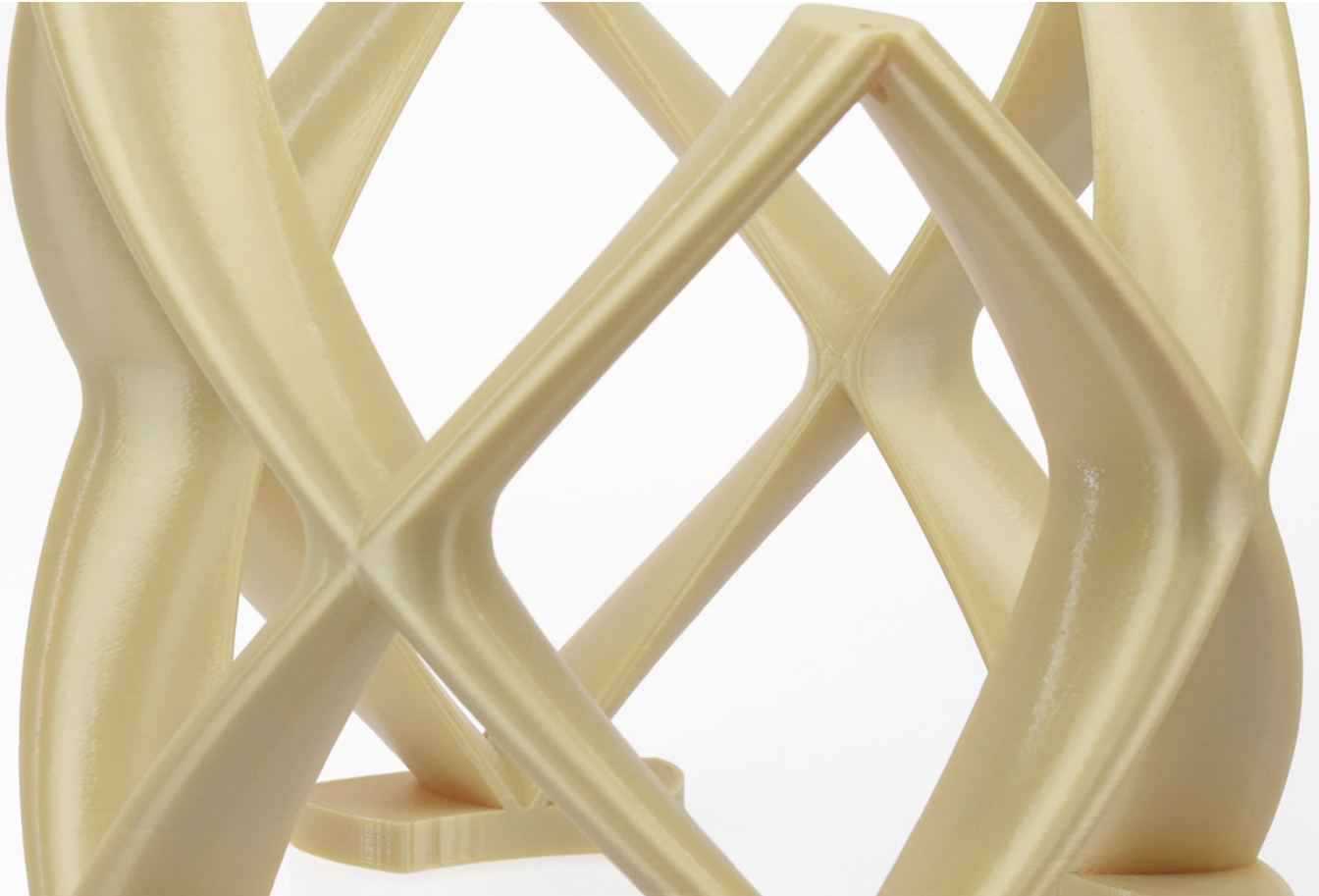


ULTEM™ 9085 Resin



FDM® Thermoplastic Filament **Fit for High-Performance Applications**

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.

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Overview

ULTEM™ 9085 resin filament is a PEI (polyetherimide) thermoplastic FDM material. It features a high strength-to-weight ratio, high thermal and chemical resistance, and meets multiple aerospace and railway industry standards for flame, smoke and toxicity (FST) characteristics. Available colors are Natural, Black, Red, Jana White, White 7362, Dream Gray, Gunship Gray and Aircraft Gray.

ULTEM™ 9085 resin CG (Certified Grade - only available in Natural) meets more stringent test criteria and possesses documented traceability from filament back to raw material lot number. Included documentation:

- Certificate of Analysis — for both raw material and filament are supplied, documenting test results and identification to match filament manufacturing lot number to raw material batch number.
- Certificate of Conformance — confirms that the material is manufactured in compliance to approved Stratasys® and industry specifications.

Typical applications include production parts and functional prototypes.

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Ordering Information

Table 1. Printer and Support Material Compatibility

Printer	Model Tip	Support Material	Support Tip
Fortus 450mc™	T16 (10 slice)	SUP8500B™ Support	T16 (all slices)
	T16A (10 slice)		
	T20 (13 slice)		
F900™	T16 (10 slice)	SUP8500B Support	T16 (10 and 13 slice)
	T16A (10 slice)		
	T20 (13 slice)		
	T40A (20 slice)		T40A (20 slice)

ULTEM™ 9085 resin colors (Red, Jana White, White 7362, Dream Gray, Gunship Gray and Aircraft Gray) are only available on the F900 and Fortus 450mc with the T16 model tip and SUP8500B support material.

Build Sheet

High temperature

- 0.02 x 26 x 38 in. (0.76 x 660 x 965 mm)
- 0.02 x 16 x 18.5 in. (0.51 x 406 x 470 mm)

Table 2. ULTEM™ 9085 Resin Ordering Information

Part Number	Description
Filament Canisters^{1,2}	
355-02310	ULTEM™ 9085 resin Natural, 92.3 cu in - Plus
355-08310	ULTEM™ 9085 resin Natural, 184 cu in - Plus
355-23101	ULTEM™ 9085 resin CG, 92.3 cu in - Plus
312-20001	ULTEM™ 9085 resin CG, 184 cu in - Classic
355-70050	ULTEM™ 9085 resin Red, 92 cu in - Plus
355-70051	ULTEM™ 9085 resin Jana White, 92 cu in - Plus
355-70052	ULTEM™ 9085 resin Dream Gray, 92 cu in - Plus
355-70053	ULTEM™ 9085 resin White 7362, 92 cu in - Plus
355-70054	ULTEM™ 9085 resin Gunship Gray, 92 cu in - Plus
355-70055	ULTEM™ 9085 resin Aircraft Gray, 92 cu in - Plus
355-02311	ULTEM™ 9085 resin Black, 92.3 cu in - Plus
312-20000	ULTEM™ 9085 resin Natural, 92.3 cu in - Classic
312-20018	ULTEM™ 9085 resin Natural, 184 cu in - Classic
312-20200	ULTEM™ 9085 resin Black, 92.3 cu in - Classic
355-03220	SUP8500B Support, 92.3 cu in - Plus
310-30600	SUP8500B Support, 92.3 cu in - Classic
Printer Consumables	
511-10401	T16 tip, 0.010 in. (0.254 mm) layer height
511-10410	T16A tip, 0.010 in. (0.254 mm) layer height
511-10701	T20 tip, 0.013 in. (0.330 mm) layer height
511-10750	T40A tip, 0.020 in. (0.508 mm) layer height
325-00475 ³	900 high temperature build sheet, 0.02 x 26 x 38 in. (0.51 x 660 x 965 mm)
325-00275 ⁴	900 & 450 high temperature build sheet, 0.02 x 16 x 18.5 in. (0.51 x 406 x 470 mm)
310-00300 ⁵	High Temperature build sheet, 0.03 x 16 x 18.5 in. (0.76 x 406 x 470 mm)

¹ Classic canisters are compatible with all Fortus 400mc™ and Fortus 900mc™ printers prior to s/n L502

² Plus canisters are compatible with all Fortus 450mc, all Stratasys F900, and Fortus 900mc printers s/n L502 and up

³ Compatible with Stratasys F900 and Fortus 900mc

⁴ Compatible with Fortus 450mc, Stratasys F900 and Fortus 900mc

⁵ Compatible with Fortus 400mc

Physical Properties

Values are measured as printed. XY, XZ and ZX orientations were tested.

