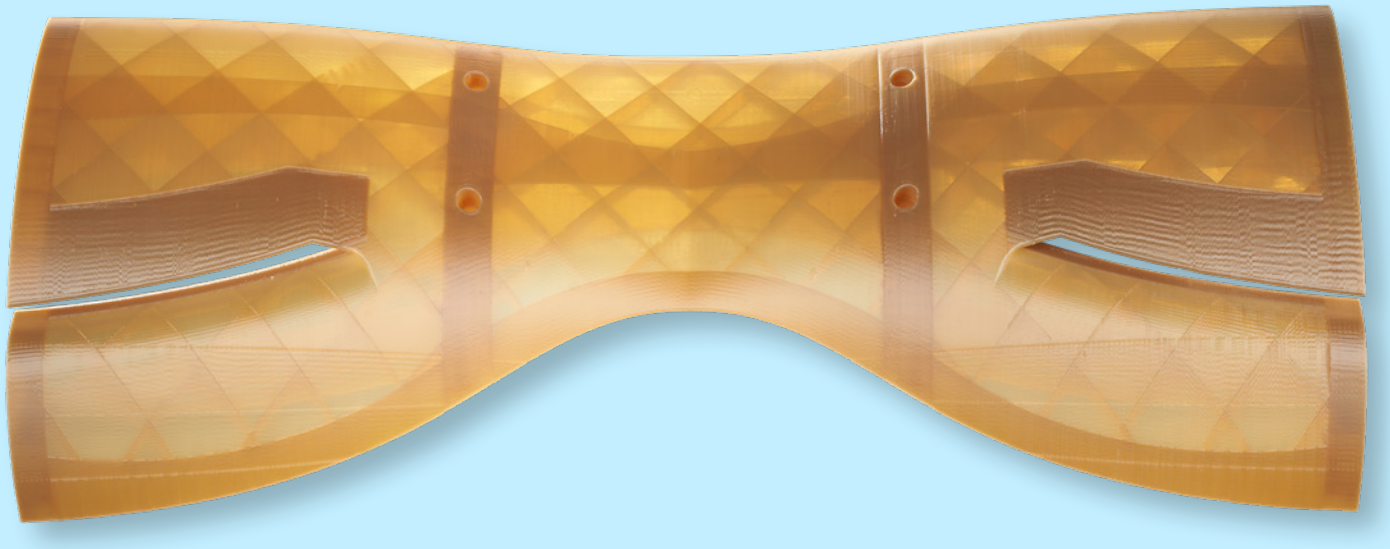
stratasys

MATERIAL DATA SHEET
FDM

ULTEM™ 1010 Resin

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

ULTEM™ 1010 resin is a high-performance FDM® polyetherimide (PEI) thermoplastic. It exhibits high tensile strength in addition to broad chemical resistance and excellent thermal stability. Its high heat resistance makes it autoclave-capable for applications involving sterilization and composite lay-up tooling.

This material is available in both general-purpose and certified grades (CG). ULTEM™ 1010 resin is used with breakaway support material and is available in natural color.

Contents:

Ordering Information

Table 1: Printer and Support Material Compatibility

Printer	Model Tip	Layer Height	Support Material	Support Tip
Fortus 450mc™	T14	0.25 mm (0.010 in.)	SUP9000B	T16
	T20	0.33 mm (0.013 in.)		
F900®	T14	0.25 mm (0.010 in.)	SUP9000B	T16
	T20	0.33 mm (0.013 in.)		
	T40A	0.51 mm (0.020 in.)		T20
F3300®	N500	0.25 mm (0.010 in.)	SUP9000B	N410S

Build Sheet

Fortus High Temperature Build Sheets

- 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 High Temperature Build Sheets

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

System Requirements[1]

Fortus 450mc

- Standard Fortus 450mc head
- ULTEM™ 1010 resin material license (included if new system)
- Fortus FDC™ (enables use of XTEND™ 250 Fortus® Plus spool)

F900

- Standard F900 head
- ULTEM™ 1010 resin material licens
- Fortus FDC (enables use of XTEND 250 Fortus Plus spool)

F3300

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

[1] Contact your Stratasys representative for ordering information.

