stratasys

MATERIAL DATA SHEET
FDM

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	Layer Height	Support Material	Support Tip
Fortus 450mc™	T20C	0.254 mm (0.010 in.)	SR-110™	T12SR100
F900®	T20C	0.254 mm (0.010 in.)	SR-110	T12SR100
	T40A	0.508 mm (0.020 in.)		T20
F3300™	N500H	0.25 mm (0.010 in.)	SR-110	N410

Build Sheet

Fortus Nylon Build Sheet

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

F3300 Nylon Build Sheet

- 0.51 x 660 x 711 mm (0.02 x 26 x 28 in.)

System Requirements[1]

Fortus® 450mc

- Hardened machine upgrade
- Hardened Fortus 450mc head
- Nylon 12CF material license (included if new system)

F900

- Hardened F900 head
- Nylon 12CF material license
- Fortus FDC (enables use of XTEND™ 250 Fortus® Plus spool)

F3300

- F3000 Series Extruder Drive
- Hardened Hot End
- No material license required

[1] Contact your Stratasys representative for ordering information.

Table 2: FDM Nylon 12CF Ordering Information

Part Number	Description	System Compatibility
Filament Consumables		
Fortus Plus Canister (black snout)		
355-02411	FDM Nylon 12CF, 92.3 cu in. - Plus	Fortus 450mc, F900
355-03130	SR-110 Soluble Support, 92.3 cu in. - Plus	
Fortus Plus Spools		
361-00300	XTEND™ 250 Fortus® Plus Nylon 12CF	F900 with Fortus FDC™
F3000 Series Spools		
363-00300	MTRL, F3000 Series, (M), Nylon 12CF, 4100cc	F3300
363-00710	MTRL, F3000 Series, (S), SR-110, 4100cc	

Part Number	Description	System Compatibility
Printer Consumables		
Fortus		
511-10720	TIP, FDM, T20C, 0.010 in. (0.254 mm) layer height	Fortus 450mc, F900
511-10100	TIP, FDM, T12SR100, 0.010 in. (0.254 mm) layer height	
511-10760	TIP, FDM, T40C, 0.020 in. (0.508 mm) layer height	F900
511-10701	TIP, FDM, T20[2], 0.020 in. (0.508 mm) layer height	
325-00750-S	Nylon build sheet, 0.02 x 16 x 18.5 in. (0.51 x 406 x 470 mm), 20 pack	Fortus 450mc, F900
325-00650-S	Nylon build sheet, 0.02 x 26 x 38 in. (0.51 x 660 x 965 mm), 10 pack	F900
F3000 Series		
533-00505-S	Hardened, FDM, N500H (0.25 mm/0.010 in. layer height)	F3300
533-00410-S	FDM, N410 Support (0.25 mm/0.010 in. layer height)	
533-00755-S	Hardened HOT END, FDM, N750H (0.50 mm/0.020 in. layer height)	
533-00750-S	HOT END, FDM, N750 Support (0.50 mm/0.020 in. layer height)	
363-30100-S	F3300 sheet bundle, Nylon 0.02 x 26 x 28 in., 10 pack	
Print Heads		
Fortus		
821726-XXXX	Hardened Fortus 450mc head (blue handle)	Fortus 450mc
380-30400-S	OpenAM Hardened Fortus 450mc head (blue handle, additional sticker)	
325-63500	Hardened F900 head (folded sheet metal handle)	F900
F3000 Series		
533-10000-S	F3000 Series Extruder Drive	F3300

[2]The T20 tip is for 0.508 mm (0.020 in.) support material and should not be confused with the T20C 0.254 mm (0.010 in.) 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 Procedure. 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 °C (320 °F)	168 °C (334 °F)
HDT @ 264 psi	ASTM D648 Method B	130 °C (266 °F)	154 °C (309 °F)
Unidirectional Toolpaths HDT @ 66 psi	ASTM D648	175 °C (347 °F)	-
Unidirectional Toolpaths HDT @ 264 psi	ASTM D648	157 °C (315 °F)	-
Tg	ASTM D7426 Inflection Point	37.5 °C (99.5 °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 °C to 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	

