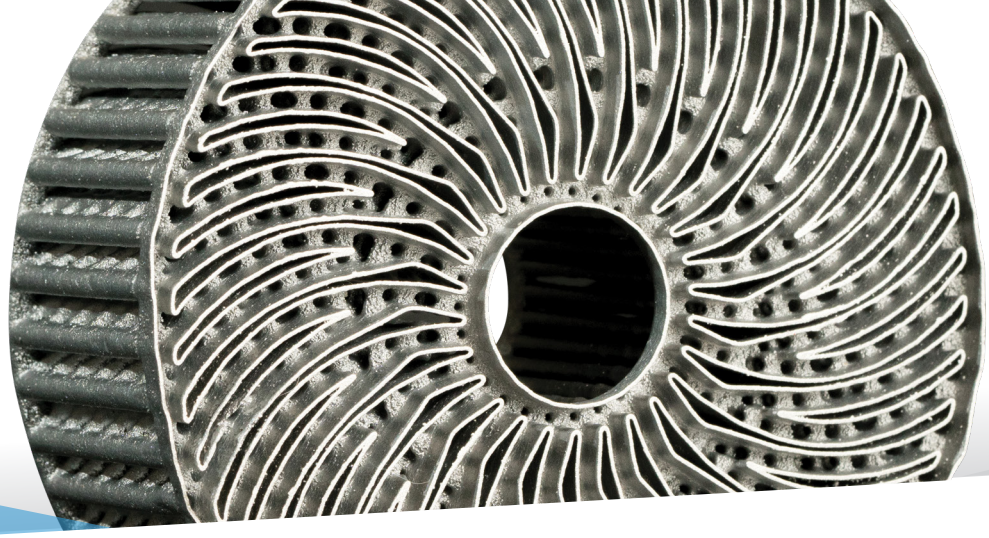


LaserForm® AlSi10Mg (A)

AlSi10Mg fine-tuned for use with DMP 350 and ProX® DMP 320 metal printers producing industrial parts with a combination of good mechanical properties and good thermal conductivity.

LaserForm AlSi10Mg (A) is formulated and fine-tuned specifically for 3D Systems DMP 320 and DMP 350 series metal 3D printers to deliver high part quality and consistent part properties. The print para-meter 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 metal production parts in various materials year over year. And for your 24/7 production 3D Systems' thorough Supplier Quality Management System guarantees consistent, monitored material quality for reliable results.

Material Description

AlSi10Mg combines silicon and magnesium as alloying elements, which results in a significant increase in strength and hardness compared to other aluminum alloys. Due to the very rapid melting and solidification during Direct Metal Printing, LaserForm AlSi10Mg (A) in as-printed condition shows fine microstructure and high strengths.

In the aerospace and automotive industry, LaserForm AlSi10Mg (A) is used for its light weight. Both innovative approaches to mold design and specific heat exchanger applications make use of the high thermal conductivity of this alloy.

Mechanical Properties[1,2,3]

MEASUREMENT	CONDITION	METRIC			U.S.		
		AS-BUILT	AFTER STRESS RELIEF	DIRECT AGEING	AS-BUILT	AFTER STRESS RELIEF	DIRECT AGEING
Young's modulus (GPa | ksi)	ASTM E1876	71 ± 2	73 ± 6	73 ± 6	10300 ± 300	10600 ± 900	10600 ± 900
Ultimate strength (MPa | ksi)	ASTM E8M						
Horizontal direction - XY		450 ± 30	310 ± 20	420 ± 30	65 ± 4	45 ± 3	61 ± 4
Vertical direction - Z		420 ± 60	300 ± 20	410 ± 40	61 ± 9	44 ± 3	60 ± 6
Yield strength Rp0.2% (MPa | ksi)	ASTM E8M						
Horizontal direction - XY		260 ± 30	200 ± 20	270 ± 20	38 ± 4	29 ± 3	39 ± 3
Vertical direction - Z		230 ± 40	170 ± 20	260 ± 40	33 ± 6	25 ± 3	38 ± 6
Plastic elongation (%)	ASTM E8M						
Horizontal direction - XY		8 ± 4	12 ± 2	6 ± 2	8 ± 4	12 ± 2	6 ± 2
Vertical direction - Z		5 ± 2	9 ± 4	3 ± 2	5 ± 2	9 ± 4	3 ± 2
Hardness, Rockwell B (HRB)	ASTM E18	71 ± 4	50 ± 6	72 ± 4	71 ± 4	50 ± 6	72 ± 4