For full details refer to the [Stratasys Materials Test Procedure](https://www.stratasys.com/materials-test-procedure) on www.stratasys.com.

DSC and TMA curves can be found in the Appendix.

Table 3. ULTEM™ 9085 Resin Physical Properties (Tested with ULTEM™ 9085 Resin Natural and T16 tip)

Property	Test Method	Typical Values	
		XY	XZ/ZX
HDT @ 66 psi	ASTM D648 Method B	178.2 °C (352.8 °F)	178.4 °C (353.1 °F)
HDT @ 264 psi	ASTM D648 Method B	170.2 °C (338.3 °F)	172.6 °C (342.7 °F)
Molded HDT @ 66 psi	ASTM D648 Method B	176.9 °C (350.4 °F)	
Molded HDT @ 264 psi	ASTM D648 Method B	172.9 °C (343.2 °F)	
Tg	ASTM D7426 Inflection Point	177.3 °C (351.2 °F)	
Mean CTE (TAN)	ASTM E831 (-50°C to 60°C)		44.45 µm/[m*°C] 24.69 µin/[in*°F]
Mean CTE (TAN)	ASTM E831 (60C to 160°C)		32.31 µm/[m*°C] 17.95 µin/[in*°F]
Mean CTE (TAN)	ASTM E831 (-50°C to 80°C)	44.89 µm/[m*°C] (24.94 µin/[in*°F])	
Mean CTE (TAN)	ASTM E831 (80°C to 160°C)	31.35 µm/[m*°C] (17.42 µin/[in*°F])	
Mean CTE (BLACK)	ASTM E831 (-50°C to 30°C)		47.79 µm/[m*°C] 26.55 µin/[in*°F]
Mean CTE (BLACK)	ASTM E831 (30°C to 165°C)		38.55 µm/[m*°C] 21.42 µin/[in*°F]
Mean CTE (BLACK)	ASTM E831 (-50°C to 80°C)	51.88 µm/[m*°C] 28.82 µin/[in*°F]	
Mean CTE (BLACK)	ASTM E831 (80°C to 160°C)	40.2 µm/[m*°C] 22.33 µin/[in*°F]	
Volume Resistivity	ASTM D257	> 6.89*10 ¹⁵ Ω·cm	
Dielectric Constant	ASTM D150 1 kHz test condition	2.80	2.87
Dielectric Constant	ASTM D150 2 MHz test condition	2.65	2.73
Dissipation Factor	ASTM D150 1 kHz test condition	0.002	0.002
Dissipation Factor	ASTM D150 2 MHz test condition	0.010	0.010
Thermal Conductivity	ASTM E1952 at 0°C	0.2136 W/m*K 0.1234 BTU/(hr*ft*F)	
Thermal Conductivity	ASTM E1952 at 30°C	0.2109 W/m*K 0.1219 BTU/(hr*ft*F)	
Thermal Conductivity	ASTM E1952 at 60°C	0.2111 W/m*K 0.1220 BTU/(hr*ft*F)	
Thermal Conductivity	ASTM E1952 at 90°C	0.2095 W/m*K 0.1211 BTU/(hr*ft*F)	
Thermal Diffusivity	ASTM E1952 at 0°C	0.148 mm²/s 2.29*10 ⁻⁴ in²/s	
Thermal Diffusivity	ASTM E1952 at 30°C	0.132 mm²/s 2.05*10 ⁻⁴ in²/s	
Thermal Diffusivity	ASTM E1952 at 60°C	0.121 mm²/s 1.88*10 ⁻⁴ in²/s	
Thermal Diffusivity	ASTM E1952 at 90°C	0.111 mm²/s 1.72*10 ⁻⁴ in²/s	
Specific Gravity	ASTM D792 at 23°C	1.27	
UL Flammability ²	ANSI/UL 746B	V0 – Blue Card #E345258	

² Applies to the natural version of ULTEM™ 9085 resin only

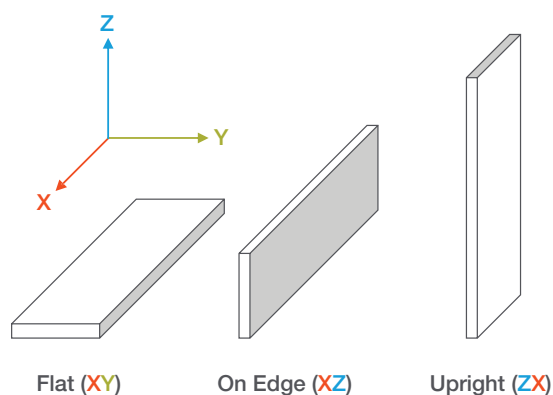
Mechanical Properties

Samples, natural and black, were printed with 0.010 in. (0.254 mm) and 0.013 in. (0.330 mm) layer heights on the F900 and Fortus 450mc.

For the full test procedure please see the [Stratasys Materials Test Procedure](https://www.stratasys.com/resources/materials-test-procedure) on www.stratasys.com.

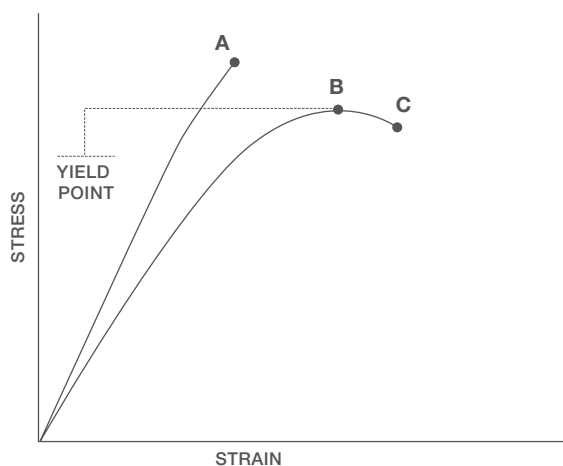
Print Orientation

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. ULTEM™ 9085 Resin Natural Mechanical Properties (F900 - T16 tip)

		XZ Orientation ¹	ZX Orientation ¹
Tensile Properties: ASTM D638			
Yield Strength	MPa	69.2 (1.0)	No yield
	psi	10,000 (150)	No yield
Elongation at Yield	%	5.4 (0.50)	No yield
Strength at Break	MPa	68.1 (1.6)	39.4 (8.7)
	psi	9,870 (230)	5,710 (1,300)
Elongation at Break	%	5.4 (0.50)	1.9 (0.51)
Modulus (Elastic)	GPa	2.52 (0.062)	2.41 (0.15)
	ksi	365 (8.9)	350 (22)
Flexural Properties: ASTM D790, Procedure A			
Strength at Break	MPa	104 (2.2)	73.1 (13)
	psi	15,000 (320)	10,600 (1,900)
Strain at Break	%	No break	3.67 (0.55)
Modulus	GPa	2.40 (0.032)	2.13 (0.081)
	ksi	348 (4.6)	309 (12)
Compression Properties: ASTM D695			
Yield Strength	MPa	139 (9.4)	342 (27)
	psi	20,100 (1,400)	49,600 (390)
Modulus	GPa	2.22 (0.047)	2.28 (0.080)
	ksi	321 (6.8)	331 (12)
Impact Properties: ASTM D256, ASTM D4812			
Izod, Notched	J/m	88.5 (21)	39.2 (4.3)
	ft*lb/in	1.66 (0.40)	0.735 (0.080)
Izod, Unnotched	J/m	647 (66)	187 (42)
	ft*lb/in	12.1 (1.2)	3.51 (0.79)

¹ Values in parentheses are standard deviations

Table 5. ULTEM™ 9085 Resin Natural Mechanical Properties (F900 - T16A tip)

