FDM Nylon 12CF

FDM Thermoplastic Filament

The information presented are typical values intended for reference and comparison purposes only.
They should not be used for design specifications or quality control purposes.

Overview

FDM® Nylon 12CF™ is a PA12 (polyamide 12) thermoplastic filament reinforced with chopped carbon fiber, 35% by weight. It has the highest flexural strength of any FDM thermoplastic, resulting in the highest stiffness-to-weight ratio. The combination of high strength, stiffness and light weight makes it an optimal replacement for heavier metal components in appropriate use cases.

Typical applications include strong, lightweight tooling, functional prototyping and select end-use parts.

Contents:

Ordering Information

Table 1. Printer and Support Material Compatibility

Printer	Model Tip (Slice)	Support Material	Support Tip
Fortus 450mc™	T20C (10 slice)	SR-110™ (soluble)	T12SR100
F900™	T20C (10 slice)	SR-110 (soluble)	T12SR100
	T40C (20 slice)	SR-110 (soluble)	T20

Build Sheet

Nylon

- 0.02 x 26 x 38 in. (0.51 x 660 x 965 mm)
- 0.02 x 16 x 18.5 in. (0.51 x 406 x 470 mm)

Hardware

Due to the high abrasion of this material, a system upgrade is required to support a hardened head and drive wheels. Ordering information can be found in Table 2.

Table 2. FDM Nylon 12CF Ordering Information

Part Number	Description
Filament Canisters	
355-02411	FDM Nylon 12CF, 92.3 cu in. - Plus
355-03130	SR-110 Soluble Support, 92.3 cu in. - Plus
Printer Consumables	
511-10720	T20C tip
511-10100	T12SR100 tip
511-10760	T40C tip
511-10701	T20 tip[1]
325-00600-S	Nylon build sheet, 0.02 x 26 x 38 in. (0.51 x 660 x 965 mm)
325-00700-S	Nylon build sheet, 0.02 x 16 x 18.5 in. (0.51 x 406 x 470 mm)
System Upgrades	
335-60000	Fortus 900mc Gen 3 Upgrade from Gen 1 & 2 Systems
325-63500	Hardened F900 Head Only

[1] The T20 tip is for support material (20 slice) and should not be confused with the T20C 10-slice model material tip.

Physical Properties

Values are measured as printed. XY, XZ, and ZX orientations were tested. For full details refer to the Stratasys Materials Test Report (immediate download upon clicking the link). DSC and TMA curves can be found in the Appendix.

Table 3. FDM Nylon 12CF Physical Properties

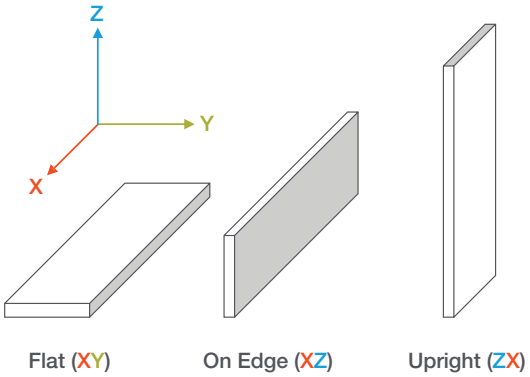
Property	Test Method	Typical Values	
		XY	XZ/ZX
HDT @ 66 psi	ASTM D648 Method B	160.4 C (320.7 F)	168.1 C (334.6 F)
HDT @ 264 psi	ASTM D648 Method B	129.8 C (265.7 F)	153.7 C (308.7 F)
Tg	ASTM D7426 Inflection Point	37.53 C (99.55 F)	
Mean CTE	ASTM E831 (-50 °C to 20 °C)	115.7 µm/[m*°C] (67.28 µin/[in*°F])	37.31 µm/[m*°C] (20.73 µin/[in*°F])
Mean CTE	ASTM E831 (20 °C to 60 °C)	180.5 µm/[m*°C] (100.3 µin/[in*°F])	
Mean CTE	ASTM E831 (60 °C to 115 °C)	195.8 µm/[m*°C] (108.8 µin/[in*°F])	
Mean CTE	ASTM E831 (115 °C to 150 °C)	296.5 µm/[m*°C] (164.7 µin/[in*°F])	
Mean CTE	ASTM E831 (20 °C to 105 °C)		46.15 µm/[m*°C] (25.64 µin/[in*°F])
Mean CTE	ASTM E831 (105 °Cto 150 °C)		58.43 µm/[m*°C] (32.46 µin/[in*°F])
Volume Resistivity	ASTM D257	2.84*10^7 Ω*cm	
Dielectric Constant	ASTM D150 1 kHz test condition	Too conductive	
Dielectric Constant	ASTM D150 2 MHz test condition	11.4	10.0
Dissipation Factor	ASTM D150 1 kHz test condition	Too conductive	
Dissipation Factor	ASTM D150 2 MHz test condition	0.100	0.000
Thermal Conductivity	ASTM E1952 @0C	0.5884 W/m*K 0.3400 BTU/(hr*ft*F)	
Thermal Conductivity	ASTM E1952 @30C	0.5988 W/m*K 0.3460 BTU/(hr*ft*F)	
Thermal Conductivity	ASTM E1952 @60C	0.5800 W/m*K 0.3352 BTU/(hr*ft*F)	
Thermal Conductivity	ASTM E1952 @90C	0.6153 W/m*K 0.3556 BTU/(hr*ft*F)	
Thermal Diffusivity	ASTM E1952 @0C	0.363 mm^2/s 5.63*10^-4 in^2/s	
Thermal Diffusivity	ASTM E1952 @30C	0.324 mm^2/s 5.02*10^-4 in^2/s	
Thermal Diffusivity	ASTM E1952 @60C	0.266 mm^2/s 4.12*10^-4 in^2/s	
Thermal Diffusivity	ASTM E1952 @90C	0.255 mm^2/s 3.95*10^-4 in^2/s	
Specific Gravity	ASTM D257 @23 °C	1.190	

