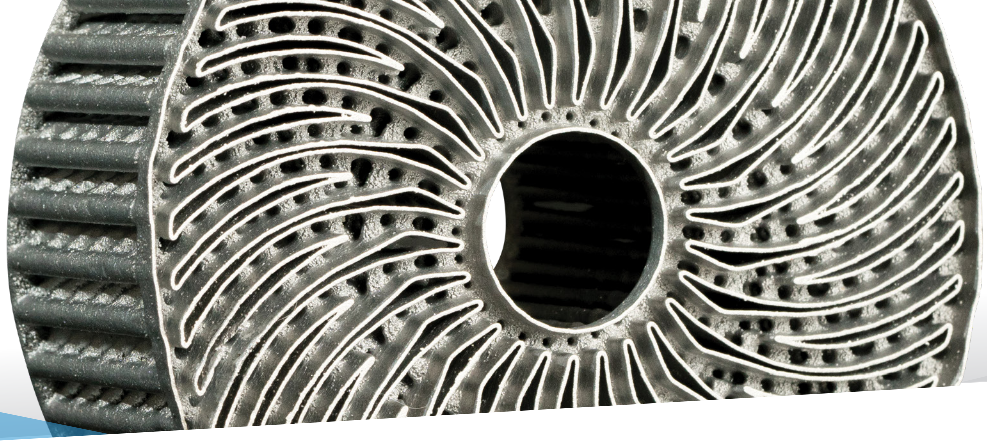


LaserForm AlSi10Mg (A)

AlSi10Mg fine-tuned for use with ProX® DMP 320, DMP Flex 350, DMP Factory 350 and DMP Factory 500 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 ProX® DMP 320, DMP Flex 350, DMP Factory 350 and DMP Factory 500 metal 3D printers to deliver high part quality and consistent 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 more than 1,000,000 challenging metal production parts in various materials year over year. Based on a multitude of test samples, the properties listed below provide high confidence to the user in terms of job-to-job and machine-to-machine repeatability. Using the LaserForm material enables the user to experience consistent and reliable part quality.

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.

CLASSIFICATION:

Parts built with LaserForm AlSi10Mg (A) have a chemical composition that complies with EN AC-43000 and ASTM F3318.

Mechanical Properties

PROX DMP 320, DMP FLEX 350, DMP FACTORY 350 - LT 30[1, 4, 5]	TEST METHOD	METRIC			U.S.		
		NHT	SR1	SR2	NHT	SR1	SR2
Ultimate tensile strength (MPa | ksi) Horizontal direction - XY Vertical direction - Z	ASTM E8	470 ± 10 460 ± 25	300 ± 20 300 ± 20	400 ± 15 430 ± 15	68 ± 1 67 ± 4	44 ± 3 44 ± 3	58 ± 2 62 ± 2
Yield strength Rp0.2% (MPa | ksi) Horizontal direction - XY Vertical direction - Z		280 ± 10 240 ± 10	190 ± 20 180 ± 20	270 ± 10 250 ± 10	41 ± 1 35 ± 1	28 ± 3 26 ± 3	39 ± 1 36 ± 1
Plastic elongation (%) Horizontal direction - XY Vertical direction - Z		13.2 ± 4.8 8.3 ± 4.0	15.6 ± 3.6 15.8 ± 2.7	9.2 ± 3.8 5.2 +3.7/-2.6	13.2 ± 4.8 8.3 ± 4.0	15.6 ± 3.6 15.8 ± 2.7	9.2 ± 3.8 5.2 +3.7/-2.6

PROX DMP 320, DMP FLEX 350, DMP FACTORY 350 – LT 60[2, 4, 5]	TEST METHOD	METRIC			U.S.		
		NHT	SR1	SR2	NHT	SR1	SR2
Ultimate tensile strength (MPa | ksi) Horizontal direction - XY Vertical direction - Z	ASTM E8	440 ± 30 425 ± 50	290 ± 20 290 ± 20	390 ± 20 400 ± 40	64 ± 4 62 ± 7	42 ± 3 42 ± 3	57 ± 3 58 ± 6
Yield strength Rp0.2% (MPa | ksi) Horizontal direction - XY Vertical direction - Z		260 ± 15 225 ± 10	170 ± 20 170 ± 20	255 ± 10 230 ± 10	38 ± 2 33 ± 1	25 ± 3 25 ± 3	37 ± 1 33 ± 1
Plastic elongation (%) Horizontal direction - XY Vertical direction - Z		8.9 ± 5.0 7.6 ± 4.9	14.0 ± 5.3 13.2 ± 6.0	8.6 ± 2.0 5.1 ± 2.8	8.9 ± 5.0 7.6 ± 4.9	14.0 ± 5.3 13.2 ± 6.0	8.6 ± 2.0 5.1 ± 2.8