		XZ Orientation ¹	ZX Orientation ¹
Tensile Properties: ASTM D638			
Yield Strength	MPa	76.2 (5.8)	54.2 (3.1)
	psi	11100 (850)	7870 (450)
Elongation at Yield	%	5.3 (0.2)	3.4 (0.9)
Strength at Break	MPa	73.9 (5.3)	55.3 (5.7)
	psi	10700 (760)	8020 (830)
Elongation at Break	%	5.8 (0.6)	3.5 (1.1)
Modulus (Elastic)	GPa	2.50 (0.15)	2.21 (0.22)
	ksi	363 (21.1)	321 (32.1)
Flexural Properties: ASTM D790, Procedure A			
Strength at Break	MPa	111 (3.2)	82.4 (4.6)
	psi	16100 (470)	11900 (670)
Strain at Break	%	No Break	4.4 (0.35)
Modulus	GPa	2.55 (0.064)	2.12 (0.054)
	ksi	370 (9.3)	308 (7.8)
Compression Properties: ASTM D695			
Yield Strength	MPa	89.3 (4.3)	94.9 (2.9)
	psi	12900 (310)	13800 (210)
Modulus	GPa	1.85 (0.031)	1.93 (0.022)
	ksi	269 (4.5)	280 (3.2)
Impact Properties: ASTM D256, ASTM D4812			
Notched	J/m	140 (65)	46.7 (7.4)
	ft*lb/in	2.63 (1.2)	0.87 (0.14)
Unnotched	J/m	1510 (190)	257 (49)
	ft*lb/in	28.4 (3.5)	4.81 (0.92)

¹ Values in parentheses are standard deviations

Table 6. ULTEM™ 9085 Resin Natural Mechanical Properties (F900 - T20 tip)

		XZ Orientation ¹	ZX Orientation ¹
Tensile Properties: ASTM D638			
Yield Strength	MPa	78.7 (1.6)	48.7 (4.8)
	psi	11400 (240)	7100 (700)
Elongation at Yield	%	6.4 (0.2)	3.1 (0.4)
Strength at Break	MPa	72.8 (2.6)	48.0 (4.7)
	psi	10600 (370)	7000 (680)
Elongation at Break	%	8.7 (0.9)	3.1 (0.4)
Modulus (Elastic)	GPa	2.11 (0.052)	1.93 (0.059)
	ksi	306 (7.5)	279 (8.6)
Flexural Properties: ASTM D790, Procedure A			
Strength at Break	MPa	113 (1.9)	72.1 (5.0)
	psi	16400 (270)	10500 (720)
Strain at Break	%	No break	4.0 (0.4)
Modulus	GPa	2.61 (0.042)	2.00 (0.067)
	ksi	379 (6.1)	289 (9.7)
Compression Properties: ASTM D695			
Yield Strength	MPa	87.8 (3.5)	90.9 (2.13)
	psi	12700 (510)	13200 (310)
Modulus	GPa	1.83 (0.058)	1.75 (0.037)
	ksi	265 (8.43)	254 (5.3)
Impact Properties: ASTM D256, ASTM D4812			
Izod, Notched	J/m	118 (43)	45.4 (12)
	ft*lb/in	2.21 (0.81)	0.851 (0.23)
Izod, Unnotched	J/m	1910 (240)	210 (40)
	ft*lb/in	35.8 (4.4)	3.94 (0.75)

¹ Values in parentheses are standard deviations

Table 7. ULTEM™ 9085 Resin Natural Mechanical Properties (F900 - T40A tip)

		XZ Orientation ¹	ZX Orientation ¹
Tensile Properties: ASTM D638			
Yield Strength	MPa	82.3 (1.4)	55.7 (1.7)
	psi	11900 (200)	8080 (250)
Elongation at Yield	%	6.1 (0.1)	4.0 (0.3)
Strength at Break	MPa	64.9 (15.8)	55.5 (2.0)
	psi	9410 (2200)	8050 (290)
Elongation at Break	%	7.4 (3.3)	4.0 (0.3)
Modulus (Elastic)	GPa	2.2 (0.1)	1.9 (0.1)
	ksi	321 (6)	273 (4)
Flexural Properties: ASTM D790, Procedure A			
Strength at Break	MPa	110.4 (3.3)	83.6 (1.6)
	psi	16000 (500)	12100 (200)
Strain at Break	%	No break	4.8 (0.2)
Modulus	GPa	2.60 (0.06)	2.05 (0.04)
	ksi	371 (9)	298 (5)
Compression Properties: ASTM D695			
Yield 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

* 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))

** XZ D638 coupons for T40A tip were larger than standards Stratasys tensile coupons. (As printed coupon dimensions: 6.500 x 0.875 x 0.200 inches (~165 x 22 x 5 mm))

Table 8. ULTEM™ 9085 Resin Black Mechanical Properties (F900 - T16 tip)

		XZ Orientation ¹	ZX Orientation ¹
Tensile Properties: ASTM D638			
Yield Strength	MPa	71.7 (1.6)	No yield
	psi	10,400 (240)	
Elongation at Yield	%	5.5 (0.27)	No yield
Strength at Break	MPa	69.8 (1.7)	41.4 (9.0)
	psi	10,100 (240)	6,000 (1,300)
Elongation at Break	%	5.4 (0.65)	2.1 (0.58)
Modulus (Elastic)	GPa	2.54 (0.050)	2.42 (0.16)
	ksi	368 (7.2)	351 (23)
Flexural Properties: ASTM D790, Procedure A			
Strength at Break	MPa	107 (3.4)	72.1 (5.9)
	psi	15,500 (490)	10,500 (860)
Strain at Break	%	No break	3.78 (0.39)
Modulus	GPa	2.47 (0.059)	2.11 (0.039)
	ksi	358 (8.6)	305 (5.7)
Compression Properties: ASTM D695			
Yield Strength	MPa	142 (9.1)	349 (24)
	psi	20,600 (1,300)	50,600 (350)
Modulus	GPa	2.27 (0.043)	2.37 (0.097)
	ksi	329 (6.3)	343 (14)
Impact Properties: ASTM D256, ASTM D4812			
Izod, Notched	J/m	94.8 (22)	37.0 (8.3)
	ft*lb/in	1.78 (0.4)	0.693 (0.16)
Izod, Unnotched	J/m	771 (140)	169 (54)
	ft*lb/in	14.4 (2.7)	3.16 (1.0)

¹ Values in parentheses are standard deviations

Table 9. ULTEM™ 9085 Resin Black Mechanical Properties (F900 - T20 tip)

		XZ Orientation	ZX Orientation ¹
Tensile Properties: ASTM D638			
Yield Strength	MPa	78.0 (2.2)	46.1 (4.8)
	psi	11300 (320)	6690 (690)
Elongation at Yield	%	6.4 (0.1)	2.7 (0.4)
Strength at Break	MPa	71.2 (3.8)	46.2 (4.8)
	psi	10300 (550)	6700 (690)
Elongation at Break	%	9.1 (0.1)	2.7 (0.4)
Modulus (Elastic)	GPa	2.13 (0.022)	2.06 (0.060)
	ksi	308 (3.2)	298 (8.8)
Flexural Properties: ASTM D790, Procedure A			
Strength at Break	MPa	114.6 (2.0)	74.9 (3.9)
	psi	16600 (290)	10900 (560)
Strain at Break	%	No break	4.0 (0.3)
Modulus	GPa	2.63 (0.040)	2.05 (75)
	ksi	381 (6.1)	297 (11)
Compression Properties: ASTM D695			
Yield Strength	MPa	89.2 (1.5)	93.9 (1.5)
	psi	12900 (1.5)	13600 (220)
Modulus	GPa	1.90 (0.059)	1.80 (0.033)
	ksi	275 (8.6)	261 (4.8)
Impact Properties: ASTM D256, ASTM D4812			
Izod, Notched	J/m	109 (31)	46.9 (8.3)
	ft*lb/in	2.05 (0.58)	0.88 (0.16)
Izod, Unnotched	J/m	1910 (200)	199 (28)
	ft*lb/in	35.8 (3.7)	3.73 (0.52)

¹ Values in parentheses are standard deviations

Table 10. ULTEM™ 9085 Resin Black Mechanical Properties (F900 - T40A tip)

