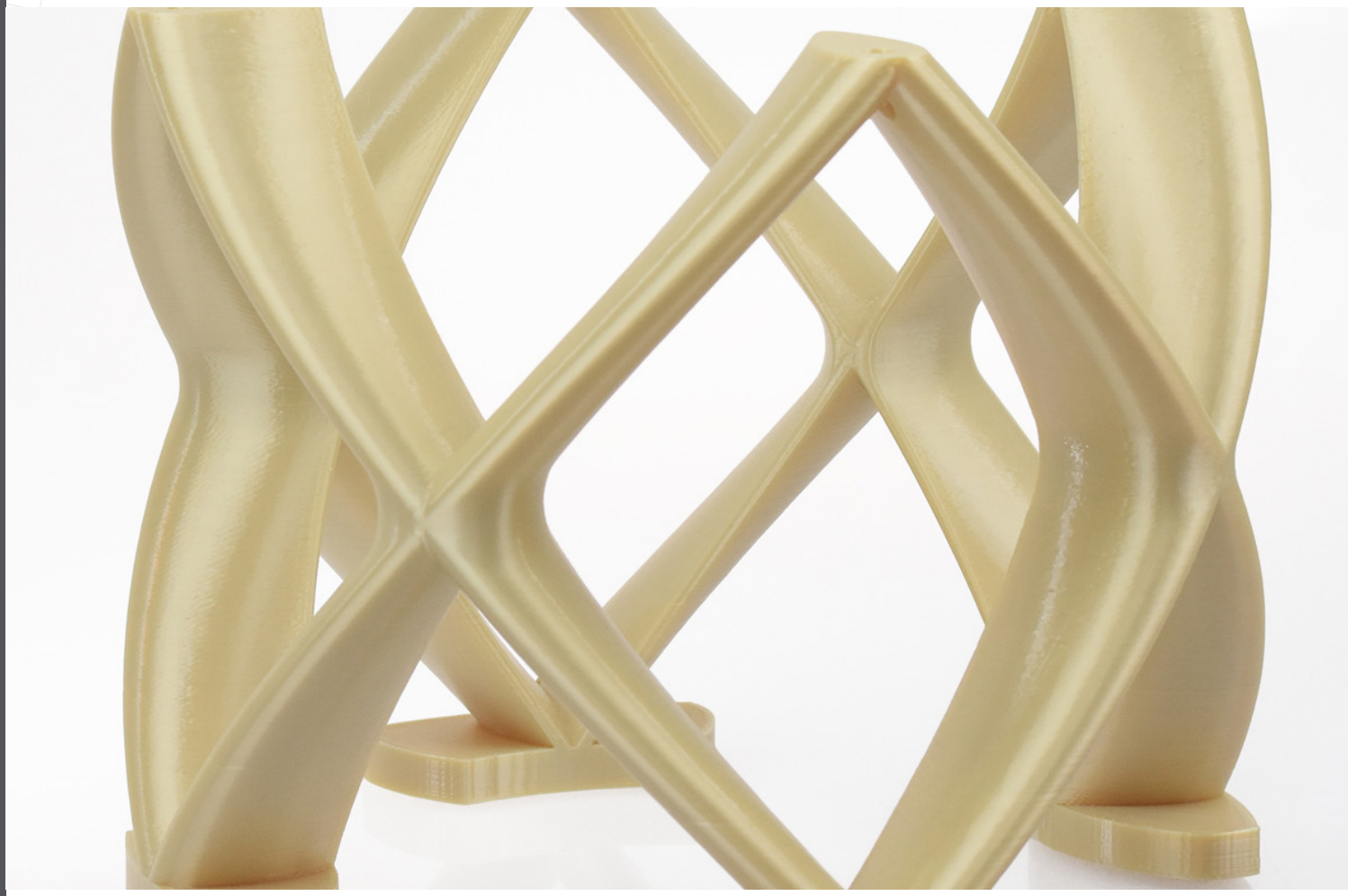
PROTOLAB
Manufacturing Total Solution (주)프로토랩

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.

