NickelAlloy HX

NickelAlloy HX is a heat and corrosion resistant metal alloy powder intended for processing on EOSINT M 280 systems.
This document provides information and data for parts built using EOS NickelAlloy HX powder.

Description

NickelAlloy HX is a nickel-chromium-iron-molybdenum alloy in fine powder form. Its composition corresponds to UNS N06002. 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 microstructure, 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 EOS NickelAlloy 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.

Technical data

General process and geometrical data

Typical achievable part accuracy [1]	
- Small parts	approx. ± 40 - 60 µm (± 0.0016 - 0.0024 inch)
- Large parts	approx. ± 0.2 %
Smallest wall thickness [2]	typ. 0.3 - 0.4 mm (0.012 – 0.016 inch)
Surface roughness [3]	
- as built	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
- peened	Rz up to < 0.5 µm Rz up to < 0.02 x 10 $^{-3}$ inch (can be very finely polished)
Volume rate [4]	2 mm³/s (7.2 cm³/h) 0.44 in³/h

[1] Based on users' experience of dimensional accuracy for typical geometries. Part accuracy is subject to appropriate data preparation and post-processing.
[2] Mechanical stability is dependent on geometry (wall height etc.) and application
[3] Due to the layerwise 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 recoating time (related to the number of layers) and other factors such as DMLS-Start settings.

Physical and chemical properties of the parts	
Material composition	Ni (Rest) Cr (20,5 - 23,0 wt-%) Fe (17,0 - 20,0 wt-%) Mo (8,0 - 10,0 wt-%) W (0,2 - 1,0 wt-%) Co (0,5 - 2,5 wt-%) C (≤ 0,1 wt-%) Si (≤ 1,0 wt-%) Mn (≤ 1,0 wt-%) S (≤ 0,03 wt-%) P (≤ 0,04 wt-%) B (≤ 0,01 wt-%) Se (≤ 0,005 wt-%) Cu (≤ 0,5 wt-%) Al (≤ 0,5 wt-%) Ti (≤ 0,15 wt-%)
Relative density	approx. 100 %
Density	min. 8.2 g/cm³ min. 0.296 lb/in³

Mechanical properties of the parts		
	As built	Heat treated [7]
Ultimate tensile strength [5]		
- in horizontal direction (XY)	850 ± 40 MPa	typ. 730 ± 40 MPa
- in vertical direction (Z)	720 ± 40 MPa	typ. 690 ± 40 MPa
Yield strength (Rp 0.2 %) [5]		
- in horizontal direction (XY)	675 ± 50 MPa	typ. 330 ± 50 MPa
- in vertical direction (Z)	570 ± 50 MPa	typ. 330 ± 50 MPa
Elongation at break [5]		
- in horizontal direction (XY)	(29 ± 8) %	typ. 45 ± 6 %
- in vertical direction (Z)	(39 ± 8) %	typ. 52 ± 6 %
Modulus of elasticity [5]		
- in horizontal direction (XY)	typ. 195 ± 20 GPa	typ. 200 ± 20 GPa
- in vertical direction (Z)	typ. 175 ± 20 GPa	typ. 190 ± 20 GPa
Hardness [6]		

[5] Tensile testing according to ISO 6892-1:2009 (B) Annex D, proportional test pieces, diameter of the neck area 5 mm (0.2 inch), original gauge length 25 mm (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”

Notes

The quoted values refer to the use of these materials with EOSINT M 270 systems according to current specifications (including the latest released process software PSW and any hardware specified for the relevant material) and operating instructions. All values are approximate. Unless otherwise stated, the quoted mechanical and physical properties refer to standard building parameters and test samples built in horizontal orientation. They depend on the building parameters and strategies used, which can be varied by the user according to the application.
The data are based on our latest knowledge and are subject to changes without notice. They are provided as an indication and not as a guarantee of suitability for any specific application.