Table 2: ULTEM™ 1010 Resin Ordering Information

Part Number	Description	System Compatibility
Filament Canisters		
Fortus Plus Canister (black snout)		
355-02330	ULTEM™ 1010 resin, 92.3 cu in - Plus	Fortus 450mc, F900, Fortus 900mc (S/N L502 and up)
355-02320	ULTEM™ 1010 resin CG, 92.3 cu in - Plus	
355-03240	SUP9000B Support, 92.3 cu in. - Plus	
Fortus Spools		
361-00550	XTEND™ 250 Fortus® Plus ULTEM™ 1010 resin	Fortus 450mc and F900 equipped with a Fortus FDC™
Fortus Classic Canister (gray snout)		
312-22000	ULTEM™ 1010 resin, 92.3 cu in - Classic	Fortus 900mc (S/N prior to L502)
355-03240	ULTEM™ 1010 resin CG, 92.3 cu in - Classic	
310-31000	SUP9000B Support, 92.3 cu in. - Classic	
F3000 Series Spools		
363-00550	MTRL, F3000 SERIES, (M), ULTEM™ 1010 resin, 4100 CC	F3300
363-00740	MTRL, F3000 SERIES, (S), SUP9000B, 4100 CC	
Printer Consumables		
Fortus		
511-12000	T14 tip	Fortus 450mc, F900, Fortus 900mc
511-10401	T16 tip	
511-10701	T20 tip	
511-10750	T40A tip	F900, Fortus 900mc
325-00275-S	High Temperature build sheet, 0.02x16x18.5 in. (0.51 x 406 x 470 mm), 20 pack	Fortus 450mc, F900, Fortus 900mc
325-00475-S	High Temperature build sheet, 0.02 x 26 x 38 in. (0.51 x 660 x 965 mm), 10 pack	F900, Fortus 900mc
F3000 Series		
533-00500-S	FDM, N500 Hot End (0.25 mm/0.010 in. layer height)	F3300
533-00420-S	FDM, N410S Support Hot End (0.25 mm/0.010 in. layer height)	
363-30200-S	F3300 Sheet Bundle, high temp, 0.02 x 26 x 28 in., 10 pack	
Print Heads		
Fortus		
821725-XXXX	Standard Fortus 450mc head (silver handle)	Fortus 450mc
380-30300-S	OpenAM Standard Fortus 450mc head (silver handle, additional sticker)	
404210-XXXX	Standard F900 head (formed rod handle)	F900
380-63600-S	OpenAM Standard F900 head (formed rod handle, additional sticker)	
F3000 Series		
533-10000-S	F3000 Series Extruder Drive	F3300

[1] Contact your Stratasys representative for ordering information.

Physical Properties

Values are measured and tested as molded and printed in the XY and XZ orientations. For full details refer to the Stratasys Materials Test Report. DSC and TMA curves can be found in the Appendix.

Table 3: ULTEM™ 1010 Resin Physical Properties

Physical Properties - Printed			
Property	**Test Method**	**XY**	**XZ**
HDT @ 66 psi	ASTM D648 Method B	216.88 °C (422.39 °F)	217.12 °C (422.82 °F)
HDT @ 264 psi	ASTM D648 Method B	215.12 °C (419.22 °F)	214.51 °C (418.12 °F)
Mean CTE	ASTM E831 (-50 °C to 60 °C)	36.08 µm/[m*°C] (20.04 µin/[in*°F])	-
	ASTM E831 (60 °C to 205 °C)	29.81 µm/[m*°C] (16.56 µin/[in*°F])	-
	ASTM E831 (-50 °C to 110 °C)	-	32.50 µm/[m*°C] (18.06 µin/[in*°F])
	ASTM E831 (110 °C to 165 °C)	-	16.19 µm/[m*°C] (8.995 µin/[in*°F])
	ASTM E831 (165 °C to 200 °C)	-	4.291 µm/[m*°C] (2.384 µin/[in*°F])
Dielectric Constant	ASTM D150 1 kHz test condition	2.841	2.888
	ASTM D150 2 MHz test condition	3.089	3.156
Dissipation Factor	ASTM D150 1 kHz test condition	-0.002	-0.002
	ASTM D150 2 MHz test condition	0	0

