Stratasys High Yield PA11 Material Properties

Preliminary information, subject to change

Processed with SAF™ technology on the Stratasys H350 3D printer, Stratasys High Yield PA11 delivers production-grade plastic parts for high-volume demands — driving new areas of business growth. Stratasys High Yield PA11 enables a high nesting density while maintaining high part consistency to deliver production-level yields.

In additive manufacturing, PA12 is the go-to material for prototyping. But in traditional high-volume production of end-use parts, PA11 is much more widely used due to its higher ductility and higher impact resistance, as well as its suitability for a wider range of industry applications. PA11 is also eco-friendly and 100 percent bio-based from sustainable castor oil.

The mechanical data below provides a good characterisation of the entire build volume across multiple printers. It was generated after measuring more than 2000 tensile specimens (972 in X/Y and 1,080 in Z direction), 540 flexural specimens (360 in X/Y and 180 in Z) and 540 impact specimens (360 in X/Y and 180 in Z), all printed in 36 builds from 5 different printers. These specimens were widely and regularly distributed throughout the build volume, in a 12% nesting density build and produced with default printer settings.

Property	Mean	Standard Deviation	Unit	Standard
Tensile Strength (XZ,YX)	51 (7397)	2.2 (319)	MPa (psi)	ASTM D638-14
Tensile Strength (ZX)	47 (6817)	4.4 (638)	MPa (psi)	ASTM D638-14
Elongation at Break (XZ,YX)	30	5.6	%	ASTM D638-14
Elongation at Break (ZX)	11	4.8	%	ASTM D638-14
0.2% Offset Yield Strength (XZ,YX)	35 (5076)	1.6 (232)	MPa (psi)	ASTM D638-14
0.2% Offset Yield Strength (ZX)	34 (4931)	2.5 (363)	MPa (psi)	ASTM D638-14
Tensile Modulus (XZ,YX)	1529 (222)	76 (11)	MPa (ksi)	ASTM D638-14
Tensile Modulus (ZX)	1609 (233)	99 (14)	MPa (ksi)	ASTM D638-14
Flexural Strength (XZ,YX)	35 (5033)	2.3 (327)	MPa (psi)	ASTM D790-17
Flexural Strength (ZX)	36 (5280)	2.9 (414)	MPa (psi)	ASTM D790-17
Flexural Modulus (XZ,YX)	826 (120)	65 (9.5)	MPa (ksi)	ASTM D790-17
Flexural Modulus (ZX)	885 (128)	79 (11.5)	MPa (ksi)	ASTM D790-17
Notched Impact Strength (XZ,YX)	7.4 (3.5)	0.6 (0.3)	kJ/m^2 ($Ft.lbf/in^2$)	ASTM D256-10
Notched Impact Strength (ZX)	4.5 (2.1)	0.2 (0.1)	kJ/m^2 ($Ft.lbf/in^2$)	ASTM D256-10

General	Value	Unit	Standard
Part Specific Gravity	1.02	-	ASTM D792-13
Virgin Particle Size D50	47 (1.9)	µm (thou)	-
Virgin Powder Melting Point	202 (396)	°C (°F)	-
Surface	**Value**	**Unit**	**Standard**
Surface Roughness, Top Surface (Ra)	8.5 (0.3)	µm (thou)	ISO 4287
Surface Roughness, Bottom Surface (Ra)	7.2 (0.3)	µm (thou)	ISO 4287
Surface Roughness, Sidewall (Ra)	7.9 (0.3)	µm (thou)	ISO 4287
Thermal	**Value**	**Unit**	**Standard**
Heat Deflection Temperature (0.45MPa/65psi)	185 (365)	°C (°F)	ASTM D648
Heat Deflection Temperature (1.82MPa/264psi)	47 (117)	°C (°F)	ASTM D648
Coefficient of Thermal Expansion	171 (0.095)	µm/°C.m (thou/in.°F)	ASTM E831
Specific Heat Capacity (20°C/68°F)	1.72 (0.411)	J/g.°C (BTU/lbm.°F)	ASTM E1952
Thermal Conductivity (20°C/68°F)	0.263 (0.152)	W/°C.m (BTU/hr.ft.°F)	ASTM E1952
Electrical	**Mean**	**Unit**	**Standard**
Surface resistivity	1.9×10^{15}	Ohm	ASTM D257
Volume resistivity	3.6×10^{14}	Ohm-cm	ASTM D257
Bio compatibility	**Result**	**Unit**	**Standard**
Determination of Sensitization - human cell line activation test (h-Clat)	Non-Sensitizer	N/A	OECD 442E 2018-06
Determination of Skin Irritation	Non-irritant	N/A	ISO 10993-10 2014-10 / OECD 439 2015-07
Determination of Cytotoxicity	Material shows no cytotoxic effect	N/A	DIN EN ISO 10993-5, 2009, Annex D
Flammability		**Unit**	**Standard**
UL94 HB	Pass*	Not Applicable	UL94 (2013)
Reusability	**Value**	**Unit**	**Standard**
Typical Powder Mix Ratio (Virgin)	30	%	-

* Product is not currently UL Blue Card Registered.