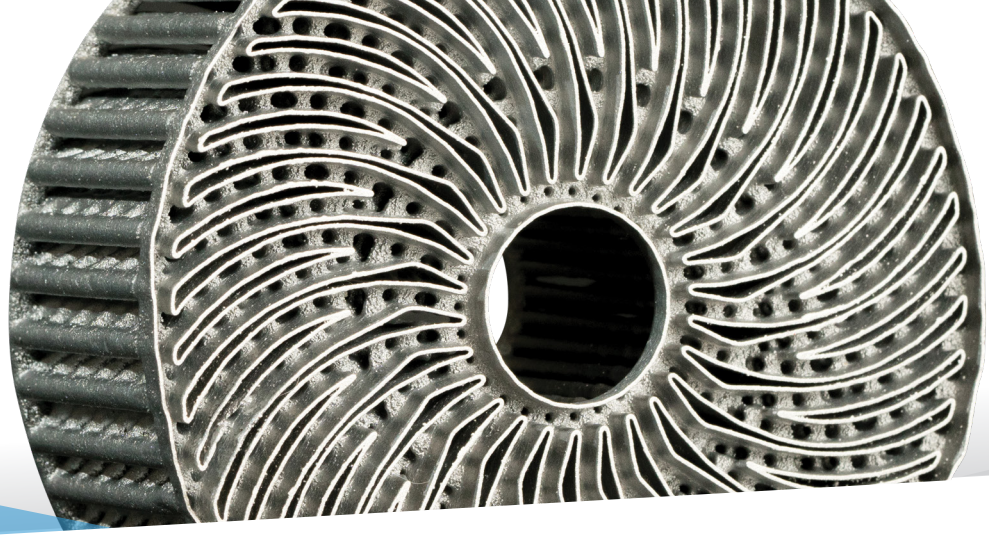
Thermal Properties

MEASUREMENT	CONDITION	METRIC			U.S.		
		AS-BUILT	AFTER STRESS RELIEF	DIRECT AGEING	AS-BUILT	AFTER STRESS RELIEF	DIRECT AGEING
Thermal conductivity[4,5] (W/(m.K) | Btu/(h.ft.°F))	at 20 °C / 68 °F	120-130	160-170	140-160	70-75	90-100	80-90
CTE - Coefficient of thermal expansion[6] (µm/(m.°C) | µ inch/(inch . °F))	in the range of 20 to 100 °C	typical 20.9			typical 11.6		
Melting range[6] (°C | °F)		typical 557 - 596			typical 543 - 613		

Electrical Properties[5,7]

MEASUREMENT	CONDITION	METRIC			U.S.		
		AS-BUILT	AFTER STRESS RELIEF	DIRECT AGEING	AS-BUILT	AFTER STRESS RELIEF	DIRECT AGEING
Electrical conductivity (10^6 S/m)	ASTM B193 at 20°C / 68°F	17-18	22-24	20-22	17-18	22-24	20-22

[1] Parts manufactured with standard parameters on a ProX DMP 320, Config B
[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] Thermal conductivity values are calculated by the Wiedemann-Franz law using the respective electrical resistivity values
[5] Results are based on limited sample size, not statistically representative
[6] Values based on literature
[7] Electrical resistivity measurements are based on four point contact method according to ASTM B193



Physical Properties

MEASUREMENT	CONDITION	METRIC	U.S.
Density			
Relative, based on pixel count[1,2,4] (%)	Optical method	> 99.2 typical 99.8	> 99.2 typical 99.8
Absolute theoretical[3] (g/cm^3 | lb/in^3)		2.68	0.097

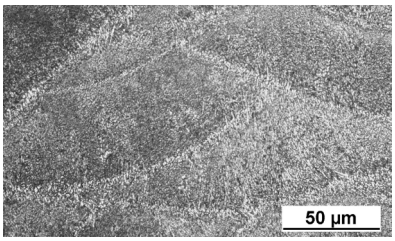
Surface Quality[4,5]

MEASUREMENT	CONDITION	SAND BLASTED METRIC	SAND BLASTED U.S.
Surface Roughness R_a	ISO 25178		
Layer Thickness 30 µm Top surface[6] (µm | µin) Vertical side surface[7] (µm | µin)		 typical 8-18 typical 7-10	 typical 315-710 typical 275-395
Layer Thickness 60 µm Top surface[6] (µm | µin) Vertical side surface[7] (µm | µin)		 typical 21-25 typical 9-14	 typical 830-990 typical 355-550

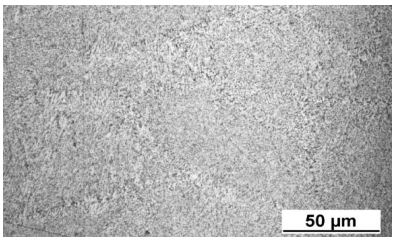
Chemical Composition

The chemical composition of LaserForm AlSi10Mg (A) conforms to the requirements EN AC-43000, and is indicated in the table below in wt%.

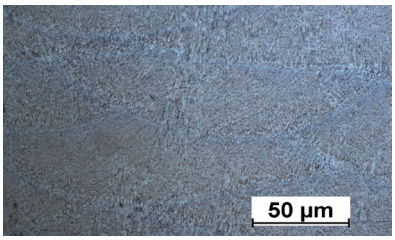
ELEMENT	% OF WEIGHT
Al	Balance
Si	9.00-11.00
Mg	0.20-0.45
Fe	≤0.55
Cu	≤ 0.03
Mn	≤0.35
Ni	≤0.05
Zn	≤0.10
Pb	≤0.05
Sn	≤0.05
Ti	≤0.15
Other (each)	≤ 0.05
Other (total)	≤ 0.15



Microstructure as built



Microstructure after stress relief



Microstructure after direct ageing

[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 B
[5] Sand blasting performed with zirconia blasting medium at 2 bar
[6] Top surface measurements along the 2 perpendicular axes of the reference square geometry
[7] Vertical side surface measurement along the building direction

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