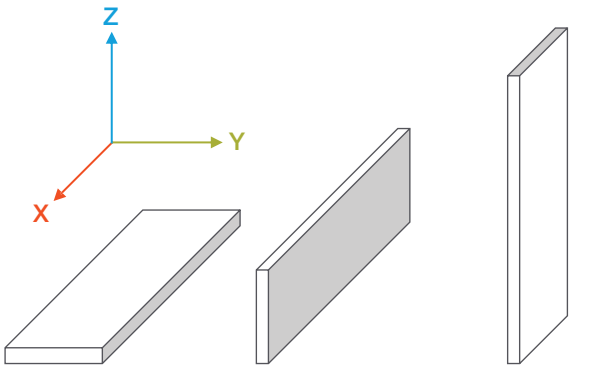
Physical Properties - Non Printed		
Property	**Test Method**	**Molded Plaques**
Tg	ASTM D7426 Inflection Point	209.37 °C (408.87 °F)
Volume Resistivity	ASTM D257	>7.00*10^14 Ω*cm
Thermal Conductivity	ASTM E1952 @0 °C	0.2430 W/m*K 0.1404 BTU/(hr*ft*F)
Thermal Conductivity	ASTM E1952 @30 °C	0.2420 W/m*K 0.1399 BTU/(hr*ft*F)
Thermal Conductivity	ASTM E1952 @60 °C	0.2426 W/m*K 0.1399 BTU/(hr*ft*F)
Thermal Conductivity	ASTM E1952 @90 °C	0.2417 W/m*K 0.1402 BTU/(hr*ft*F)
Thermal Diffusivity	ASTM E1952 @0 °C	0.158 mm^2/s 2.45*10^-4 in^2/s
Thermal Diffusivity	ASTM E1952 @30 °C	0.141 mm^2/s 2.19*10^-4 in^2/s
Thermal Diffusivity	ASTM E1952 @60 °C	0.130 mm^2/s 2.02*10^-4 in^2/s
Thermal Diffusivity	ASTM E1952 @90 °C	0.121 mm^2/s 1.88*10^-4 in^2/s
Specific Gravity	ASTM D792 @23 °C	1.290

Mechanical Properties

ULTEM™ 1010 resin samples were printed with a 0.25 mm (0.010 in.) layer height on the F900 and the F3300. For the full test procedure please see the Stratasys Materials Test Procedure.

Print Orientation

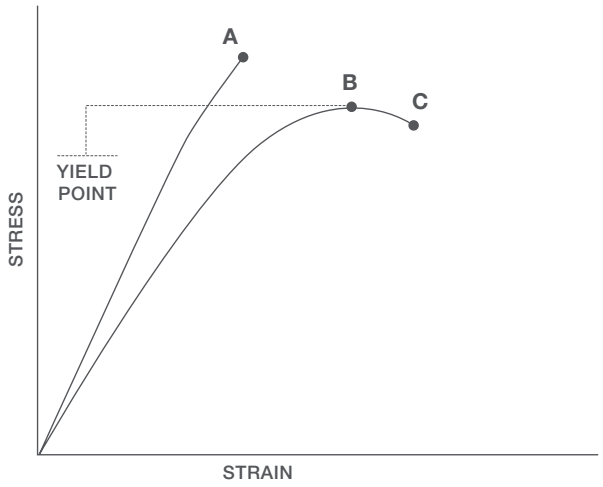
Parts created using FDM are anisotropic as a result of the printing process. Below is a reference of the different orientations used to characterize the material.