DMP FACTORY 500 – LT 60[3, 4, 5]	TEST METHOD	METRIC			U.S.		
		NHT	SR1	SR2	NHT	SR1	SR2
Ultimate tensile strength (MPa | ksi) Horizontal direction - XY Vertical direction - Z	ASTM E8	NA	290 ± 20 300 ± 20	405 ± 20 420 +20/-60	NA	42 ± 3 44 ± 3	59 ± 3 61 +3/-9
Yield strength Rp0.2% (MPa | ksi) Horizontal direction - XY Vertical direction - Z		NA	170 ± 20 180 ± 20	270 +15/-30 250 ± 20	NA	25 ± 3 26 ± 3	39 +2/-4 36 ± 3
Plastic elongation (%) Horizontal direction - XY Vertical direction - Z		NA	17.5 ± 4.9 13.3 ± 5.7	9.4 ± 5.5 5.8 ± 3.4	NA	17.5 ± 4.9 13.3 ± 5.7	9.4 ± 5.5 5.8 ± 3.4

[1] Parts manufactured with standard parameters and protocols on a ProX DMP 320, DMP Flex and Factory 350, Config B, using layer thickness 30 µm (LT30)

[2] Parts manufactured with standard parameters and protocols on a ProX DMP 320, DMP Flex and Factory 350, Config B, using layer thickness 60 µm (LT60)

[3] Parts manufactured with standard parameters and protocols on a DMP Factory 500, using layer thickness 60 µm (LT60)

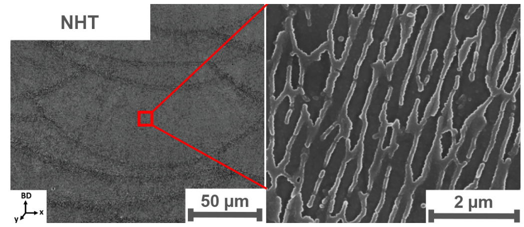
[4] NHT is non-heat-treated sample condition; SR1 is a heat treatment at 285 °C for 2 h; SR2 is a heat treatment at 190 °C for 6h. Values based on average and 95% tolerance interval with 95% confidence

[5] Tested according to ASTM E8 using round tensile test specimen type 4

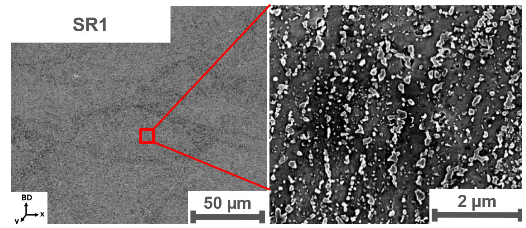
Printed Part Properties[6]

DENSITY	TEST METHOD	METRIC	U.S.
Theoretical density[7] (g/cm³ | lb/in³)	Value from literature	2.68	0.097
Relative density (%), layer thickness 30 µm [1, 8]	Optical method (pixel count)	≥ 99.7 Typical 99.9	≥ 99.7 Typical 99.9
Relative density (%), layer thickness 60 µm [2, 3, 8]	Optical method (pixel count)	≥ 99.5 Typical 99.8	≥ 99.5 Typical 99.8

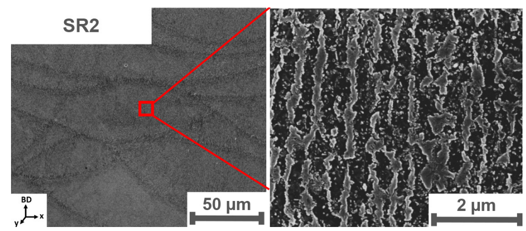
SURFACE ROUGHNESS R_a [9,10]	TEST METHOD	METRIC	U.S.
Vertical side surface (µm | µin) Layer thickness 30 µm	ISO 25178	Typically, around 8	Typically, around 315
Vertical side surface (µm | µin) Layer thickness 60 µm	ISO 25178	Typically, around 15	Typically, around 591



Microstructure without heat treatment (NHT)



Microstructure after SR1



Microstructure after SR2

Thermal Properties

MEASUREMENT	CONDITION	METRIC			U.S.		
		NHT	SR1	SR2	NHT	SR1	SR2
Thermal conductivity[11,12] (W/(m.K) | BTU·in/h·ft²·°F	at 20 °C / 68 °F	120-130	160-170	140-160	833-902	1110 -1180	971-1110
CTE - Coefficient of thermal expansion[7] (µm/(m.°C) | µ inch/(inch . °F))	in the range of 20 to 100 °C	typical 20.9			typical 11.6		
Melting range[7] (°C | °F)		typical 557 - 596			typical 1035 - 1105		

Electrical Properties[12,13]

MEASUREMENT	CONDITION	METRIC			U.S.		
		NHT	SR1	SR2	NHT	SR1	SR2
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

Chemical Composition

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

[6] May deviate depending on specific part geometry
[7] Values based on literature
[8] Minimum values based on 95% tolerance interval with 95% confidence. Tested on specific 3DS density test coupons
[9] Surface treatment performed with zirconia blasting medium at 2 bar
[10] Vertical side surface measurement along the building direction
[11] Thermal conductivity values are calculated by the Wiedemann-Franz law using the respective electrical resistivity values
[12] Results are based on limited sample size, not statistically representative. Samples printed on a ProX DMP 320, Config B
[13] Electrical resistivity measurements are based on four point contact method according to ASTM B193

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