		XZ Orientation ¹	ZX Orientation ¹
Tensile Properties: ASTM D638			
Yield Strength	MPa	79.1 (0.8)	52.8 (2.8)
	psi	11500 (100)	7660 (410)
Elongation at Yield	%	6.2 (0.1)	3.6 (0.5)
Strength at Break	MPa	62.7 (9.9)	52.9 (2.8)
	psi	9100 (1440)	7670 (400)
Elongation at Break	%	8.9 (3.5)	3.6 (0.6)
Modulus (Elastic)	GPa	2.20 (0.04)	1.88 (0.04)
	ksi	315 (6)	272 (6)
Flexural Properties: ASTM D790, Procedure A			
Strength at Break	MPa	111.9 (2.7)	83.4 (3.5)
	psi	16200 (400)	12100 (500)
Strain at Break	%	No break	4.5 (0.4)
Modulus	GPa	2.6 (0.06)	2.05 (0.03)
	ksi	375 (9)	298 (5)
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

^{*} 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))

^{**} XZ D638 coupons for T40A tip were larger than standards Stratasys tensile coupons. (As printed coupon dimensions: 6.500 x 0.875 x 0.200 inches (~165 x 22 x 5 mm))

Table 11. ULTEM™ 9085 Resin Natural Mechanical Properties (Fortus 450mc - T16A tip)

		XZ Orientation	ZX Orientation
Tensile Properties: ASTM D638			
Yield Strength	MPa	73.0 (2.2)	54.5 (4.1)
	psi	10,600 (320)	7,900 (590)
Elongation at Yield	%	5.8 (0.22)	3.1 (0.31)
Strength at Break	MPa	70.3 (2.3)	54.1 (4.1)
	psi	10,200 (330)	7,850 (590)
Elongation at Break	%	6.6 (0.59)	3.1 (0.31)
Modulus (Elastic)	GPa	2.11 (0.057)	2.11 (0.034)
	ksi	306 (8.2)	306 (5.00)
Flexural Properties: ASTM D790, Procedure A			
Strength at Break	MPa	No break	76.8 (6.5)
	psi	No break	11,100 (940)
Strength at 5% Strain	MPa	106 (3.9)	NA
	psi	15,400 (570)	NA
Strain at Break	%	No break	3.9 (0.4)
Modulus	GPa	2.45 (0.66)	2.19 (0.12)
	ksi	355 (9.6)	318 (17)
Compression Properties: ASTM D695			
Yield Strength	MPa	91.3 (1.9)	99.1 (2.9)
	psi	13,200 (270)	14,400 (420)
Modulus	GPa	1.89 (0.066)	1.94 (0.028)
	ksi	273 (9.6)	281 (4.1)
Impact Properties: ASTM D256, ASTM D4812			
Notched	J/m	106 (23)	53.0 (8.2)
	ft*lb/in	1.98 (0.42)	0.992 (0.15)
Unnotched	J/m	1,430 (110)	325 (88)
	ft*lb/in	26.8 (2.0)	6.09 (1.64)

Table 12. ULTEM™ 9085 Resin Black Mechanical Properties (Fortus 450mc - T20 tip)

		XZ Orientation	ZX Orientation
Tensile Properties: ASTM D638			
Yield Strength	MPa	76.5 (1.4)	No Yield
	psi	11,100 (200)	No Yield
Elongation at Yield	%	6.2 (0.2)	No Yield
Strength at Break	MPa	74.0 (2.0)	41.6 (5.0)
	psi	10,700 (290)	6,030 (730)
Elongation at Break	%	6.6 (0.49)	2.6 (0.38)
Modulus (Elastic)	GPa	2.04 (0.048)	1.9 (0.032)
	ksi	295 (6.9)	275 (4.6)

UV Aging

ULTEM™ 9085 resin was tested before and after UV exposure. Ten ASTM D638 upright (ZX) dogbones were tested in tensile after UV exposure and additional 10 ASTM D638 ZX dogbones 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 Materials white paper.

Table 13. ULTEM™ 9085 Resin 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)
ULTEM™ 9085 resin	No UV Exposure	8130	56.0	8080	55.7	3.5		293	2.02
	UV Exposure	8060	55.5	8070	55.6	3.7	-0.1%	302	2.08

ULTEM™ 9085 resin coupons were built on the Fortus F900 using the T16A tip.

Performance at Temperature

ULTEM™ 9085 resin was tested at various temperatures. Ten ASTM D638 upright (ZX) T16 dogbone coupons were tested in tensile. The percent change from the reported room temperature results are listed below.

For more information, see the **Temperature Impact on FDM Strength Performance** white paper.

Table 14. Performance of ULTEM™ 9085 Resin at Temperature

Material	Temperature		Strength at Break	Elongation at Break	Modulus
	(F)	(C)			
ULTEM™ 9085 resin - T16	-65	-54	157%	125%	137%
	-40	-40	156%	119%	147%
	120	49	122%	98%	137%
	180	82	102%	95%	121%
	220	104	87%	91%	100%
	270	132	70%	82%	100%
	300	149	55%	NA	NA

Flame, Smoke and Toxicity

ULTEM™ 9085 resin, natural (T20 tip and T16A tip) and black (T16 tip), printed on the Stratasys F900 and tested per 14 CFR 25.853, BSS 7238 and 7239, and AITM 2.0007B and 3.0005. The testing done establishes that this material **meets requirements** for:

- 60s and 12s Vertical Burn
- 15s Horizontal Burn
- Toxic Gas Emission
- Smoke Density
- Heat Release Rate of Cabin Materials

Table 15. ULTEM™ 9085 Resin Flame, Smoke and Toxicity Test Results

	Avg Time to Extinguish (seconds)	Avg Burned Length (inches)	Drip Time to Extinguish (seconds)
12 Second Vertical Ignition per 14 CFR 25.853(a), Appendix F, Part I, Paragraph (a)(1)(ii)			
ULTEM™ 9085 Resin, Natural, T20 Tip, Build XZ	1.6	0.2	0 (no drips)
ULTEM™ 9085 Resin, Natural, T20 Tip, Build ZX	1.7	0.5	0 (no drips)
ULTEM™ 9085 Resin, Natural, T16A Tip, Build XY	2.0	0.2	0 (no drips)
ULTEM™ 9085 Resin, Natural, T16A Tip, Build XZ	1.5	0.2	0 (no drips)
ULTEM™ 9085 Resin, Natural, T16A Tip, Build ZX	2.0	0.2	0 (no drips)
ULTEM™ 9085 Resin, Black, T16 Tip, Build XZ	1.1	0.3	0 (no drips)
ULTEM™ 9085 Resin, Black, T16 Tip, Build ZX	<1	0.4	0 (no drips)
60 Second Vertical Ignition per 14 CFR 25.853(a), Appendix F, Part I, Paragraph (a)(1)(i)			
ULTEM™ 9085 Resin, Natural, T20 Tip, Build XZ	1.5	1.8	0 (no drips)
ULTEM™ 9085 Resin, Natural, T20 Tip, Build ZX	<1	1.9	0 (no drips)
ULTEM™ 9085 Resin, Natural, T16A Tip, Build XY	<1	0.4	0 (no drips)
ULTEM™ 9085 Resin, Natural, T16A Tip, Build XZ	3.6	0.6	0 (no drips)
ULTEM™ 9085 Resin, Natural, T16A Tip, Build ZX	<1	0.4	0 (no drips)
ULTEM™ 9085 Resin, Black, T16 Tip, Build XZ	<1	1.2	0 (no drips)
ULTEM™ 9085 Resin, Black, T16 Tip, Build ZX	<1	1.5	0 (no drips)
Avg Burn Rate (in/min)			
15 Second Horizontal Ignition per 14 CFR 25.853(a), Appendix F, Part I, Paragraph (a)(1)(iv)(v)			
ULTEM™ 9085 Resin, Natural, T20 Tip, Build XZ	0		
ULTEM™ 9085 Resin, Natural, T20 Tip, Build ZX	0		
ULTEM™ 9085 Resin, Natural, T16A Tip, Build XY	0		
ULTEM™ 9085 Resin, Natural, T16A Tip, Build XZ	0		
ULTEM™ 9085 Resin, Natural, T16A Tip, Build ZX	0		
ULTEM™ 9085 Resin, Black, T16 Tip, Build XZ	0		
ULTEM™ 9085 Resin, Black, T16 Tip, Build ZX	0		