Mechanical Properties

FDM Nylon 12CF samples were printed with a 0.010 in. (0.254 mm) layer height on the F900. For the full test procedure please see the Stratasys Materials Test Procedure (immediate download upon clicking the link).

Print Orientation

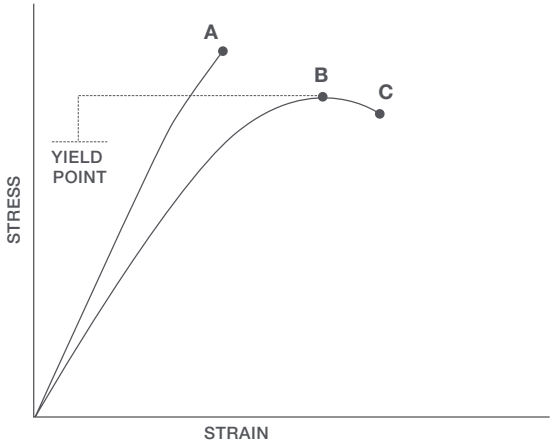
Parts created using FDM are anisotropic as a result of the printing process. Below is a reference of the different orientations used to characterize the material.



Flat (XY) On Edge (XZ) Upright (ZX)

Tensile Curves

Due to the anisotropic nature of FDM, tensile curves look different depending on orientation. Below is a guide of the two types of curves seen when printing tensile samples and what reported values mean.



A = Tensile at break, elongation at break (no yield point)
B = Tensile at yield, elongation at yield
C = Tensile at break, elongation at break

Table 4. FDM Nylon 12CF Mechanical Properties (F900 - T20C tip)

		XZ Orientation[1]	ZX Orientation[1]
Tensile Properties: ASTM D638			
Yield Strength	MPa	No yield	No yield
	psi	No yield	No yield
Elongation @ Yield	%	No yield	No yield
Strength @ Break	MPa	83.5 (1.7)	32.7 (3.5)
	psi	12100 (250)	4750 (510)
Elongation @ Break	%	2.4 (0.29)	1.2 (0.27)
Modulus (Elastic)	GPa	9.46 (0.46)	3.00 (0.43)
	ksi	1370 (67)	434 (63)
Flexural Properties: ASTM D790, Procedure A			
Strength @ Break	MPa	153 (2.1)	62.4 (3.4)
	psi	22200 (310)	9080 (490)
Strain @ Break	%	2.65 (0.086)	3.10 (0.26)
Modulus	GPa	11.1 (0.28)	2.34 (0.085)
	ksi	1610 (40)	339 (12)
Compression Properties: ASTM D695			
Yield Strength	MPa	110 (3.0)	141 (2.6)
	psi	16000 (440)	20400 (380)
Modulus	GPa	6.78 (0.55)	3.67 (0.11)
	ksi	984 (79)	532 (16)
Impact Properties: ASTM D256, ASTM D4812			
Notched	J/m	106 (6.6)	24 (3.2)
	ft*lb/in.	1.99 (0.12)	0.45 (0.060)
Unnotched	J/m	346 (40)	121 (18)
	ft*lb/in.	6.48 (0.74)	2.27 (0.33)

[1] Values in parenthesis are standard deviations.

