relative density	approx. 100%		
Density	min. 8.2 g/cm ³		
	min. 0.296 lb/in ³		

MECHANICAL PROPERTIES OF PARTS AT ROOM TEMPERATURE - AS BUILT

	<i>Horizontal Axis [XY]</i>	<i>Vertical Axis [Z]</i>
Ultimate tensile strength ^[5]	850 ± 40 MPa	720 ± 40 MPa
Yield strength (Rp 0.2 %) ^[5]	675 ± 50 MPa	570 ± 50 MPa
Young's modulus ^[5]	typ. 195 ± 20 GPa	typ. 175 ± 20 GPa
Elongation at break ^[5]	29 ± 8%	39 ± 8%

MECHANICAL PROPERTIES OF PARTS AT ROOM TEMPERATURE - HEAT TREATED ^[7]

	<i>Horizontal Axis [XY]</i>	<i>Vertical Axis [Z]</i>
Ultimate tensile strength ^[5]	typ. 730 ± 40 MPa	typ. 690 ± 40 MPa
Yield strength (Rp 0.2 %) ^[5]	typ. 330 ± 50 MPa	typ. 330 ± 50 MPa
Young's modulus ^[5]	typ. 200 ± 20 GPa	typ. 190 ± 20 GPa
Elongation at break ^[5]	typ. 45 ± 6 %	typ. 52 ± 6 %
Hardness ^[6]	175 HBW	



MATERIAL DATA SHEET

- [1] Based on users' experience of dimensional accuracy for typical geometries, e.g. $\pm 40 \mu\text{m}$ [0.0016 inch] when parameters can be optimized for a certain class of parts or $\pm 60 \mu\text{m}$ [0.0024 inch] when building a new kind of geometry for the first time. Part accuracy is subject to appropriate data preparation and post-processing, in accordance with EOS training.
- [2] Mechanical stability is dependent on geometry (wall height etc.) and application.
- [3] Due to the layer-wise building, the surface structure depends strongly on the orientation of the surface, for example sloping and curved surfaces exhibit a stair-step effect. The values also depend on the measurement method used. The values quoted here given an indication of what can be expected for horizontal (up-facing) or vertical surfaces.
- [4] Volume rate is a measure of build speed during laser exposure. The total build speed depends on the average volume rate, the re-coating time (related to the number of layers) and other factors such as DMLS-Start settings.
- [5] Tensile testing according to ISO 6892-1:2009 (B) Annex D, proportional test pieces, diameter of the neck area 5mm [0.2 inch], original gauge length 25mm [1 inch].
- [6] Brinell Hardness measurement according to EN ISO 6506-1 on polished surface. HBW 2.5/187.5.
- [7] Heat treatment: Solution anneal at 1177 °C, 1 hour. HT according to SAE AMS 2773 "Heat Treatment Cast Nickel Alloy and Cobalt Alloy Parts"