Table 16. ULTEM™ 9085 Resin Flame, Smoke and Toxicity Test Results

	Test Mode	Average D _s (maximum) within 4 minutes, (⁴ D _{max})					
Smoke Density per BSS 7238, Rev. C							
ULTEM™ 9085 Resin, Natural, T20 Tip, Build XZ	Flaming	4					
ULTEM™ 9085 Resin, Natural, T20 Tip, Build ZX	Flaming	5					
ULTEM™ 9085 Resin, Natural, T16A Tip, Build XY	Flaming	4					
ULTEM™ 9085 Resin, Natural, T16A Tip, Build ZX	Flaming	4					
ULTEM™ 9085 Resin, Black, T16 Tip, Build XZ	Flaming	10					
ULTEM™ 9085 Resin, Black, T16 Tip, Build ZX	Flaming	15					
Smoke Density per AITM 2.0007B, Issue 3							
ULTEM™ 9085 Resin, Natural, T20 Tip, Build XZ	Flaming	5					
ULTEM™ 9085 Resin, Natural, T20 Tip, Build ZX	Flaming	5					
ULTEM™ 9085 Resin, Natural, T20 Tip, Build XZ	Non-Flaming	0					
ULTEM™ 9085 Resin, Natural, T20 Tip, Build ZX	Non-Flaming	0					
ULTEM™ 9085 Resin, Natural, T16A Tip, Build XY	Flaming	5					
ULTEM™ 9085 Resin, Natural, T16A Tip, Build ZX	Flaming	6					
ULTEM™ 9085 Resin, Natural, T16A Tip, Build XY	Non-Flaming	0					
ULTEM™ 9085 Resin, Natural, T16A Tip, Build ZX	Non-Flaming	0					
ULTEM™ 9085 Resin, Black, T16 Tip, Build XZ	Flaming	12					
ULTEM™ 9085 Resin, Black, T16 Tip, Build ZX	Flaming	14					
ULTEM™ 9085 Resin, Black, T16 Tip, Build XZ	Non-Flaming	0					
ULTEM™ 9085 Resin, Black, T16 Tip, Build ZX	Non-Flaming	0					
	Test Mode	CO ppm	SO ₂ ppm	NO _x ppm	HCN ppm	HCl ppm	HF ppm
Toxic Gas Emission per BSS 7239, Rev. A							
ULTEM™ 9085 Resin, Natural, T20 Tip, Build XZ	Flaming	50	0 (NI)	2	0 (NI)	0 (NI)	0 (NI)
ULTEM™ 9085 Resin, Natural, T20 Tip, Build ZX	Flaming	50	0 (NI)	2	0 (NI)	0 (NI)	0 (NI)
ULTEM™ 9085 Resin, Natural, T16A Tip, Build XY	Flaming	50	0 (NI)	2	0 (NI)	0 (NI)	0 (NI)
ULTEM™ 9085 Resin, Natural, T16A Tip, Build ZX	Flaming	50	0 (NI)	2	0 (NI)	0 (NI)	0 (NI)
ULTEM™ 9085 Resin, Black, T16 Tip, Build XZ	Flaming	100	0 (NI)	1	0 (NI)	0 (NI)	0 (NI)
ULTEM™ 9085 Resin, Black, T16 Tip, Build ZX	Flaming	75	0 (NI)	1	0 (NI)	0 (NI)	0 (NI)

Table 17. ULTEM™ 9085 Resin Flame, Smoke and Toxicity Test Results

	Test Mode	CO ppm	SO ₂ ppm	NO _x ppm	HCN ppm	HCl ppm	HF ppm
Toxic Gas Emission per AITM 3.0005, Issue 2							
ULTEM™ 9085 Resin, Natural, T20 Tip, Build XZ	Flaming	92	0	2.8	0 (NI)	0 (NI)	0 (NI)
ULTEM™ 9085 Resin, Natural, T20 Tip, Build ZX	Flaming	102	0	4	0 (NI)	0 (NI)	0 (NI)
ULTEM™ 9085 Resin, Natural, T20 Tip, Build XZ	Non-Flaming	2.6	0	0	0 (NI)	0 (NI)	0 (NI)
ULTEM™ 9085 Resin, Natural, T20 Tip, Build ZX	Non-Flaming	2.2	0	0	0 (NI)	0 (NI)	0 (NI)
ULTEM™ 9085 Resin, Natural, T16A Tip, Build XY	Flaming	61	0	2.3	0 (NI)	0 (NI)	0 (NI)
ULTEM™ 9085 Resin, Natural, T16A Tip, Build ZX	Flaming	78	0	3.2	0 (NI)	0 (NI)	0 (NI)
ULTEM™ 9085 Resin, Natural, T16A Tip, Build XY	Non-Flaming	4	0	0	0 (NI)	0 (NI)	0 (NI)
ULTEM™ 9085 Resin, Natural, T16A Tip, Build ZX	Non-Flaming	5	0	0	0 (NI)	0 (NI)	0 (NI)
ULTEM™ 9085 Resin, Black, T16 Tip, Build XZ	Flaming	93	0	1	0 (NI)	0 (NI)	0 (NI)
ULTEM™ 9085 Resin, Black, T16 Tip, Build ZX	Flaming	103	0	3	0 (NI)	0 (NI)	0 (NI)
ULTEM™ 9085 Resin, Black, T16 Tip, Build XZ	Non-Flaming	2	0	0	0 (NI)	0 (NI)	0 (NI)
ULTEM™ 9085 Resin, Black, T16 Tip, Build ZX	Non-Flaming	2	0	0	0 (NI)	0 (NI)	0 (NI)
	Peak HRR (kW/m²)	Time to Peak Heat Release (seconds)		2 Minute Total HRR (kW-min./m²)			
Heat Release Rate of Cabin Materials per 14 CFR 25.853(d), Appendix F, Part IV							
ULTEM™ 9085 Resin, Natural, T20 Tip, Build XZ	54.5	73		35.5			
ULTEM™ 9085 Resin, Natural, T20 Tip, Build ZX	48.2	66		41.0			
ULTEM™ 9085 Resin, Natural, T16A Tip, Build XY	57.0	57		43.7			
ULTEM™ 9085 Resin, Natural, T16A Tip, Build ZX	56.6	57		52.8			
ULTEM™ 9085 Resin, Black, T16 Tip, Build XZ	55.4	48		32.7			
ULTEM™ 9085 Resin, Black, T16 Tip, Build ZX	41.8	51		34.1			

Outgassing

ULTEM™ 9085 resin, natural and black, was printed with a T20 and T16 tip on the Stratasys F900 and tested per ASTM E595. Full report available upon request.

Table 18. ULTEM™ 9085 Resin Outgassing Test Results

Sample	TML (%)	CVCM (%)	WVR (%)
ULTEM™ 9085 Resin, Natural, T20 Tip	0.34	0.02	0.35
ULTEM™ 9085 Resin, Natural, T16A Tip	0.37	< 0.01	0.38
ULTEM™ 9085 Resin, Black, T16 Tip	0.33	< 0.01	0.22
Testing Observations⁽¹⁾			
Visible Condensate	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 of Railway Vehicles

NFPA 130

ULTEM™ 9085 resin CG resin was printed with a T16A tip on the Stratasys F900 using single contour and +45/-45 solid rasters, which are typical default settings and tested per NFPA 130.

* It should be noted that products with other wall thicknesses and/or printed at different machines and with different settings (orientation/ filling/ tip size) may perform differently.

* Further testing should be done by the customer to make sure the material fits their final application.