Table 5. Nylon 12CF Mechanical Properties (F900 - T40C tip)

		XZ Orientation[1]	ZX Orientation[1]
Tensile Properties: ASTM D638*			
Yield Strength	MPa	107.9 (5.3)	36.2 (1.4)
	psi	15600 (800)	5200 (200)
Elongation @ Yield	%	1.9 (0.2)	2.9 (0.4)
Strength @ Break	MPa	106.7 (4.9)	36.0 (1.5)
	psi	15500 (700)	5200 (200)
Elongation @ Break	%	1.9 (0.2)	2.9 (0.4)
Modulus (Elastic)	GPa	12.7 (0.5)	2.13 (0.07)
	ksi	1840 (80)	310 (10)
Flexural Properties: ASTM D790, Procedure A			
Strength @ Break	MPa	187.4 (4.9)	64.7 (2.1)
	psi	27200 (700))	9400 (300)
Strain @ Break	%	2.4 (0.2)	4.0 (0.3)
Modulus	GPa	12.5 (0.3)	2.30 (0.07)
	ksi	1820 (40)	330 (10)
Compression Properties: ASTM D695			
Peak Strength	MPa	Not Available	Not Available
	psi	Not Available	Not Available
Modulus	GPa	Not Available	Not Available
	ksi	Not Available	Not Available

[1] Values in parenthesis are standard deviations.

*ZX D638 coupons were water jetted from printed plaques. (Coupon dimensions: 6.500 x 0.875 x 0.200 inches (~165 x 22 x 5 mm))

Performance at Temperature

Nylon 12CF was tested at various temperatures. Ten ASTM D638 upright (ZX) T20C dogbones coupons were tested in tensile. The percent change from the reported room temperature results are listed below.
For more information see the FDM Strength Performance Across Temperatures white paper.

Table 6. Performance of FDM Nylon 12CF at Temperature

Material	Temperature		Strength at Break	Elongation at Break	Modulus
	(F)	(C)			
Nylon 12CF - T20C	-65	-54	176%	60%	126%
	-40	-40	160%	57%	128%
	110	43	95%	77%	80%
	180	82	66%	173%	41%
	220	104	50%	223%	30%
	270	132	34%	257%	21%

Appendix

Figure 1. 2nd heating scan DSC data for the Nylon 12CF Flat (XY) sample.