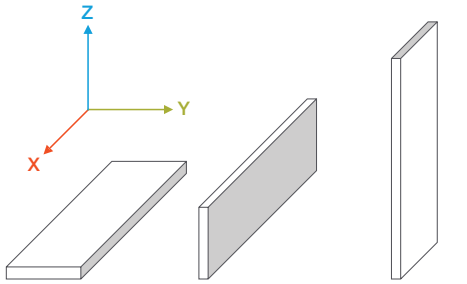
Property	Test Method	Typical Values XY	Typical Values XZ/ZX
Dielectric Constant	ASTM D150 2 MHz test condition	11.4	10.0
Dissipation Factor	ASTM D150 1 kHz test condition	Too conductive	
Dissipation Factor	ASTM D150 2 MHz test condition	0.100	0.000
Thermal Conductivity	ASTM E1952 @0 °C	0.5884 W/m*K 0.3400 BTU/(hr*ft°F)	
Thermal Conductivity	ASTM E1952 @30 °C	0.5988 W/m*K 0.3460 BTU/(hr*ft°F)	
Thermal Conductivity	ASTM E1952 @60 °C	0.5800 W/m*K 0.3352 BTU/(hr*ft°F)	
Thermal Conductivity	ASTM E1952 @90 °C	0.6153 W/m*K 0.3556 BTU/(hr*ft°F)	
Thermal Diffusivity	ASTM E1952 @0 °C	0.363 mm^2/s $5.63*10^{-4}$ in^2/s	
Thermal Diffusivity	ASTM E1952 @30 °C	0.324 mm^2/s $5.02*10^{-4}$ in^2/s	
Thermal Diffusivity	ASTM E1952 @60 °C	0.266 mm^2/s $4.12*10^{-4}$ in^2/s	
Thermal Diffusivity	ASTM E1952 @90 °C	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 0.254 mm (0.010 in.) layer height on the F900 and the Fortus 450mc. For the full test procedure please see the Stratasys Materials Test Procedure.

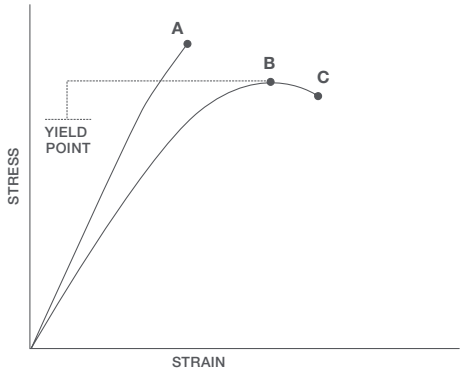
Print Orientation

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.



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

0.254 mm (0.010 in.) Layer Height		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	12,100 (250)	4,750 (510)
Elongation @ Break	%	2.4 (0.29)	1.2 (0.27)
Modulus (Elastic)	GPa	9.46 (0.46)	3.00 (0.43)
	ksi	1,370 (67)	434 (63)
Flexural Properties: ASTM D790, Procedure A			
Strength @ Break	MPa	153 (2.1)	62.4 (3.4)
	psi	22,200 (310)	9,080 (490)
Strain @ Break	%	2.65 (0.086)	3.10 (0.26)
Modulus	GPa	11.1 (0.28)	2.34 (0.085)
	ksi	1,610 (40)	339 (12)
Compression Properties: ASTM D695			
Yield Strength	MPa	110 (3.0)	141 (2.6)
	psi	16,000 (440)	20,400 (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 parentheses are standard deviations.

Table 5: Nylon 12CF Mechanical Properties - F900 - T40C tip

0.508 mm (0.020 in.) Layer Height		XZ Orientation[1]	ZX Orientation[1]
Tensile Properties: ASTM D638[2]			
Yield Strength	MPa	107.9 (5.3)	36.2 (1.4)
	psi	15,600 (800)	5,200 (200)
Elongation @ Yield	%	1.9 (0.2)	2.9 (0.4)
Strength @ Break	MPa	106.7 (4.9)	36.0 (1.5)
	psi	15,500 (700)	5,200 (200)
Elongation @ Break	%	1.9 (0.2)	2.9 (0.4)
Modulus (Elastic)	GPa	12.7 (0.5)	2.13 (0.07)
	ksi	1,840 (80)	310 (10)
Flexural Properties: ASTM D790, Procedure A			
Strength @ Break	MPa	187.4 (4.9)	64.7 (2.1)
	psi	27,200 (700)	9,400 (300)
Strain @ Break	%	2.4 (0.2)	4.0 (0.3)
Modulus	GPa	12.5 (0.3)	2.30 (0.07)
	ksi	1,820 (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 parentheses are standard deviations.
[2] ZX D638 coupons were water jetted from printed plaques. (Coupon dimensions: 165 x 22 x 5 mm (6.500 x 0.875 x 0.200 in.))