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: ULTEM™ 1010 Resin Mechanical Properties - F900 - T14 Tip

0.25 mm (0.010 in.) Layer Height		XZ Orientation[1]	ZX Orientation[1]
Tensile Properties: ASTM D638			
Yield Strength	MPa	No yield	No yield
	psi		
Elongation @ Yield	%	No yield	No yield
Strength @ Break	MPa	79.2 (4.9)	28.2 (8.8)
	psi	11,500 (710)	4,080 (1,300)
Elongation @ Break	%	4.0 (0.42)	1.1 (0.45)
Modulus (Elastic)	GPa	3.04 (0.18)	3.00 (0.45)
	ksi	441 (27)	435 (65)
Flexural Properties: ASTM D790, Procedure A			
Strength @ Break	MPa	No break	81.6 (13)
	psi	No break	11,800 (1,900)
Strength @ 5% Strain	MPa	128 (1.8)	-
	psi	18,600 (270)	-
Strain @ Break	%	No break	3.19 (0.53)
Modulus	MPa	2.91 (0.049)	2.64 (0.13)
	ksi	422 (7.0)	383 (19)
Compression Properties: ASTM D695			
Yield Strength	MPa	245 (50)	438 (31)
	psi	35,600 (7,200)	63,500 (4,500)
Modulus	GPa	2.93 (0.14)	3.23 (0.57)
	ksi	425 (20)	468 (83)
Impact Properties: ASTM D256, ASTM D4812			
Notched	J/m	26.6 (3.5)	21.7 (4.7)
	ft*lb/in.	0.498 (0.065)	0.407 (0.089)
Unnotched	J/m	260 (57)	68.0 (29.8)
	ft*lb/in.	4.87 (1.1)	1.27 (0.56)

[1] Values in parentheses are standard deviations.

Table 5: ULTEM™ 1010 Resin Mechanical Properties - F3300 - N500 Hot End

0.25 mm (0.010 in.) Layer Height		XZ Orientation[1]	ZX Orientation[1]
Tensile Properties: ASTM D638			
Yield Strength	MPa	92.8 (4)	35.3 (6.4)
	psi	13,500 (580)	5,130 (930)
Elongation @ Yield	%	4.2 (0.35)	1.4 (0.29)
Strength @ Break	MPa	91.6 (4.6)	36.7 (6.9)
	psi	13,300 (670)	5,320 (1,000)
Elongation @ Break	%	4.1 (0.38)	1.5 (0.32)
Modulus (Elastic)	GPa	2.92 (0.048)	2.64 (0.13)
	ksi	424 (7)	383 (19)
Flexural Properties: ASTM D790, Procedure A			
Strength @ Break	MPa	144 (2.2)	71.5 (12)
	psi	21,000 (320)	10,400 (1,700)
Strain @ Break	%	No break	2.9 (0.71)
Modulus	GPa	3.26 (0.056)	2.33 (0.3)
	ksi	473 (8.2)	338 (43)
Compression Properties: ASTM D695			
0.2% Offset Yield[2]	MPa	77.7 (3.3)	88.1 (2)
	psi	11,300 (480)	12,800 (300)
1.0% Offset Yield[2]	MPa	104 (3.5)	120 (2)
	ksi	15,100 (510)	17,300 (280)
Modulus	GPa	2.42 (0.06)	2.54 (0.055)
	ksi	352 (8.7)	368 (8)
Impact Properties: ASTM D256, ASTM D4812 (sample thickness 0.125 inches)			
Notched	J/m	36.3 (4.8)	27.2 (2.4)
	ft*lb/in.	0.68 (0.09)	0.509 (0.045)
Unnotched	J/m	406 (65)	116 (41)
	ft*lb/in.	7.61 (1.2)	2.17 (0.77)

[1] Values in parenthesis are standard deviations.

[2] An updated method for compression testing of FDM parts improves consistency by using offset yield values and an earlier test-termination point to better capture reliable material properties.

Outgassing

ULTEM™ 1010 resin, natural, was printed with a 0.25 mm (0.010 in.) layer height on a Stratasys Fortus 450mc and tested per ASTM E595-15. Full report available upon request.