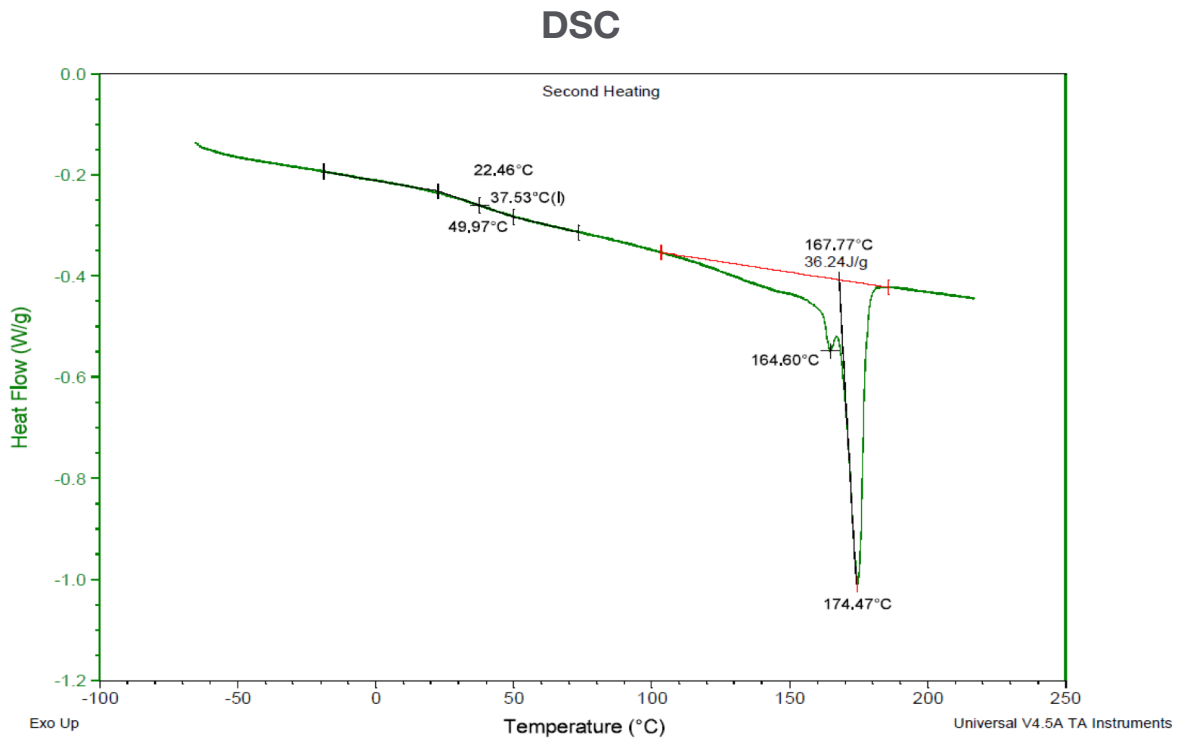


Figure 2. Dimension change data as a function of temperature for the Nylon 12CF Flat (XY) sample.

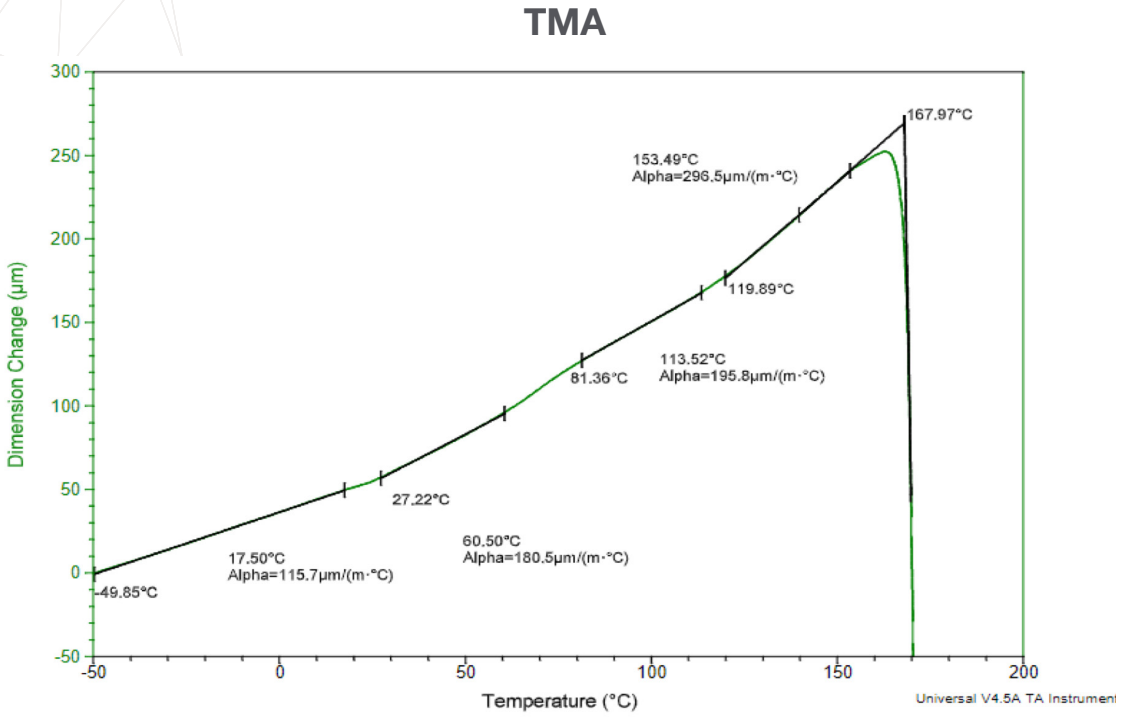


Figure 3. Dimension change data as a function of temperature for the Nylon 12CF On Edge (XZ) sample.