Table 6: FDM Nylon 12CF Mechanical Properties - Fortus 450mc - T20C tip

0.254 mm (0.010 in.) Layer Height		XZ Orientation[1]	ZX Orientation[1]
Tensile Properties: ASTM D638			
Yield Strength	MPa	77.5 (2.4)	38.3 (1.6)
	psi	11,200 (350)	5,500 (230)
Elongation @ Yield	%	3.1 (0.2)	2.2 (0.17)
Strength @ Break	MPa	76.5 (3.5)	38.4 (1.5)
	psi	11,100 (500)	5,570 (220)
Elongation @ Break	%	3.2 (0.28)	2.2 (0.16)
Modulus (Elastic)	GPa	7.91 (0.31)	2.64 (0.078)
	ksi	1,150 (45)	384 (11)

[1] Values in parentheses are standard deviations.

0.254 mm (0.010 in.) Layer Height		XZ Orientation[1]	ZX Orientation[1]
Flexural Properties: ASTM D790, Procedure A			
Strength @ Break	MPa	152 (3.8)	67.4 (3.5)
	psi	22,100 (550)	9,770 (510)
Strain @ Break	%	2.7 (0.1)	3.6 (0.23)
Modulus	GPa	11 (0.26)	2.18 (0.11)
	ksi	1,600 (38)	317 (16)
Compression Properties: ASTM D695			
Peak Strength	MPa	105 (5.4)	135 (3.5)
	psi	15,200 (780)	19,600 (510)
Modulus	GPa	2.73 (0.33)	2.44 (0.13)
	ksi	397 (48)	354 (19)
Impact Properties: ASTM D256, ASTM D4812			
Notched	J/m	102 (3.8)	22.4 (2.2)
	ft*lb/in	1.91 (0.071)	0.42 (0.041)
Unnotched	J/m	619 (58)	125 (12)
	ft*lb/in	11.6 (1.1)	2.35 (0.22)

[1] Values in parentheses are standard deviations.

Table 7: FDM Nylon 12CF Mechanical Properties with Unidirectional Toolpaths

0.254 mm (0.010 in.) Layer Height		XY Orientation[1]
Tensile Properties: ASTM D638		
Yield Strength	MPa	No Yield
	psi	No Yield
Elongation @ Yield	%	No Yield
Strength @ Break	MPa	111 (1.6)
	psi	16,100 (240)
Elongation @ Break	%	1.6 (0.08)
Modulus (Elastic)	GPa	15.1 (0.15)
	ksi	2,180 (21)
Flexural Properties: ASTM D790, Procedure B		
Strength @ Break	MPa	183 (2.2)
	psi	26,600 (320)
Strain @ Break	%	2.4 (0.7)
Modulus	GPa	11.9 (0.11)
	ksi	1,730 (16)
Impact Properties: ASTM D256		
Notched	J/m	122 (3.1)
	ft*lb/in	2.28 (0.058)

[1] Values in parentheses are standard deviations.

UV Aging

Nylon 12CF coupons were built on the F900 using the T20C tip with 0.254 mm (0.010 in.) layer height. The coupons were then tested before and after UV exposure. Ten ASTM D638 upright (ZX) coupons were tested in tensile after UV exposure and an additional 10 ASTM D638 ZX coupons were the control (no UV exposure). The UV exposed samples were cycled in the QUV chamber per ASTM G154 (Standard Practice for Operation Fluorescent UV Light Apparatus for Exposure of Nonmetallic Materials) for 1,000 hours, alternating for eight hours at 60 ˚C (140 ˚F) and four hours at 50 ˚C (122 ˚F) with humidity and condensation. The increase in stress at break is from the control samples. For more information see the Impact of UV Exposure on FDM 3D Printing Materials white paper.