Table 6: ULTEM™ 1010 Resin Outgassing Test Results

Sample	TML (%)	CVCM (%)	WVR (%)
ULTEM™ 1010 Resin, Natural, T14 tip, Flat (XY)	0.55	0.02	0.39
ULTEM™ 1010 Resin, Natural, T14 tip, Upright (ZX)	0.58	0.03	0.33
Testing Observations[1]			
Visible Consendate	No	Opaque	N/A
Percent Covered	0%	Interference Fringes	N/A
Thin	N/A	Colored Fringes	N/A
Heavy	N/A	Sample appearance after test	No change
Transparent	N/A		

[1]Observations apply to all tested samples

Fire Protection for Devices and Appliances
UL Blue Card

ULTEM™ 1010 resin was printed on the Fortus 400mc, Fortus 450mc, Fortus 900mc, and the F900 printers with a T14, T20, and T40A model tip. For more information reference file number E345258 on the iq.ulprospector.com website (login required).

Table 7: ULTEM™ 1010 resin UL Blue Card Overview

Build Direction	Layer Height	Model Tip	Minimum Sample Thickness	Rating	Printer
Horizontal	0.25 mm (0.010 in.)	T14	1.5 mm (0.059 in.)	V-0	Fortus 400mc
	0.330 mm (0.013 in.)	T20	3.0 mm (0.118 in.)	V-0	Fortus 400mc, Fortus 450mc
	0.508 mm (0.020 in.)	T40A	1.0 mm (0.039 in.)	V-0	Fortus 900mc, F900
Vertical	0.25 mm (0.010 in.)	T14	1.0 mm (0.039 in.)	V-0	Fortus 400mc, Fortus 900mc, F900
	0.330 mm (0.013 in.)	T20	1.5 mm (0.059 in.)	V-0	Fortus 400mc, Fortus 450mc
	0.508 mm (0.020 in.)	T40A	1.0 mm (0.039 in.)	V-0	Fortus 900mc, F900

Appendix

Figure 1: 2nd heating scan DSC data for the ULTEM™ 1010 resin Flat (XY) sample.

