材料详情表
Materialdatenblatt
Material Data Sheet

镍合金 IN625 / 2.4856 / B446 [1]

概述

从1960年代早期被合成出来开始，IN625至今还是航空发动机可选择的合金之一（工作温度低于650 °C）。IN625是一种沉淀硬化处理的镍铬合金，其中还包含了不少的铁、铌以及钼元素，另外还有微量的铝和钛元素。IN625有很高的抗腐蚀性和强度，它的可焊性以及很少的焊后开裂也给人们留下很深的印象。这种镍合金在不高于700 °C的环境中有很好的蠕变断裂强度。

General

Developed in the early 1960's, IN625 is still considered the material of choice for the majority of aircraft engine components with service temperatures below 1200 °F (650 °C). IN625 is a precipitation-hardenable nickel-chromium alloy containing also significant amounts of iron, niobium, and molybdenum along with lesser amounts of aluminum and titanium. It combines corrosion resistance and high strength with outstanding weldability including resistance to postweld cracking. The alloy has excellent creep-rupture strength at temperatures to 1300 °F (700 °C).

材料结构

经过SLM工艺处理的IN625零件展现出各向同性、近乎无孔的结构，因此其机械特性可以参考概述中对于IN625的性能描述。同时，如有对零件性能的特殊要求，也可以通过硬化、热处理或热等静压（HIP）等后处理来实现。

Material Structure

Components produced by SLM in Inconel show a homogenous, nearly void free structure. The mechanical properties are in the range of material specification. By post processing like heat treatment, hardening or hot isostatic pressing, the material properties can be adjusted to the individual required conditions. In the SLM process of IN625 theoretical build-up rates of 9.1 cm³/h (layer thickness: 30 µm) and 16.4 cm³/h (layer thickness: 50 µm) are achieved.

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物理/化学 性质
Physical and Chemical Properties

材料密度 *Material Density*	8,44 g/cm³			
20 °C时的导热系数 Thermal Conductivity at 20 °C	9,8 W/mK			
打印件密度[2] *Build Part Density[2]*	层厚 30 µm[3] *Layer Thickness 30 µm*	> 99,8 %	层厚 50 µm[4] *Layer Thickness 50 µm*	> 99,5 %

化学成分(wt%)[5]
Chemical Composition (wt%)[5]

Element *Element*	**Min.** *Min.*	**Max.** *Max.*
Ni	Balance	Balance
Cr	20	23
Mo	8	10
Nb	3,15	4,15
Fe	-	5
Si	-	0,5
Mn	-	0,5
Ti	-	0,4
Al	-	0,4
C	-	0,1
Co	-	0,1
S	-	0,015
P	-	0,015

颗粒大小分布（范围）[5] *Particle Size Distribution[5]*	10 – 45 µm *10 – 45 µm*
晶粒形状[6] *Grain Shape[6]*	球状 *Spherical*

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机械特性
Mechanical Data

拉伸试验[7] *Tensile Test[7]*		层厚 30 µm[3] *Layer Thickness 30 µm[3]*	层厚 50 µm[4] *Layer Thickness 50 µm[4]*
拉伸强度 *Tensile Strength*	R_m [MPa]	961 ± 41	890 ± 49
屈服强度 *Yield Strength*	R_e [MPa]	707 ± 41	623 ± 34
断裂伸长率 *Elongation Break*	A [%]	33 ± 2	28 ± 7
断面收缩率 *Contraction at Fracture*	Z [%]	51 ± 5	35 ± 8
弹性模量 *Young's modulus*	E [GPa]	182 ± 3	171 ± 13

硬度测试[8] *Hardness Test[8]*		层厚 30 µm[3] *Layer Thickness 30 µm[3]*	层厚 50 µm[4] *Layer Thickness 50 µm[4]*
维氏硬度 *Vickers Hardness*	[HV10]	285 ± 3	272 ± 6

粗糙度测试[9] *Roughness Measurement[9]*		层厚 30 µm[3] *Layer Thickness 30 µm[3]*	层厚 50 µm[4] *Layer Thickness 50 µm[4]*
平均粗糙度 *Mean Roughness Index*	R_a [µm]	7 ± 2	8 ± 2
平均表面粗糙度 *Average Surface Roughness*	R_z [µm]	40 ± 10	42 ± 10

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本表中的测试性能与机械特性的粉末是由SLM Solutions测试及销售的，测试是在使用SLM Solutions提供的参数和机器的情况下，根据适当的操作指令（包括机器状况和维护）进行的。零件的性能是严格实验的结果，如需了解更多细节可以与SLM Solutions沟通询问。
本表中阐释的材料特性来源于最新的知识体系以及实际经验总结，但不足以支撑整个零件设计体系。一些产品或零件的特定性能以及特殊应用中的零件并不在保证范围以内。产品或部件的制造商负责对特定应用的性能及其适用性进行资格验证。产品或部件的制造商负责保护任何第三方的专有权利以及遵守现有的法律和法规。

The properties and mechanical characteristics apply to powder that is tested and sold by SLM Solutions, and that has been processed on SLM Solutions machines using the original SLM Solutions parameters in compliance with the applicable operating instructions (including installation conditions and maintenance). The part properties are determined on the basis of specified procedures. More details about the procedures used by SLM Solutions are available upon request.
The specifications correspond to the most recent knowledge and experience available to us at the time of publication and do not themselves form a sufficient basis for component design. Certain properties of products or parts or the suitability of products or parts for specific applications are not guaranteed. The manufacturer of the products or parts is responsible for the qualified verification of the properties and their suitability for specific applications. The manufacturer of the products or parts is responsible for protecting any third-party proprietary rights as well as existing laws and regulations.

SLM Solutions Group AG
Materialentwicklung / Material Development
Lübeck, den 08.02.2017

[1] Material gemäß DIN 17744 / ASTM B446/ *Material according to DIN 17744 / ASTM B446.*
[2] Optische Dichtebestimmung mittels Lichtmikroskopie. / *Optical density determination by light microscopy.*
[3] Materialdatei / *Material data file:* Inc_SLM_BP2.1_30_Stripes-US_T200_S09-02_V4101
[4] Materialdatei / *Material data file :* Inc_SLM_BP2.1_50_Stripes-US_T0_S32-04_V4101
[5] Bzgl. pulverförmigen Ausgangsmaterial. / *With respect to powder material.*
[6] Gemäß DIN EN ISO 3252. / *According DIN EN ISO 3252.*
[7] Zugprüfung gemäß ISO 6892-1: 2009 B (DIN 50125 – B6x30); Ausrichtung: 0° und 90°; Wärmebehandlung: keine; Prüfmaschine: Zwick 1484; Lastbereich: 200 kN; Prüfgeschwindigkeit 0,008 1/s; Prüftemperatur: Raumtemperatur; Prüflabor: EWIS GmbH. Die Proben sind vor dem Zugversuch abgedreht worden. / *Tensile test according to ISO 6892-1: 2009 B (DIN 50125 – B6x30); Orientation: 0° und 90°; Heat treatment: None; Testing machine: Zwick 1484; Load range: 200 kN; Testing speed: 0,008 1/s; Testing temperature: room temperature; Test laboratory: EWIS GmbH. Test samples were turned before Tensile test.*
[8] Härteprüfung gemäß DIN EN ISO 6507-1. / *Hardness testing according to DIN EN ISO 6507-1.*
[9] Rauheitsmessung gemäß DIN EN ISO 4288: 1998; λc = 2,5 mm. / *Roughness Measurement according to DIN EN ISO 4288: 1998; λc = 2,5 mm.*

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