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.

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. Available colors are natural and black.

Contents:

Ordering Information

Table 1. Printer and Support Material Compatibility

Printer	Model Tip	Support Material	Support Tip
Fortus 450mc™	T16 (10 slice) T16A (10 slice) T20 (13 slice)	9085 Support	T16 (all slices)
F900®	T16 (10 slice) T16A (10 slice) T20 (13 slice)	9085 Support	T16 (all slices)

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 cu. in. – Plus
355-08310	ULTEM™ 9085 resin natural, 184 cu. in. – Plus
355-23101	ULTEM™ 9085 resin CG, 92 cu. in. – Plus
355-02311	ULTEM™ 9085 resin black, 92 cu. in. – Plus
355-03220	ULTEM™ 9085 resin BASS, 92 cu. in. – Plus
312-20001	ULTEM™ 9085 resin CG, 92 cu. in. – Classic
312-20000	ULTEM™ 9085 resin natural, 92 cu. in. – Classic
312-20018	ULTEM™ 9085 resin natural, 184 cu. in. – Classic
312-20200	ULTEM™ 9085 resin black, 92 cu. in. – Classic
310-30600	ULTEM™ 9085 resin BASS, 92 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
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 on www.stratasys.com.

DSC and TMA curves can be found in the Appendix.

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

Property	Test Method	Typical Values	
		XY	XZ/ZX
HDT @ 66psi	ASTM D648 Method B	176.9 °C (350.4 °F)	
HDT @ 264psi	ASTM D648 Method B	172.9 °C (343.2 °F)	
Tg	ASTM D7426 Inflection Point	177.32 °C (351.18 °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)		32.31µm/[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 mm^2/s 2.29*10^-4 in^2/s	
Thermal Diffusivity	ASTM E1952 at 30°C	0.132 mm^2/s 2.05*10^-4 in^2/s	
Thermal Diffusivity	ASTM E1952 at 60°C	0.121 mm^2/s 1.88*10^-4 in^2/s	
Thermal Diffusivity	ASTM E1952 at 90°C	0.111 mm^2/s 1.72*10^-4 in^2/s	
Specific Gravity	ASTM D792 at 23°C	1.27	
UL Flammability[1]	ANSI/UL 746B	V0 – Blue Card #E345258	

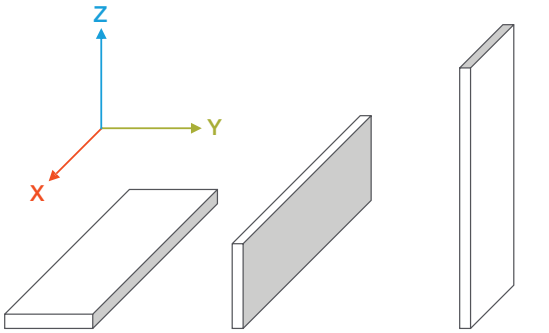
[1] Applies to the natural version of ULTEM™ 9085 resin only

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 on www.stratasys.com.

Print Orientation

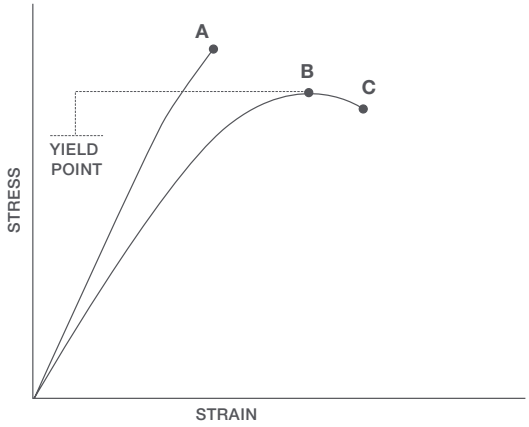
Parts created using FDM are anisotropic as a result of the printing process. Below is a reference of the different orientations used to characterize the material.