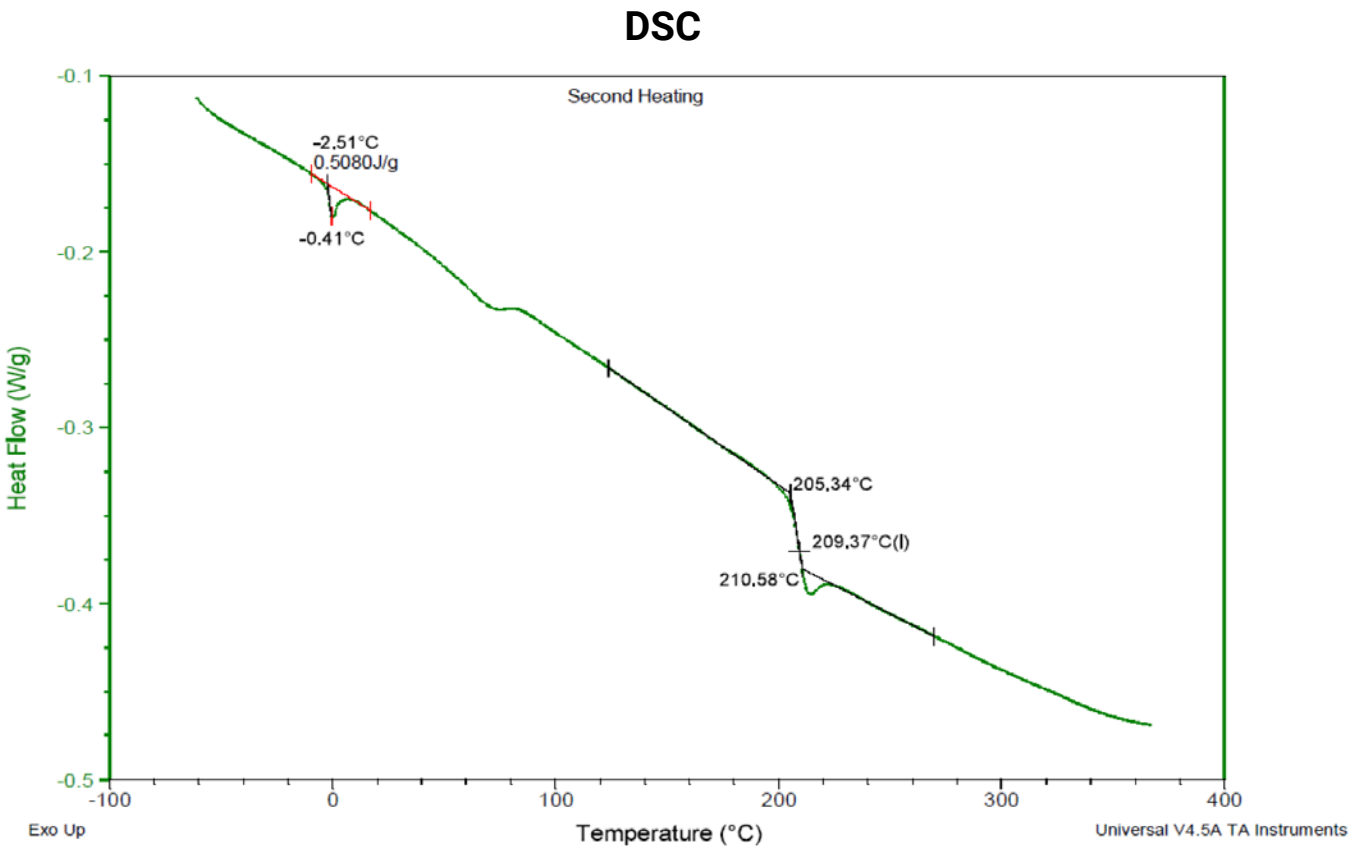


Figure 2: Dimension change data as a function of temperature for the ULTEM™ 1010 resin Flat (XY) sample.

