Material data sheet

EOS NickelAlloy HX

EOS NickelAlloy HX is a heat and corrosion resistant metal alloy powder intended for processing on EOS M systems.

This document provides information and data for parts built using EOS NickelAlloy HX powder (EOS art.-no. 9011-0023) on the following system specifications:

- EOSINT M 280 with PSW 3.6 and EOS Parameter Set HX_Surface 1.0
- EOS M290 400W with EOSPRINT 1.0 and Parameter Set HX_Surface 1.0

Description, application

EOS 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.

EOS GmbH - Electro Optical Systems

Robert-Stirling-Ring 1
D-82152 Krailling / München

Telephone: +49 (0)89 / 893 36-0
Telefax: +49 (0)89 / 893 36-285
Internet: www.eos.info

Technical data

General process data

Typical achievable part accuracy [1], [8]	
- small parts	approx. ± 40 - 60 µm (± 0.0016 - 0.0024 inch)
- large parts	approx. ± 0.2 %
Min. wall thickness [2], [8]	typ. 0.3 - 0.4 mm (0.012 – 0.016 inch)
Surface roughness [3], [8]	
- after shot-peening	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
- after polishing	Rz up to < 0.5 µm Rz up to < 0.02 x 10 $^{-3}$ inch (can be very finely polished)
Volume rate [4]	2 mm^3/s (7.2 cm^3/h) 0.44 in^3/h

[1] Based on users' experience of dimensional accuracy for typical geometries, e.g. ± 40 µm when parameters can be optimized for a certain class of parts or ± 60 µm when building a new kind of geometry for the first time. Part accuracy is subject to appropriate data preparation and postprocessing.

[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.

EOS GmbH - Electro Optical Systems
Robert-Stirling-Ring 1
D-82152 Krailling / München

Physical and chemical properties of parts

Materialzusammensetzung	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 with standard parameters	approx. 100 %
Density with standard parameters	min. 8.2 g/cm³ min. 0.296 lb/in³

EOS GmbH - Electro Optical Systems
Robert-Stirling-Ring 1
D-82152 Krailling / München

Mechanical properties of parts (at room temperature) [8]

	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, Rp0.2% [5]		
- in horizontal direction (XY)	675 ± 50 MPa	typ. 330 ± 50 MPa
- in vertical direction (Z)	570 ± 50 MPa	typ. 330 ± 50 MPa
Young's modulus [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
Elongation at break [5]		
- in horizontal direction (XY)	29 ± 8 %	typ. 45 ± 6 %
- in vertical direction (Z)	39 ± 8 %	typ. 52 ± 6 %
Hardness [6]		(175 HBW)

[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"

[8] Hint: these properties were determined on an EOSINT M 280-400W. Test parts from following machine types EOSINT M 280-200W and EOS M 290-400W correspond with these data.

Abbreviations

typ.	typical
min.	minimum
approx.	approximately
wt	weight

EOS GmbH - Electro Optical Systems
Robert-Stirling-Ring 1
D-82152 Krailling / München

Notes

The quoted values refer to the use of these materials with EOSINT M 280 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 vertical 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.

EOS GmbH - Electro Optical Systems
Robert-Stirling-Ring 1
D-82152 Krailling / München