Table 19. ULTEM™ 9085 Resin CG NFPA 130 Fixed Guideway Transit and Passenger Transit Systems Test Results

Test	Thickness	Performance Criteria	Result	
ASTM E162	12.7 mm	Depends on function of material. Refer to NFPA 130 Table 8.4.1	Is (flat) = 0 Is (upright) = 0	
ASTM E662	20 mm	Depends on function of material. Refer to NFPA 130 Table 8.4.1	Flat, Non-flaming	Flat, Flaming
			Ds (1.5) = 0	Ds (1.5) = 0
			Ds (4.0) = 0	Ds (4.0) = 12.3
			Upright, Non-flaming	Upright, flaming
			Ds (1.5) = 0	Ds (1.5) = 0.7
ASTM E1354	25 mm	Average Heat Release Rate < 100 kW/m2 Average Smoke Extinction Area < 500 m2/kg	Ds (4.0) = 0	Ds (4.0) = 17
			Flat	
			Average Heat Release Rate: 67.1 kW/m2	
			Average Smoke Extinction Area: 262.4 m2/kg	
			Upright	
			Average Heat Release Rate: 61.4 kW/m2	
			Average Smoke Extinction Area: 372.3 m2/kg	

Fire Protection of Railway Vehicles

EN-45545-2

ULTEM™ 9085 resin CG

ULTEM™ 9085 resin CG resin was printed with a T16A tip on the Stratasys F900 using single contour and +45/-45 solid rasters, which are typical default settings and tested per EN-45545-2.

The limited testing done establishes that this material meets requirements for:

- R1, R2, R3, R6, R7, R17: HL1/2/3 at 25mm thick in XY and XZ orientations
- R2, R3, R17: HL1/2/3 at 5mm thick in XY orientation
- Not classified at 5mm thick in XZ orientation
- R22: HL1/2 at 0.508 mm thick in XY orientation
- R22: HL1/2/3, 1mm to 10.5mm in XY orientation
- R23: HL1/2/3, 0.508mm to 10.5 mm in XY orientation

* Additional tests are in progress. Please consult Stratasys Application Engineers to learn more.

* It should be noted that products with other wall thicknesses and/or printed at different machines and with different settings (orientation/ filling/ tip size) may perform differently.

* Further testing should be done by the customer to make sure the material fits their final application.

Table 20. ULTEM™ 9085 Resin CG Fire Protection of Railway Vehicles Test Results for R1 Requirement Set

Test	Results	5mm XY	5mm XZ	25mm XY	25mm XZ
ISO 5659-2 50 kW/m ²	D _s (4)	-	-	38	57
	VOF ₄	-	-	62	94
	D _m	-	-	228	231
ISO 5659-2 + EN 45545-2 Appendix C 50 kW/m ²	ITC 4 minutes	-	-	0.02	0.01
	ITC 8 minutes	-	-	0.08	0.06
ISO 5660-1	MAHRE (kW/m ²)	-	-	24.1	19.9
ISO 5658-2	CFE (kW/m ²)	16.5	12.5	29.9	28.6

Table 21. ULTEM™ 9085 Resin CG Fire Protection of Railway Vehicles Test Results for R22/23 Requirement Set

Test	Results	0.508mm XY	1mm XY	10.5mm XY
ISO 5659-2 25 kW/m ²	D _s (4)	2	3	0
	VOF ₄	2	3	0
	D _s max	15	15	6
NF X 70-100	CIT _{NLP}	0.8	0.69	0.6
ISO4589-2	%O ₂	37.6	42.5	49

Fire Protection of Buses

UN ECE Regulation 118

ULTEM™ 9085 resin CG

ULTEM™ 9085 resin CG was printed with a T16 tip on the Stratasys F900 using single contour and +45/-45 solid rasters, which are typical default settings and tested per EN-45545-2

- Orientation: Flat XY
- Sample thickness: 3mm

Table 22. ULTEM™ 9085 Resin CG Fire Protection of Buses Test Results

Horizontal Burning Annex VI	Melting Behavior Annex VII	Vertical Burn Annex VIII
Passed	Passed	Passed
The tested samples do not ignite, the burning rate is 0mm/min.	No drop is formed that ignites the cotton wool during testing.	The tested samples do not ignite, the burning rate is 0mm/min.

Appendix

Validated Materials

Stratasys Validated Materials are developed by Stratasys or a third-party provider, meet Stratasys quality standards, and have received basic reliability testing for use with Stratasys FDM printers.

Table 23. Colored ULTEM™ 9085 Resin Validated Materials

		XZ Orientation ¹	ZX Orientation ¹
Tensile Properties: ASTM D638			
Validated Material - ULTEM™ 9085 Resin Aircraft Gray, Fortus 450mc, T16			
Yield Strength	MPa	78.8 (0.57)	56.4 (3.2)
	psi	11400 (82)	8180 (460)
Elongation @ Yield	%	6.2 (0.070)	3.2 (0.35)
Strength @ Break	MPa	75.1 (1.6)	55.9 (3.0)
	psi	10900 (230)	8110 (440)
Elongation @ Break	%	7.9 (0.34)	3.1 (0.32)
Modulus (Elastic)	GPa	2.25 (0.026)	2.18 (0.026)
	ksi	326 (3.8)	316 (3.7)
Validated Material - ULTEM™ 9085 Resin Aircraft Gray, F900, T16			
Yield Strength	MPa	70.6 (2.4)	No yield
	psi	10200 (350)	
Elongation @ Yield	%	5.6 (0.13)	
Strength @ Break	MPa	69.5 (2.2)	56.0 (2.3)
	psi	10100 (310)	8120 (340)
Elongation @ Break	%	6.1 (0.26)	3.3 (0.29)
Modulus (Elastic)	GPa	2.09 (0.042)	2.12 (0.018)
	ksi	303 (6.1)	308 (2.6)
Validated Material - ULTEM™ 9085 Resin Gunship Gray, Fortus 450mc, T16			
Yield Strength	MPa	81.0 (0.50)	47.2 (9.6)
	psi	11700 (73)	6850 (1400)
Elongation @ Yield	%	6.2 (0.09)	2.5 (0.65)
Strength @ Break	MPa	78.5 (3.2)	48.7 (8.2)
	psi	11400 (460)	7060 (1200)
Elongation @ Break	%	7.1 (0.81)	2.7 (0.58)
Modulus (Elastic)	GPa	2.27 (0.022)	2.19 (0.0096)
	ksi	330. (3.2)	318 (1.4)

¹ Values in parenthesis are standard deviations.

		XZ Orientation ¹	ZX Orientation ¹
Tensile Properties: ASTM D638			
Validated Material - ULTEM™ 9085 Resin Gunship Gray, F900, T16			
Yield Strength	MPa	69.9 (2.3)	No yield
	psi	10100 (330)	
Elongation @ Yield	%	5.7 (0.13)	
Strength @ Break	MPa	68.8 (2.2)	55.6 (2.9)
	psi	9970 (320)	8070 (430)
Elongation @ Break	%	6.2 (0.28)	3.4 (0.37)
Modulus (Elastic)	GPa	2.08 (0.055)	4.17 (0.035)
	ksi	302 (7.9)	605 (5.1)
Validated Material - ULTEM™ 9085 Resin White 7362 (AIC 12.16), Fortus 450mc, T16			
Yield Strength	MPa	76.6 (1.4)	36.8 (3.2)
	psi	11100 (200)	5340 (470)
Elongation @ Yield	%	5.8 (0.22)	1.9 (0.23)
Strength @ Break	MPa	75.1 (1.4)	36.4 (6.2)
	psi	10900 (200)	5270 (900)
Elongation @ Break	%	6.1 (0.34)	1.9 (0.40)
Modulus (Elastic)	GPa	2.22 (0.033)	2.26 (0.066)
	ksi	322 (4.8)	328 (9.6)
Validated Material - ULTEM™ 9085 Resin White 7362 (AIC 12.16), F900, T16			
Yield Strength	MPa	64.4 (2.6)	No yield
	psi	9340 (380)	
Elongation @ Yield	%	5.1 (0.19)	
Strength @ Break	MPa	63.5 (2.6)	40.2 (2.1)
	psi	9210 (380)	5830 (300)
Elongation @ Break	%	5.5 (0.40)	2.3 (0.18)
Modulus (Elastic)	GPa	2.04 (0.055)	2.10 (0.042)
	ksi	296 (8.0)	304 (6.1)

¹ Values in parenthesis are standard deviations.

