LaserForm® Ti Gr23 (A)

Titanium alloy fine-tuned for use with ProX® DMP 320 metal powder producing technical and medical parts with a combination of high specific strength and excellent biocompatibility. LaserForm Ti Gr23 (A) is ELI (Extra Low Interstitial) grade with lower iron, carbon, and oxygen content and is known for higher purity than LaserForm Ti Gr5 (A) resulting in improved ductility and fracture toughness.

LaserForm Ti Gr23 (A) is formulated and fine-tuned specifically for 3D Systems' ProX DMP 320 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 in aerospace and medical applications because of its high strength, low weight and excellent biocompatibility. The essential difference between Ti6Al4V ELI (grade 23) and Ti6Al4V (grade 5) is the reduction of oxygen content to 0.13% (maximum) in grade 23. This confers improved ductility and fracture toughness, with some reduction in strength.

These benefits make LaserForm Ti Gr23 (A) the most used medical and aerospace titanium grade. It can be used in biomedical applications such as surgical implants, orthodontic appliances or in-joint replacements due to its biocompatibility, good fatigue strength and low modulus.

Classification

Parts built with LaserForm Ti Gr23 (A) Alloy have a chemical composition that complies with ASTM F3001, ISO 5832-3, ASTM F136 and ASTM B348 standards.

Mechanical Properties [1,2,3]

MEASUREMENT	CONDITION	METRIC			U.S.		
		AFTER STRESS RELIEF 1	AFTER STRESS RELIEF 2	AFTER HIP	AFTER STRESS RELIEF 1	AFTER STRESS RELIEF 2	AFTER HIP
Youngs modulus (GPa | ksi)	ASTM E8M	118 ± 4	118 ± 4	115 ± 8	17100 ± 600	17100 ± 600	16700 ± 1200
Ultimate Strength (MPa | ksi)	ASTM E8M						
Horizontal direction — XY Vertical direction — Z		1160 ± 20 1170 ± 50	1070 ± 30 1070 ± 30	980 ± 50 980 ± 70	168 ± 3 170 ± 7	155 ± 4 155 ± 4	142 ± 7 142 ± 10
Yield strength Rp0.2% (MPa | ksi)	ASTM E8M						
Horizontal direction — XY Vertical direction — Z		1060 ± 30 1100 ± 60	970 ± 30 1000 ± 60	890 ± 50 890 ± 90	154 ± 4 160 ± 9	141 ± 4 145 ± 9	129 ± 7 129 ± 13
Plastic elongation (%)	ASTM E8M						
Horizontal direction — XY Vertical direction — Z		10 ± 2 10 ± 3	13 ± 2 13 ± 3	14 ± 2 14 ± 2	10 ± 2 10 ± 3	13 ± 2 13 ± 3	14 ± 2 14 ± 2
Reduction of area (%)	ASTM E8M						
Horizontal direction — XY Vertical direction — Z		35 ± 10 40 ± 10	45 ± 10 45 ± 15	45 ± 5 45 ± 5	35 ± 10 40 ± 10	45 ± 10 45 ± 15	45 ± 5 45 ± 5
Hardness, Rockwell C	ASTM E18	37 ± 2	37 ± 4	34 ± 1	37 ± 2	37 ± 4	34 ± 1
Impact toughness[4] (J | ft-lb)	ASTM E23	21 ± 6	21 ± 3	32 ± 4	15 ± 5	15 ± 3	23 ± 3
Fatigue[5] (MPa | ksi)	ASTM E47	400	NA	500	58	NA	73

Thermal Properties[6]

MEASUREMENT	CONDITION	METRIC	U.S.
Thermal conductivity (W/(m.K) | Btu in/(h.ft²°F))	At 50 °C/ 120 °F	6.7	3.87
Coefficient of thermal expansion (µm/(m.°C) | µ inch/(inch . °F))	In the range of 20 to 600 °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] HIP indicates hot isostatic pressing post treatment
[3] Values based on average and double standard deviation
[4] Tested with Charpy V-notch impact test specimens type A at room temperature
[5] Parts were machined
[6] Values based on literature, Axial testing at R = 0,1"

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Physical Properties

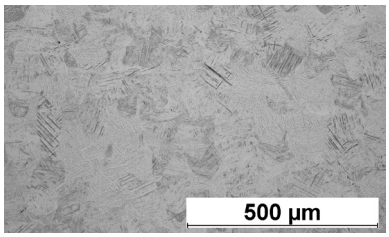
MEASUREMENT	CONDITION	METRIC		U.S.	
		AS BUILT AND AFTER STRESS RELIEF	AFTER HIP	AS BUILT AND AFTER STRESS RELIEF	AFTER HIP
Density — Relative, based on pixelcount (%)		> 99.9	≈100	> 99.9	≈100
Density — Absolute theoretical[1] (g/cm^3 | lb/in^3)		4.42		0.16	

Surface Quality[2]

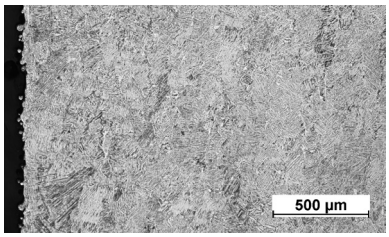
MEASUREMENT	METRIC		U.S.	
	AS BUILT	SANDBLASTED	AS BUILT	SANDBLASTED
Surface Roughness				
Horizontal direction (XY) (µm | µin)	5-10	4-8	200-400	150-300
Vertical direction (Z) (µm | µin)	5-10	4-8	200-400	150-300

Chemical Composition

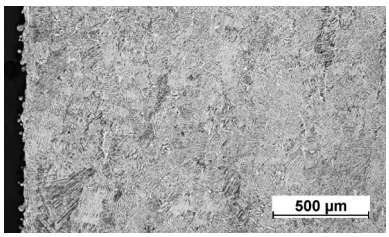
ELEMENT	% OF WEIGHT
Ti	Bal.
N	≤0.03
C	≤0.08
H	≤0.012
Fe	≤0.25
O	≤0.13
Al	5.5 - 6.5
V	3.5 - 4.5
Y	≤0.005
Residuals (each)	≤0.1
Residuals (total)	≤0.4



Microstructure as built



Microstructure after HIP



Microstructure after stress relief

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[1] Values based on literature
[2] Parts manufactured with standard parameters on a ProX DMP 320, Config A

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