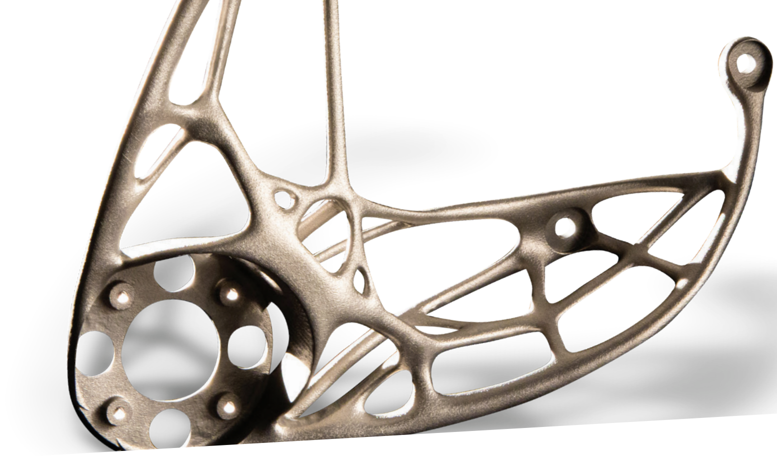


LaserForm® Ti Gr5 (A)

Titanium alloy fine-tuned for use with ProX® DMP 320 and DMP 350 metal printers. This alloy is used in technical and medical applications because of its high strength, low density and excellent biocompatibility. The essential difference between Ti6Al4V ELI (grade 23) and Ti6Al4V (grade 5) is the allowed higher oxygen and iron content in Ti Gr5. This confers improved strength.

LaserForm Ti Gr5 (A) is formulated and fine-tuned specifically for 3D Systems ProX DMP 320 and DMP 350 metal 3D printers to deliver highest part quality and best part properties. The print parameter database that 3D Systems provides together with the material has been extensively developed, tested and optimized in 3D Systems' part production facilities that hold the unique expertise of printing 500,000 challenging production parts year over year. Based on over 1000 test samples the below listed part quality data and mechanical properties give you high planning security. And for a 24/7 production 3D Systems' thorough Supplier Quality Management System guarantees consistent, monitored material quality for reliable process results.

Material Description

This titanium alloy is commonly used for lightweight and high-strength components such as aerospace and motor sports applications. Because of its excellent biocompatibility Ti Gr5 (A) is also very well suited for medical implants, tools and devices and dental prostheses. The essential difference between Ti6Al4V ELI (grade 23) and Ti6Al4V (grade 5) is the allowed higher oxygen and iron content in Ti Gr5. This confers improved strength while slightly reducing ductility.

These benefits make LaserForm Ti Gr5 (A) the ideal material for light-weight, high-strength components as required for a broad scope of parts in aerospace, sports and marine products. Its high strength and biocompatibility make it the material of choice for medical tools and devices.

Classification

Parts built with LaserForm Ti Gr5 Alloy have a chemical composition that meets the requirements of ASTM B265, B348 (grade 5), F2924, F3302, ISO 5832-3 and Werkstoff Nr. 3.7165.

Mechanical Properties[1,2,3]

MEASUREMENT	CONDITION	METRIC		U.S.	
		AFTER STRESS RELIEF 1	AFTER HIP	AFTER STRESS RELIEF 1	AFTER HIP
Youngs modulus (GPa | ksi)[4]	ASTM E8M	105-120	105-120	15000-17500	15000-17500
Ultimate strength (MPa | ksi)	ASTM E8M				
Horizontal direction — XY Vertical direction — Z		1180 ± 30 1160 ± 50	1000 ± 30 1020 ± 50	171 ± 5 168 ± 8	145 ± 4 148 ± 8
Yield strength Rp0.2% (MPa | ksi)	ASTM E8M				
Horizontal direction — XY Vertical direction — Z		1090 ± 30 1080 ± 50	910 ± 30 930 ± 30	158 ± 5 157 ± 8	132 ± 5 134 ± 5
Elongation at break (%)	ASTM E8M				
Horizontal direction — XY Vertical direction — Z		9 ± 2 9 ± 2	15 ± 3 14 ± 3	9 ± 2 9 ± 2	15 ± 3 14 ± 3
Hardness, Rockwell C (HRC)	ASTM E18	40 ± 2	36 ± 2	40 ± 2	36 ± 2