Table 9: Nylon 12CF UV Exposure Test Results

Material	Conditioning	Yield Strength		Stress at Break		Elongation at Break	Increase in Stress at Break	Modulus	
		(psi)	(MPa)	(psi)	(MPa)	%	%	(ksi)	(GPa)
Nylon 12CF	No UV Exposure	4,760	32.8	4,720	32.5	1.7	-	361	2.49
	UV Exposure	6,500	44.8	6,460	44.5	2.2	36.80	421	2.9

Performance at Temperature

Nylon 12CF coupons were built on the F900 using the T20C tip with 0.254 mm (0.010 in.) layer height and tested at various temperatures. Ten ASTM D638 upright (ZX) coupons were tested in tensile. The percent change from the reported room temperature results are listed below. For more information see the Impact of Temperature on High-Performance FDM Materials white paper.

Table 8: Performance of FDM Nylon 12CF at Temperature

Material	Temperature (°F)	Temperature (°C)	Strength at Break	Elongation at Break	Modulus
Nylon 12CF	-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.

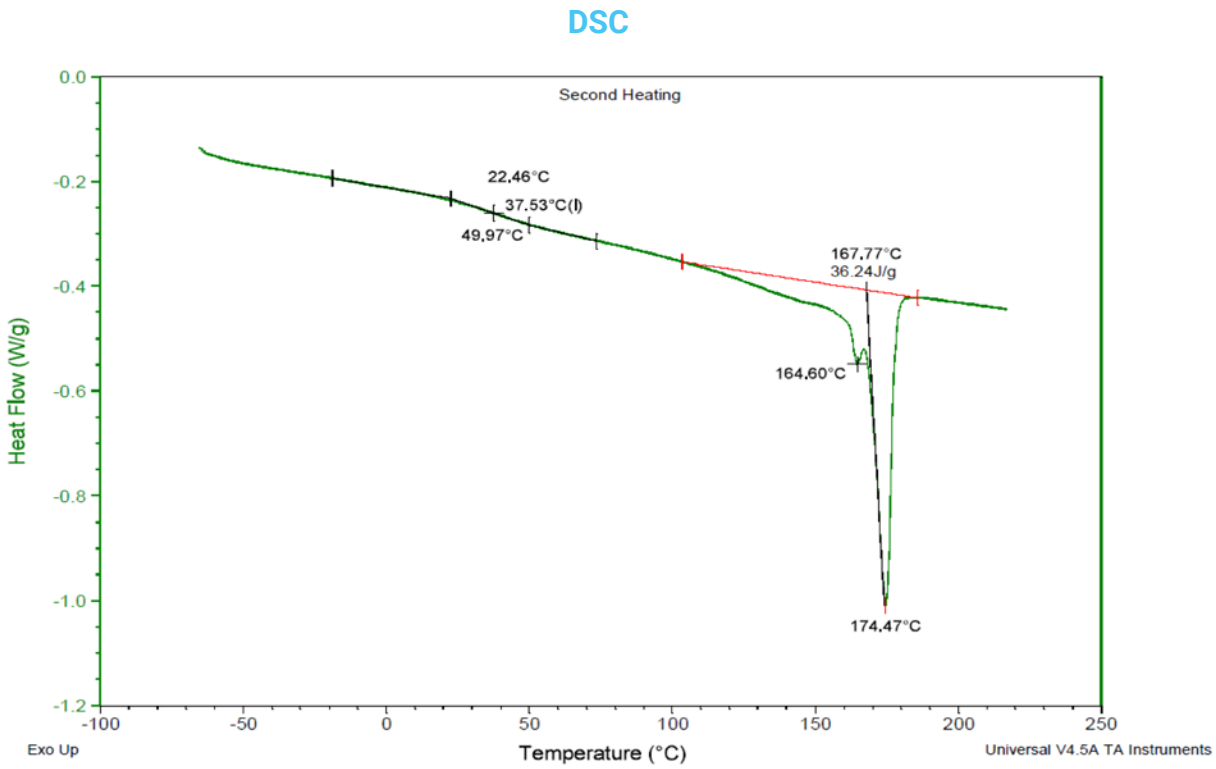


Figure 2: Dimension change data as a function of temperature for the Nylon 12CF Flat (XY) sample.