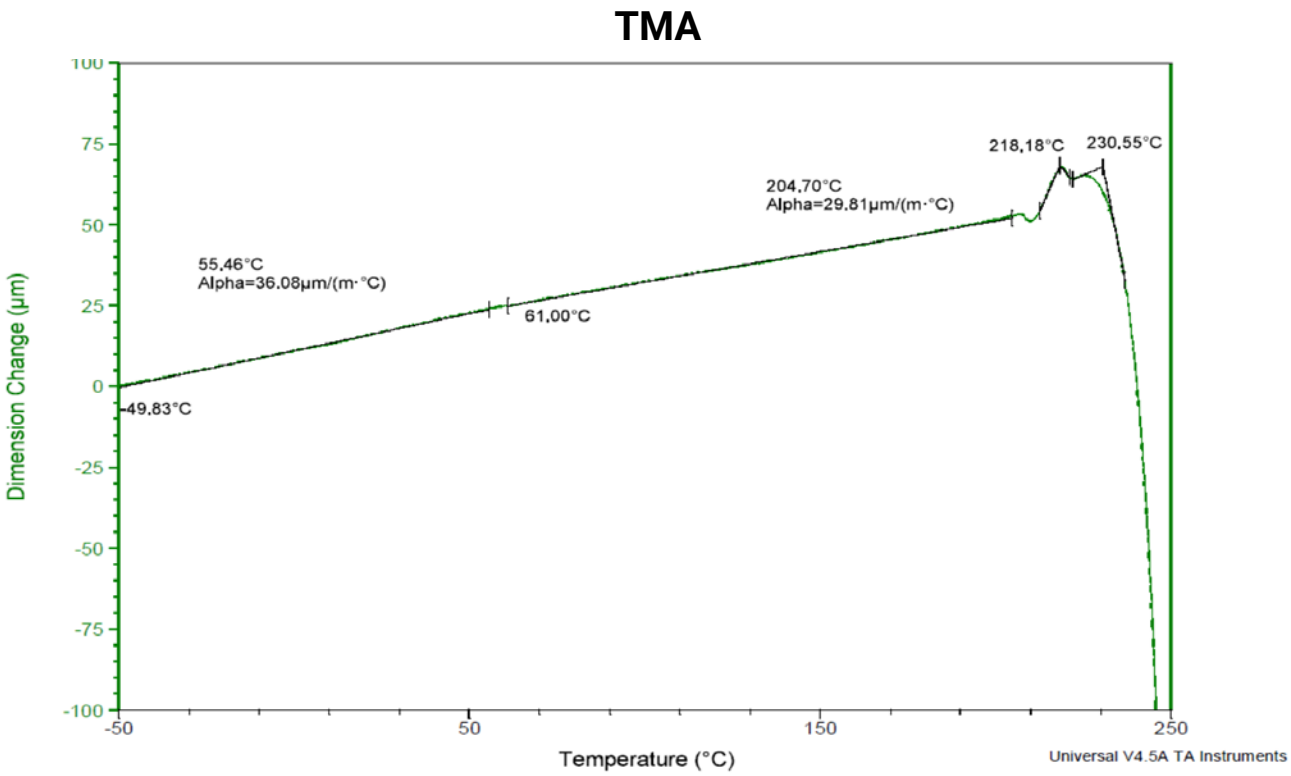


Figure 3: Dimension change data as a function of temperature for the ULTEM™ 1010 resin On Edge (XZ) sample.