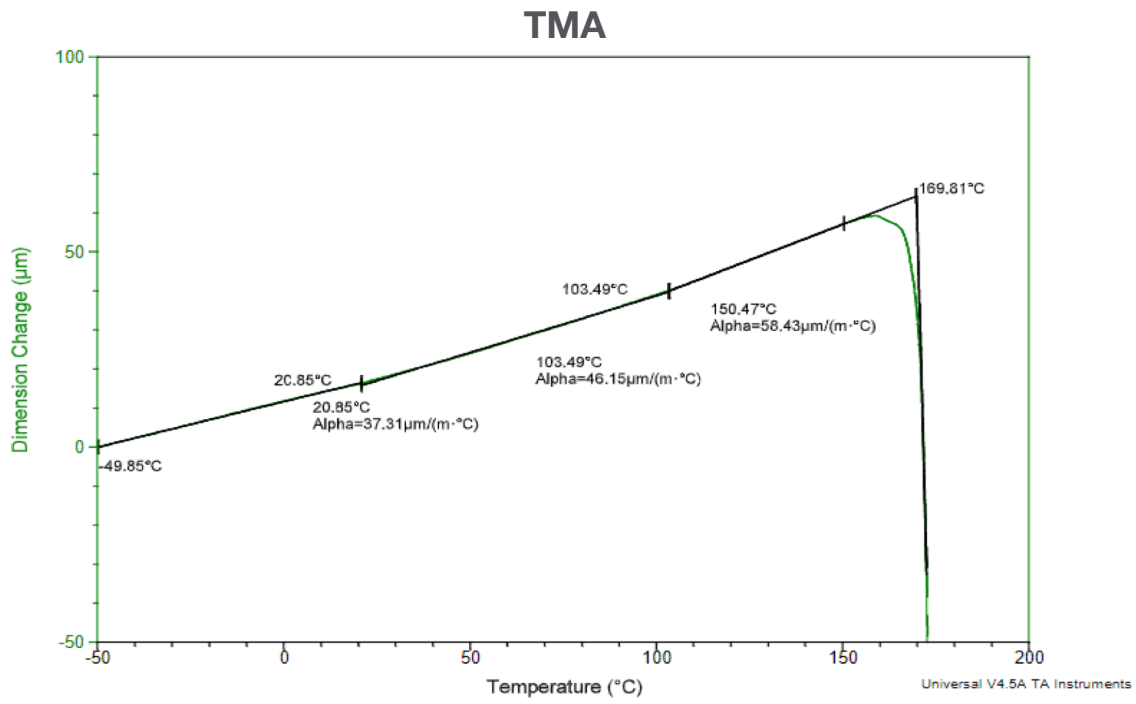
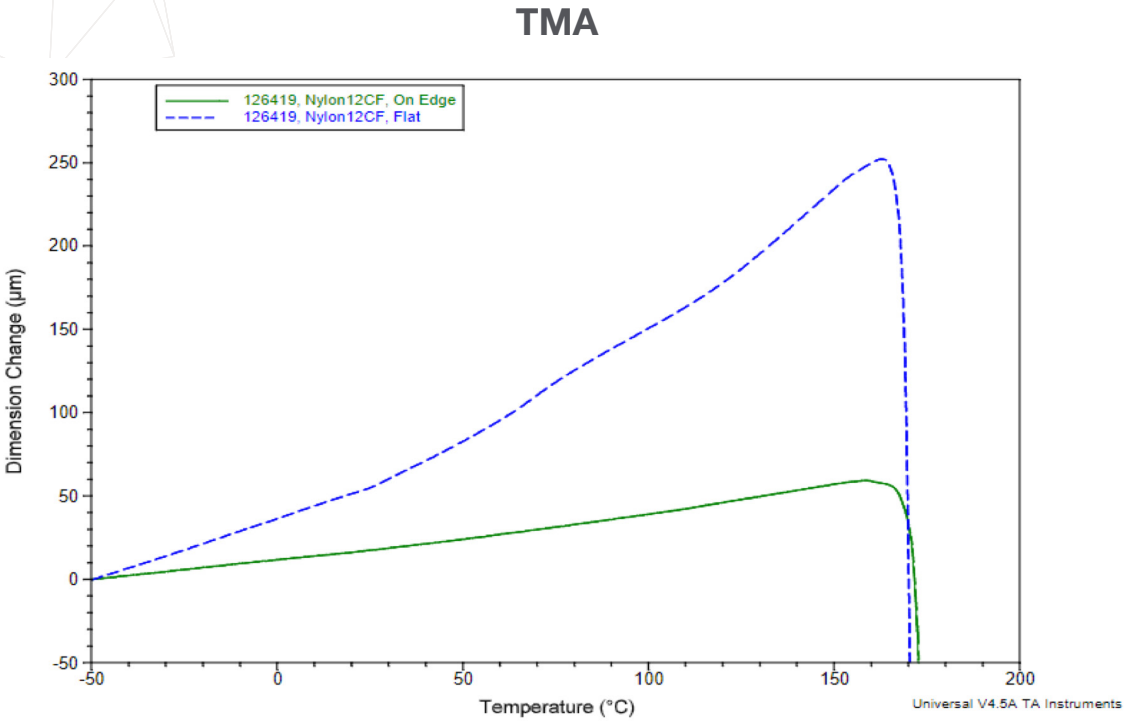


Figure 4. Overlay of the dimension change data for the Flat (XY) and On Edge (XZ) Nylon 12CF samples.



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