材料详情表
Materialdatenblatt
Material Data Sheet

钛合金 TiAl6V4 ELI (grade 23)/3.7165/B348/F136[1]

概述

TiAl6V4 是目前世界上应用得最多的钛合金，密度为4,43 g/cm³，属于轻型金属合金。高强度、低密度以及优秀的抗腐蚀能力让钛合金零件应用非常广泛。因为金属钛的热膨胀系数不高，金属钛和钛合金从上个世纪50年代开始便在汽车工业和航空航天工业成功开展了应用。而在生物相容性方面，钛合金也被广泛应用于医学，因此，像牙科植入物以及髋关节假体等都可以用TiAl6V4来进行制造。

General

TiAl6V4 is the most frequently used titanium alloy worldwide and, since it has a density of 4.43 g/cm³, ranks among the light metal alloys. High strength at low density and also excellent corrosion resistance allow a broad range of applications of titanium parts. Titanium and its alloys have been used successfully in the automotive and aerospace industry since the 1950s. Here titanium stands out through a low thermal expansion.
By the biocompatibility of titanium, it can be used in medical technology. Thus, for example, implants for dentistry or individual hip implants can be manufactured out of TiAl6V4 Grade 23 (small interstitial impurities).

材料结构

经过SLM工艺处理的钛合金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钛合金的性能描述。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。此外，由SLM技术制造的太合金零件需要在氩气的保护下经过4个小时800 °C的时效热处理来保证最佳性能。

Material Structure

Components produced by SLM in titanium show a homogenous, nearly void free structure whereby the mechanical characteristic values lie within the range of the material specifications. By post processing like heat treatment, hardening or hot isostatic pressing, the material properties can be adjusted to the individual required conditions. For components produced by SLM, a heat treatment at 800 °C for 4 h under inert argon atmosphere is recommended. In the SLM process with TiAl6V4 are theoretical build-up rates of 10.0 cm³/h (layer thickness 30 µm) and 16.4 cm³/h (layer thickness 50 µm) achieved.

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物理/化学 性质
Physical and Chemical Properties

材料密度 *Material Density*	4,43 g/cm³			
20 °C时的导热系数 Thermal Conductivity at 20 °C	7,1 W/mK			
打印件密度[2] *Build Part Density[2]*	层厚 30 µm[3] *Layer thickness 30 µm*	> 99,5 %	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.*
Ti	Balance	Balance
Al	5,50	6,50
V	3,50	4,50
C	-	0,08
O	-	0,13
N	-	0,03
Fe	-	0,25
H	-	0,0125
Other ind.	-	0,10
Other total	-	0,40

颗粒大小分布（范围）[5] *Particle Size Distribution[5]*	20 – 63 µm *20 – 63 µm*
晶粒形状[6] *Grain Shape[6]*	球状 *Spherical*

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机械特性
Mechanical Data

拉伸测试[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]	1286 ± 57	1251 ± 61
屈服强度 *Yield Strength*	$R_{p0,2}$ [MPa]	1116 ± 61	1120 ± 44
断裂伸长率 *Elongation Break*	A [%]	8 ± 2	3 ± 1
断面收缩率 *Contraction at Fracture*	Z [%]	30 ± 10	5 ± 2
弹性模量 *Young's modulus*	E [GPa]	111 ± 4	110 ± 7

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]	384 ± 5	380 ± 8

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]	12 ± 1	14 ± 1
平均表面粗糙度 *Average Surface Roughness*	R_z [µm]	70 ± 3	86 ± 11

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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] Ti6Al4V Grade 23 gemäß DIN 17851 / ASTM B348 / F136 / *Ti6Al4V grade23 according to DIN 17851 / ASTM B348 / F136*

[2] Optische Dichtebestimmung mittels Lichtmikroskopie. / *Optical density determination by light microscopy.*

[3] Materialdatei / *Material data file:* Ti_SLM_BP2.1_30_Stripes-US_T200_S21-01_V5001

[4] Materialdatei / *Material data file :* Ti_SLM_BP2.1_50_Chess_T200_S32_04_V5001

[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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