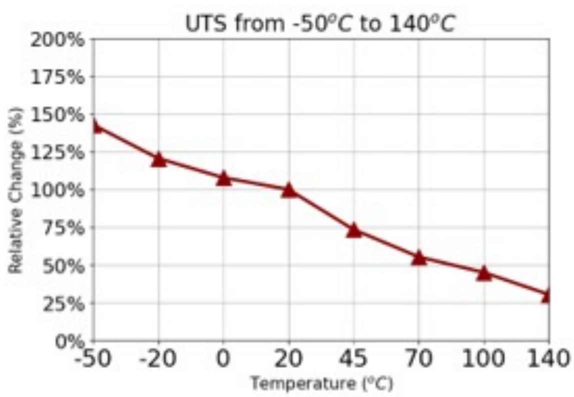
Testing Varying Temperatures

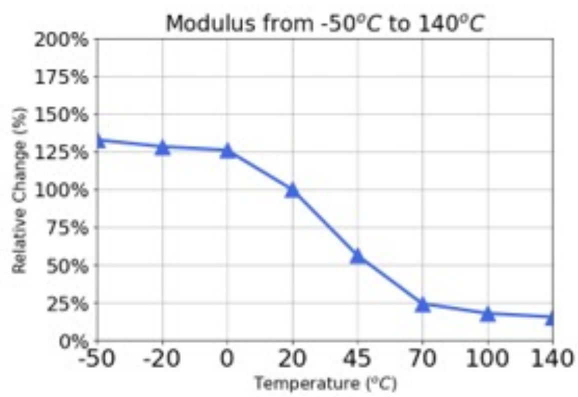
The following results give an indication of the tensile properties of the material across a range of temperatures. Tensile testing was conducted between -50°C (-58°F) and 140°C (284°F) with all coupons and testing in accordance with ASTM D638-22. Coupons were manufactured in both XZ and ZX directions with 5 coupons per direction. The results are presented as a percentage of room temperature properties.

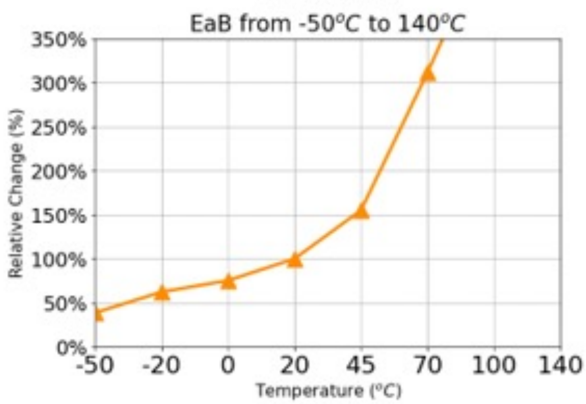
XZ

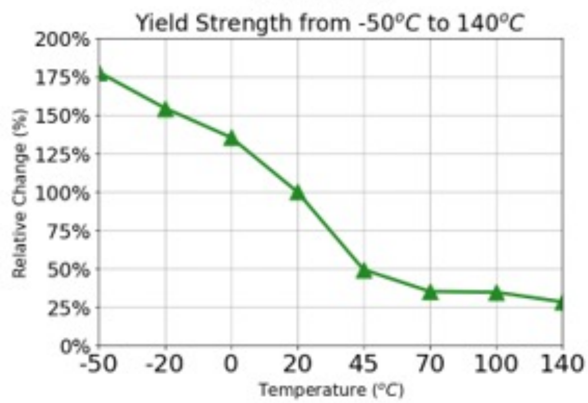
When testing samples at high temperatures, ductility is significantly increased. This can lead to samples stretching beyond the capability of the test equipment rather than having a definitive failure point. With no failure point, the elongation at break and ultimate strength of the sample cannot be accurately measured. Values affected by this are highlighted in **blue**. Where necessary, these values are excluded from the plots below to keep the scales legible.