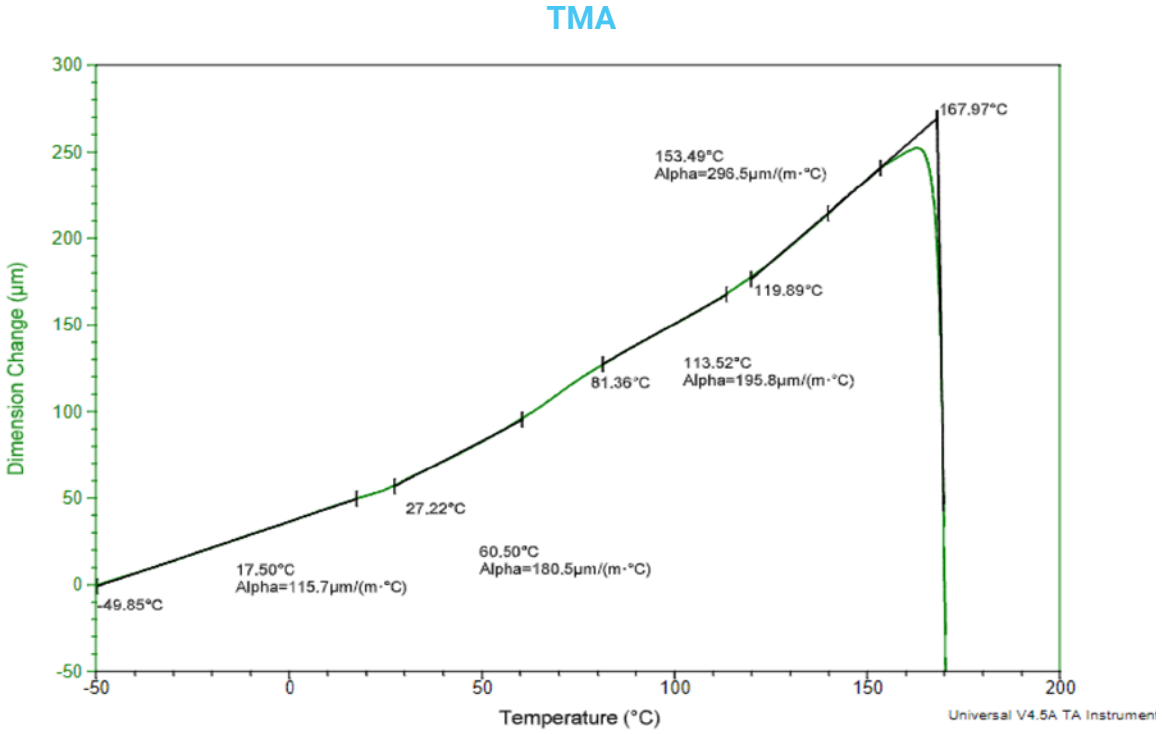


Figure 3: Dimension change data as a function of temperature for the Nylon 12CF On Edge (XZ) sample.