		XZ Orientation ¹	ZX Orientation ¹
Tensile Properties: ASTM D638			
Validated Material - ULTEM™ 9085 Resin Dream Gray (AIC 2.49), Fortus 450mc, T16			
Yield Strength	MPa	73.2 (0.75)	39.1 (6.2)
	psi	10600 (110)	5680 (900)
Elongation @ Yield	%	5.5 (0.20)	2.0 (0.39)
Strength @ Break	MPa	72.1 (0.73)	40.2 (5.1)
	psi	10500 (110)	5830 (740)
Elongation @ Break	%	5.9 (0.41)	2.1 (0.34)
Modulus (Elastic)	GPa	2.22 (0.051)	2.30 (0.29)
	ksi	321 (7.4)	334 (41)
Validated Material - ULTEM™ 9085 Resin Dream Gray (AIC 2.49), F900, T16			
Yield Strength	MPa	63.9 (2.5)	46.6 (2.8)
	psi	9270 (360)	6770 (410)
Elongation @ Yield	%	5.6 (0.21)	2.7 (0.23)
Strength @ Break	MPa	63.9 (2.5)	26.0 (2.8)
	psi	9270 (360)	3770 (410)
Elongation @ Break	%	5.6 (0.21)	2.7 (0.23)
Modulus (Elastic)	GPa	1.98 (0.051)	2.11 (0.024)
	ksi	288 (7.3)	307 (3.4)
Validated Material - ULTEM™ 9085 Resin Jana White (AIC 12.36), Fortus 450mc, T16			
Yield Strength	MPa	77.4 (0.44)	40.2 (5.7)
	psi	11200 (63)	5830 (830)
Elongation @ Yield	%	6.2 (0.09)	2.1 (0.41)
Strength @ Break	MPa	75.3 (2.1)	40.2 (5.7)
	psi	10900 (310)	5830 (830)
Elongation @ Break	%	7.0 (0.37)	2.1 (0.41)
Modulus (Elastic)	GPa	2.30 (0.053)	2.27 (0.068)
	ksi	334 (7.7)	329 (9.9)
Validated Material - ULTEM™ 9085 Resin Jana White (AIC 12.36), F900, T16			
Yield Strength	MPa	65.9 (2.8)	No yield
	psi	9550 (410)	
Elongation @ Yield	%	5.3 (0.18)	
Strength @ Break	MPa	64.7 (2.8)	56.0 (2.3)
	psi	9390 (400)	8120 (340)
Elongation @ Break	%	5.8 (0.40)	3.3 (0.29)
Modulus (Elastic)	GPa	2.06 (0.051)	2.12 (0.018)
	ksi	299 (7.3)	308 (2.6)

¹ Values in parenthesis are standard deviations.

		XZ Orientation ¹	ZX Orientation ¹
Tensile Properties: ASTM D638			
Validated Material - ULTEM™ 9085 Resin Red, Fortus 450mc, T16			
Yield Strength	MPa	74.7 (3.3)	53.3 (4.1)
	psi	10800 (480)	7730 (600)
Elongation @ Yield	%	6.0 (0.21)	3.1 (0.35)
Strength @ Break	MPa	72.7 (4.0)	53.7 (4.0)
	psi	10500 (580)	7790 (580)
Elongation @ Break	%	6.7 (0.55)	3.1 (0.33)
Modulus (Elastic)	GPa	2.15 (0.037)	2.12 (0.028)
	ksi	312 (5.4)	307 (4.1)
Validated Material - ULTEM™ 9085 Resin Red, F900, T16			
Yield Strength	MPa	68.9 (2.2)	No yield
	psi	9990 (320)	
Elongation @ Yield	%	5.7 (0.11)	
Strength @ Break	MPa	67.1 (2.1)	53.3 (2.8)
	psi	9730 (310)	7730 (400)
Elongation @ Break	%	6.6 (0.37)	3.0 (0.25)
Modulus (Elastic)	GPa	2.06 (0.048)	2.15 (0.035)
	ksi	299 (6.9)	311 (5.1)

¹ Values in parenthesis are standard deviations.

Figure 1. 2nd heating scan DSC data for ULTEM™ 9085 resin, natural

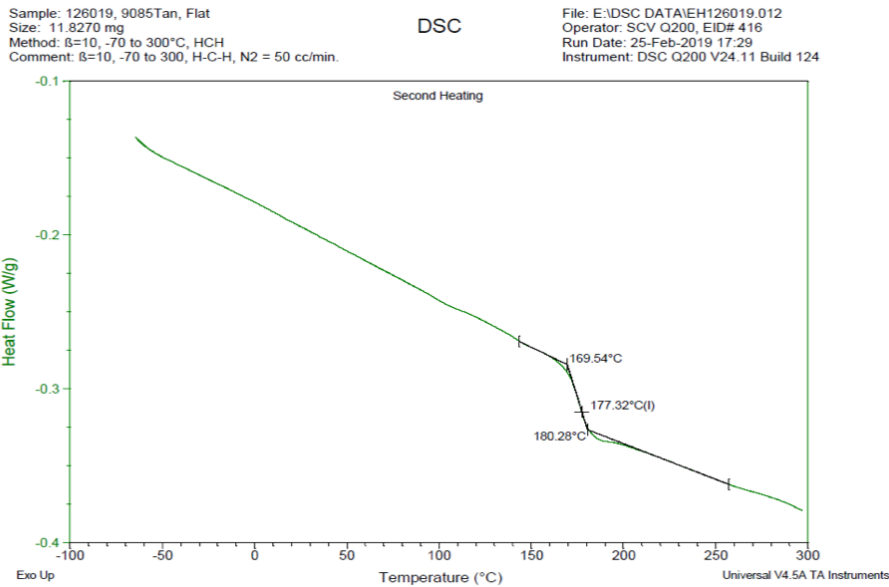


Figure 2. 2nd heating scan DSC data for ULTEM™ 9085 resin, black

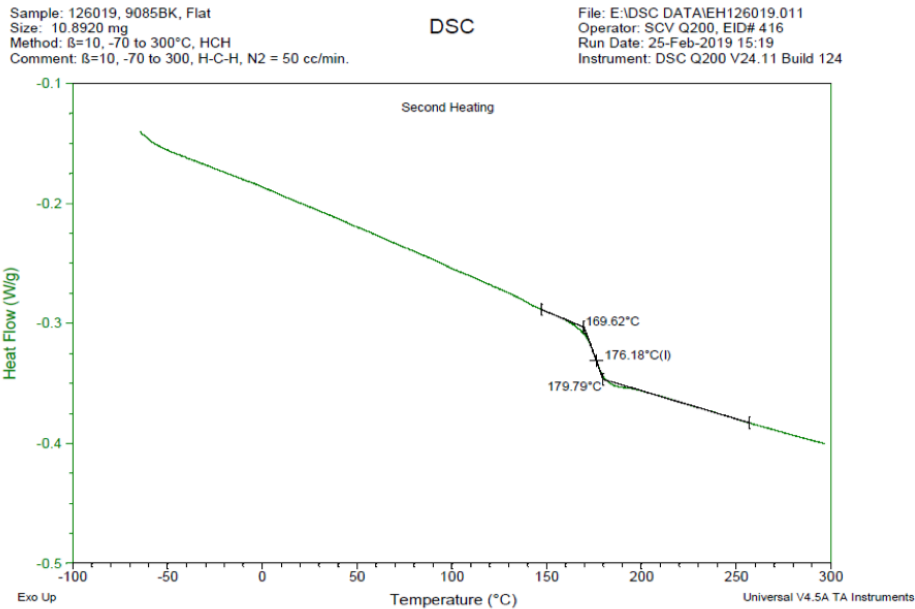


Figure 3. Dimension change data as a function of temperature for ULTEM™ 9085 resin, natural, flat (XY)