Material	Direction	Temp (F)	Temp (C)	Ultimate Tensile Strength	Elongation at Break	Tensile Modulus	Yield Strength
High Yield PA11	XZ	-58	-50	143%	39%	133%	178%
		-4	-20	121%	62%	128%	155%
		32	0	108%	75%	126%	135%
		113	45	74%	155%	56%	49%
		158	70	55%	311%	24%	35%
		212	100	45%	479%	18%	35%
		284	140	31%	485%	16%	28%



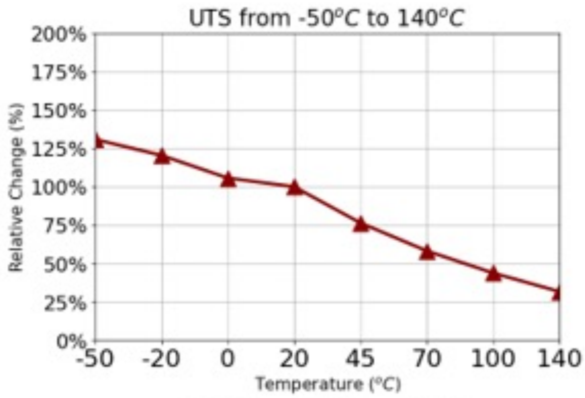


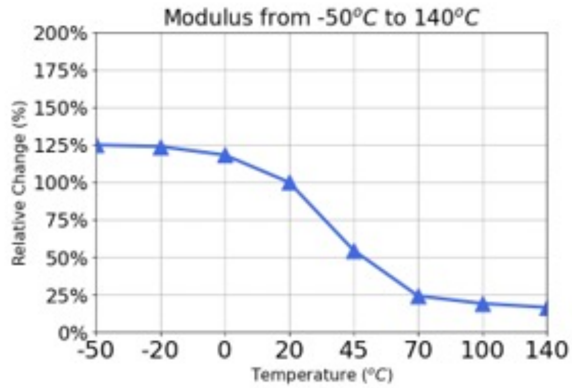


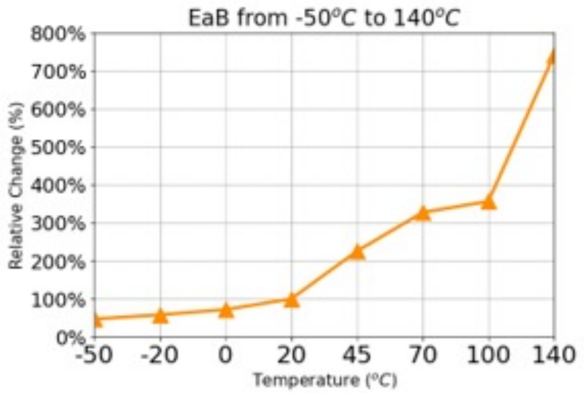


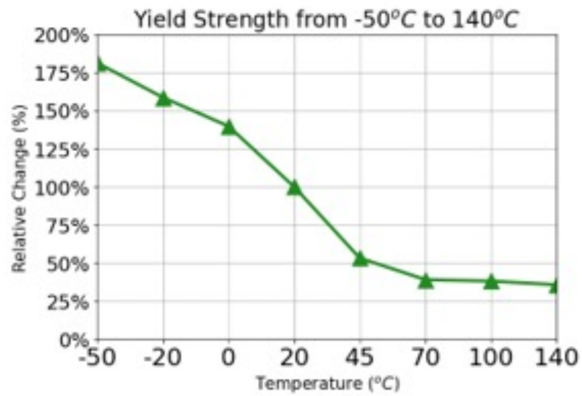
ZX

Material	Direction	Temp (F)	Temp (C)	Ultimate Tensile Strength	Elongation at Break	Tensile Modulus	Yield Strength
High Yield PA11	ZX	-58	-50	131%	47%	125%	181%
		-4	-20	120%	58%	124%	159%
		32	0	106%	72%	118%	140%
		113	45	76%	225%	55%	53%
		158	70	58%	327%	24%	39%
		212	100	44%	356%	19%	38%
		284	140	32%	741%	17%	36%









Tests were performed on parts produced on the H350 using a Full Standard Test Build (FSTB), with 12% nesting density, on multiple machines after a standard installation process, using the default machine settings with 70/30 reused/virgin mix throughout the testing process. H350 installation includes a standard calibration process. Post processing of parts followed H350 recommended guidelines including 24 hours cooling after removal from the machine, manual breaking out, and powder removal via automatized bead blasting with no further post processing. All testing was to ASTM or ISO standards where applicable. All mechanical parts were preconditioned according to ASTM D618-13.

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