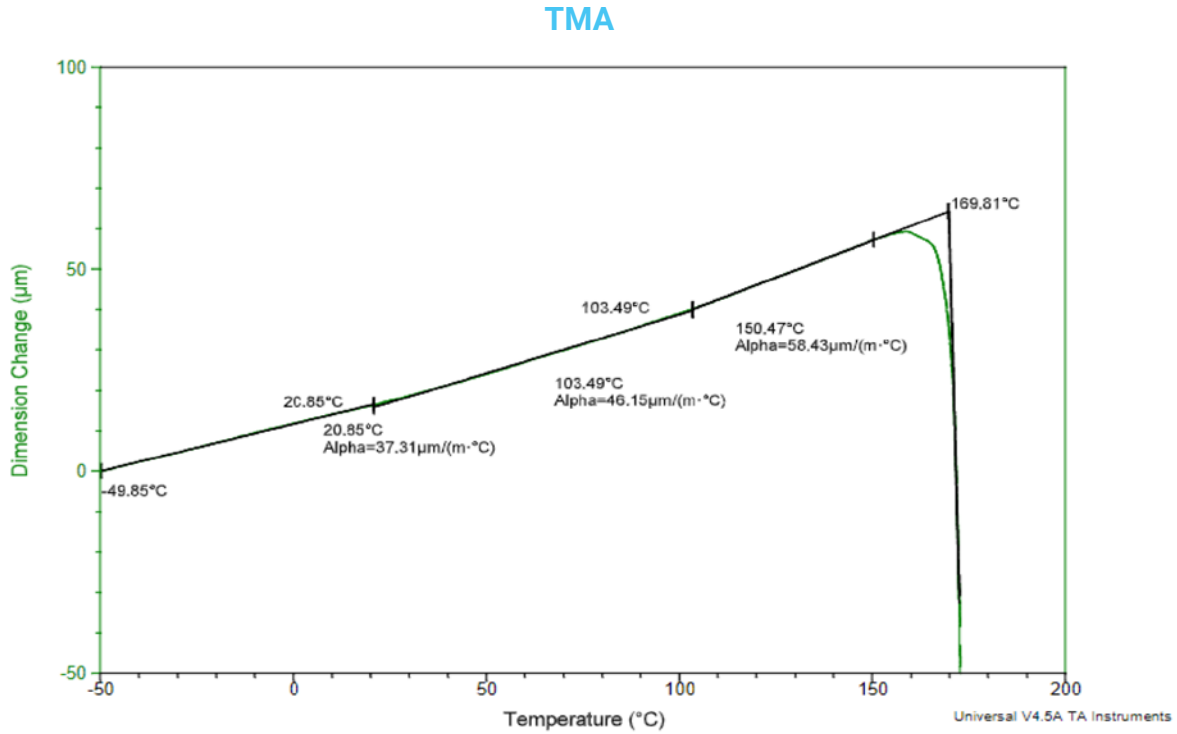
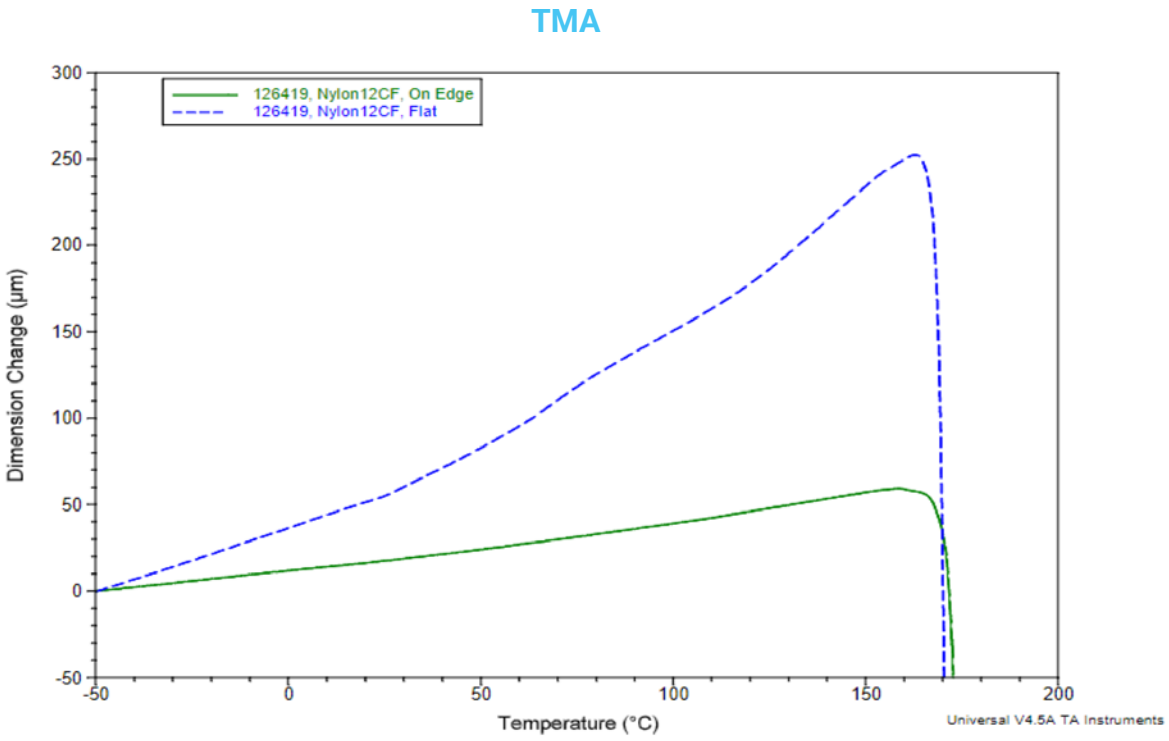


Figure 4: Overlay of the dimension change data for the Flat (XY) and On Edge (XZ) Nylon 12CF samples.



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