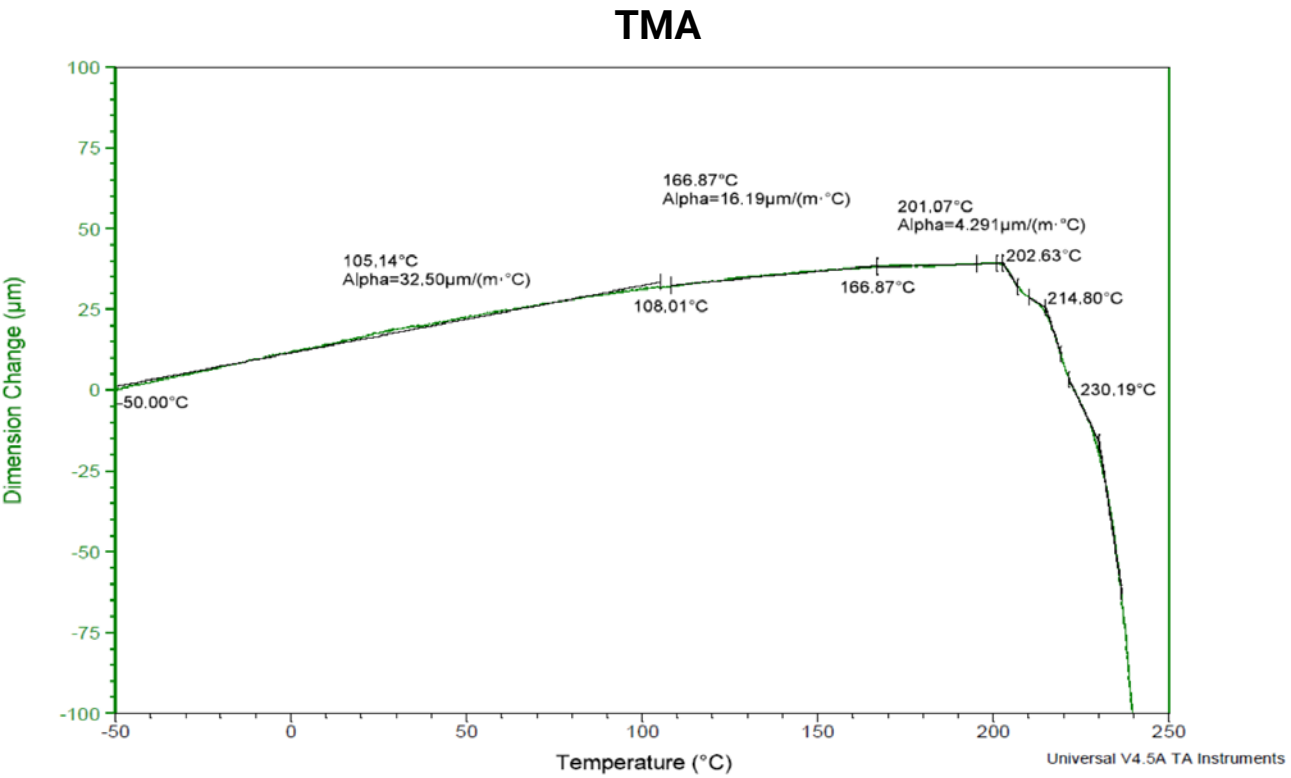
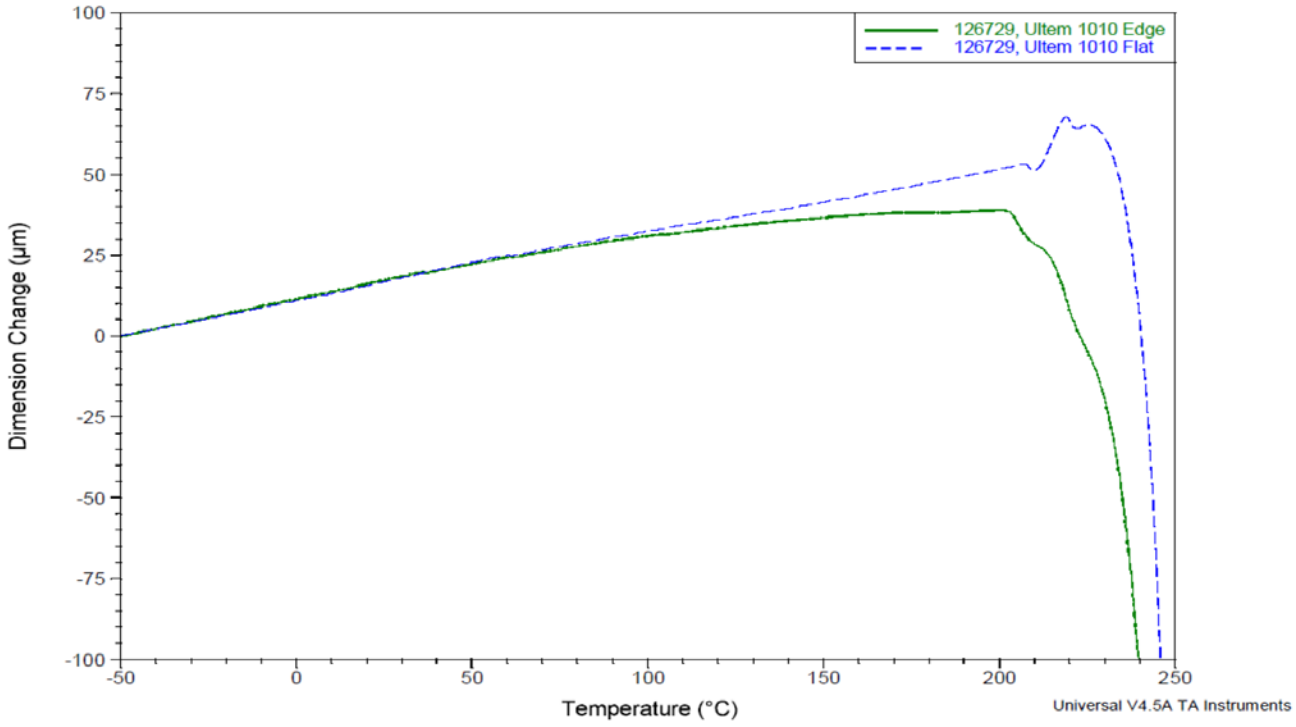


Figure 4: Overlay of the dimension change data for the Flat (XY) and On Edge (XZ) ULTEM™ 1010 resin samples.



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