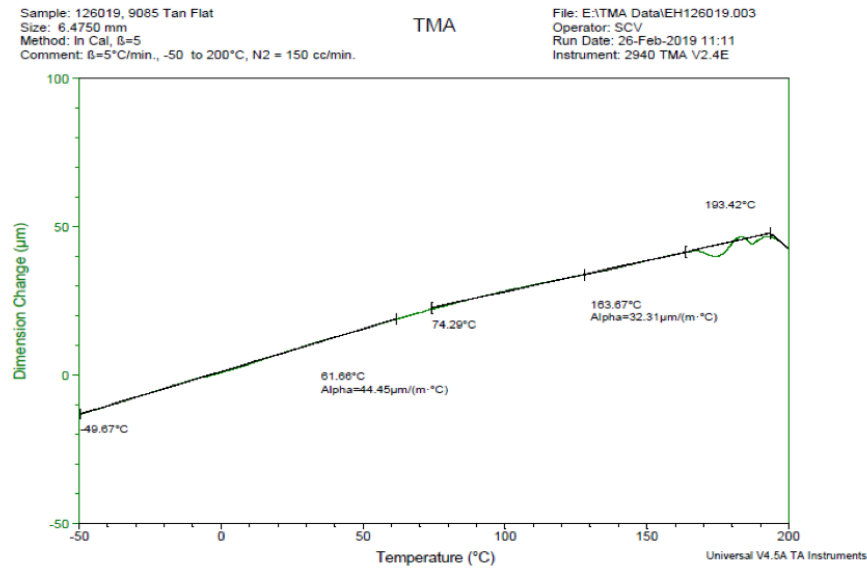


Figure 4. Dimension change data as a function of temperature for ULTEM™ 9085 resin, natural, upright (XZ)

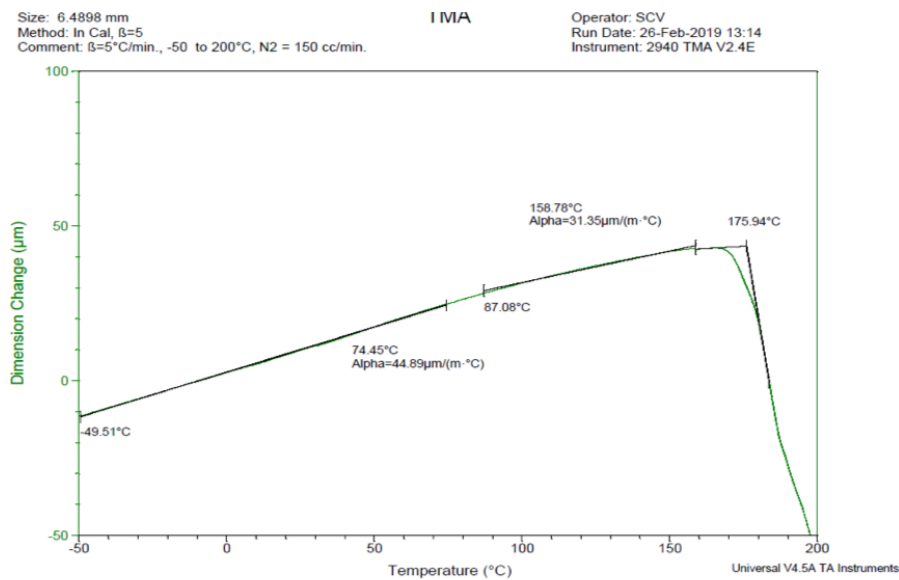


Figure 5. Dimension change data as a function of temperature for ULTEM™ 9085 resin, black, flat (XY)

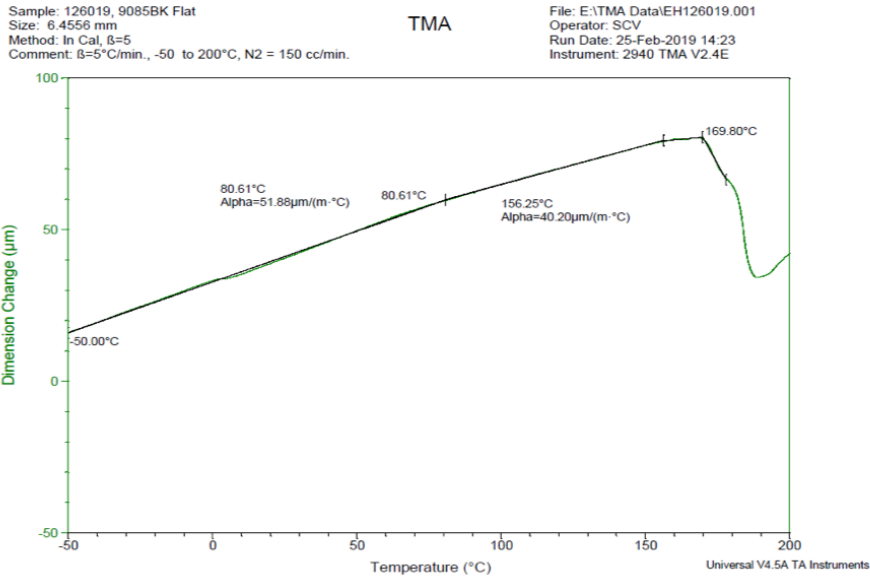


Figure 6. Dimension change data as a function of temperature for ULTEM™ 9085 resin, black, upright (XZ)

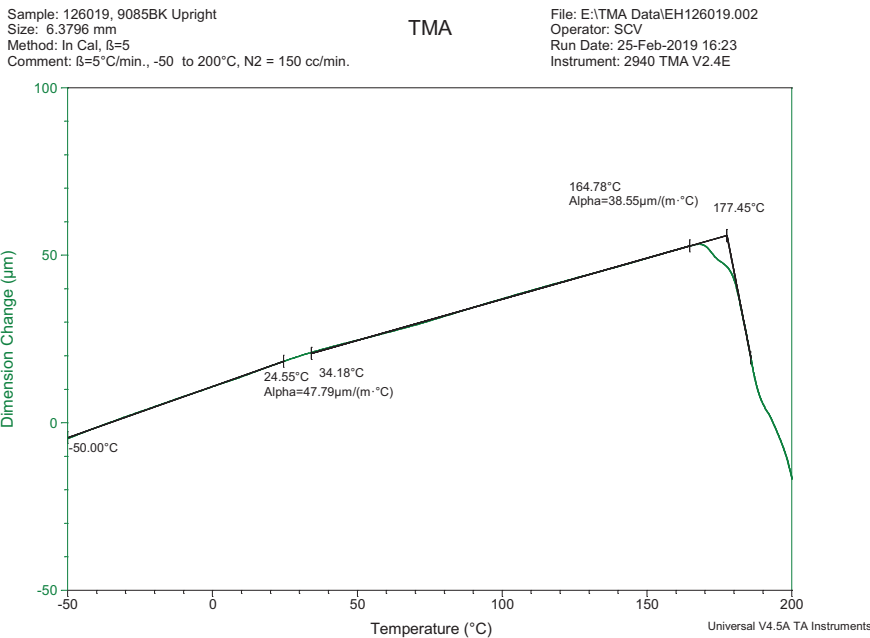
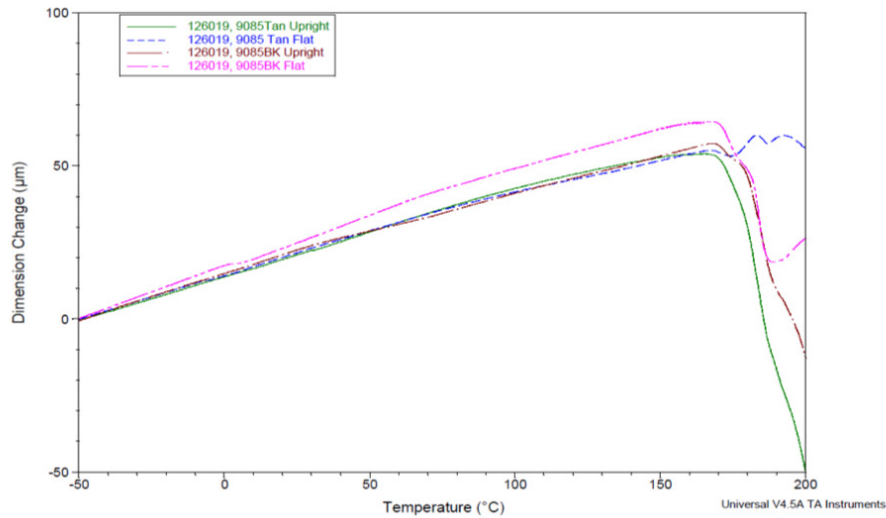


Figure 7. Overlay of the dimension change data for all the ULTEM™ 9085 resin samples



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