Thermal Properties[4]

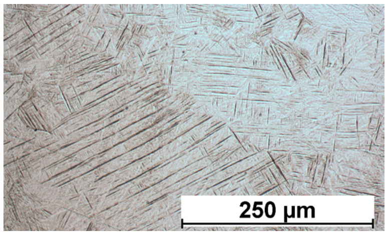
MEASUREMENT	CONDITION	METRIC	U.S.
Thermal conductivity (W/(m.K) | Btu in/(h.ft.°F)	At 50 °C/ 120 °F	6.7	3.9
Coefficient of thermal expansion (µm/m-°C / µin/(in.°F)	In the range of 20 to 100 °C	8.6	4.8
Melting range (°C | °F)		1692-1698	3046-3056

[1] Parts manufactured with standard parameters on a ProX DMP 320, Config A
[2] Values based on average and double standard deviation
[3] Surface condition of test samples: Horizontal samples (XY) tested in machined surface condition only, vertical (Z) tested in as-printed and machined surface condition
[4] Values based on literature

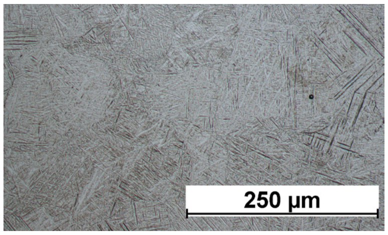
LaserForm® Ti Gr5 (A)

Physical Properties

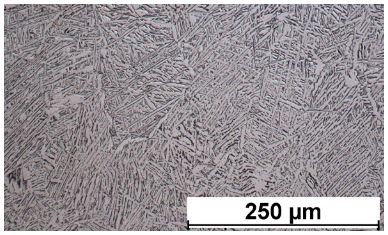
MEASUREMENT	CONDITION	METRIC		U.S.	
		AS BUILT AND AFTER STRESS RELIEF	AFTER HIP	AS BUILT AND AFTER STRESS	AFTER HIP
Density — Relative, based on pixelcount[1,2] (%)	Optical method	> 99.6 typical 99.8		> 99.6 typical 99.8	
Density — Absolute theoretical[3] (g/cm^3 | lb/in^3)		4.42		0.159	



Microstructure as built



Microstructure after stress relief



Microstructure after HIP

Surface Quality

MEASUREMENT	CONDITION	SANDBLASTED METRIC	SANDBLASTED U.S.
Surface Roughness Ra_a[4,5]	ISO 25178		
Layer thickness 30μm and 60μm Top surface[6] (μm | μin) Vertical side surface[7] (μm | μin)		typical 3-8 typical 5-7	typical 120-320 typical 200-280
Layer thickness 90μm Top surface[6] (μm | μin) Vertical side surface[7] (μm | μin)		typical 13-19 typical 6-12	typical 500-750 typical 240-480

Chemical Composition

Ti	bal.
N	≤0.05
c	≤0.08
H	≤0.015
Fe	≤0.30
O	≤0.20
Al	5.50-6.75
V	3.50-4.50
Y	≤0.005
residuals each	≤0.10
residuals total	≤0.40

[1] Minimum value based on 95% confidence interval. Tested on typical density test coupons
[2] May deviate depending on specific part geometry
[3] Values based on literature
[4] Parts manufactured with standard parameters on a ProX DMP 320, Config A
[5] Sand blasting performed with zirconia blasting medium at 5 bar
[6] Top surface measurements along the 2 perpendicular axes of the reference square geometry
[7] Vertical side surface measurement along the building direction

3D SYSTEMS

www.3dsystems.com

PN 10107C

07-20