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™ 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	ZX Orientation
Tensile Properties: ASTM D638			
Strength at 0.2% offset yield	MPa	45.2	38.2
	psi	6,560	5,540
Ultimate Strength	MPa	77.1	59.0
	psi	11,200	8,550
Modulus (Elastic)	GPa	2.62	2.39
	ksi	377	347
Flexural Properties: ASTM D790, Procedure A			
Ultimate Strength	MPa	98.3	80.3
	psi	14,300	11,600
Modulus	GPa	2.63	2.26
	ksi	381	328
Compression Properties: ASTM D695			
Strength at 0.2% offset yield	MPa	78.9	60.1
	psi	11,400	8,710
Modulus	GPa	2.98	266
	ksi	433	386
Impact Properties: ASTM D256, ASTM D4812			
Izod, Notched	J/m	73.7	69.3
	ft*lb/in	1.4	1.3

stratasys

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

		XZ Orientation[1]	ZX Orientation[1]
Tensile Properties: ASTM D638			
Yield Strength	MPa	68.5 (0.46)	No yield
	psi	9,930 (67)	No yield
Elongation at Yield	%	5.8 (0.044)	No yield
Strength at Break	MPa	67.8 (0.66)	38.9 (3.7)
	psi	9,840 (95)	5,640 (530)
Elongation at Break	%	5.7 (0.32)	2.5 (0.35)
Modulus (Elastic)	GPa	2.31 (0.056)	1.98 (0.16)
	ksi	335 (8.1)	287 (23)
Flexural Properties: ASTM D790, Procedure A			
Strength at Break	MPa	102 (1.0)	58.8 (8.8)
	psi	14,800 (150)	8,530 (1,300)
Strain at Break	%	No break	3.25 (0.57)
Modulus	GPa	2.39 (0.021)	1.93 (0.045)
	ksi	346 (3.1)	280 (6.5)
Compression Properties: ASTM D695			
Yield Strength	MPa	86.5 (2.8)	209 (6.6)
	psi	12,500 (410)	30,400 (960)
Modulus	GPa	1.60 (0.046)	2.00 (0.072)
	ksi	232 (6.7)	290 (10)
Impact Properties: ASTM D256, ASTM D4812			
Izod, Notched	J/m	124 (35)	36.6 (7.6)
	ft*lb/in	2.31 (0.66)	0.685 (0.14)
Izod, Unnotched	J/m	952 (130)	141 (35)
	ft*lb/in	17.8 (2.4)	2.65 (0.66)

[1] Values in parentheses are standard deviations

Table 7. 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

stratasys

Table 8. 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 9. 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)

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

	Test Mode	Average D_s (maximum) within 4 minutes, ($^4D_{max}$)
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)

stratasys

Table 10. 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/m^2)	Time to Peak Heat Release (seconds)	2 Minute Total HRR ($kW\text{-}min./m^2$)
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 11. 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 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 12. ULTEM 9085 CG Resin 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 Ds (1.5) = 0 Ds (4.0) = 0	Flat, Flaming Ds (1.5) = 0 Ds (4.0) = 12.3
			Upright, Non-flaming Ds (1.5) = 0 Ds (4.0) = 0	Upright, flaming Ds (1.5) = 0.7 Ds (4.0) = 17
ASTM E1354	25 mm	Average Heat Release Rate < 100 kW/m2 Average Smoke Extinction Area < 500 m2/kg	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 CG

ULTEM™ 9085 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 13. ULTEM™ 9085 CG Resin 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/m2	Ds(4)	-	-	38	57
	VOF4	-	-	62	94
	Dm	-	-	228	231
ISO 5659-2 + EN 45545-2 Appendix C 50 kW/m2	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 14. ULTEM™ 9085 CG Resin 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 CG

ULTEM™ 9085 CG resin 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 15. ULTEM 9085 CG Resin 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

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

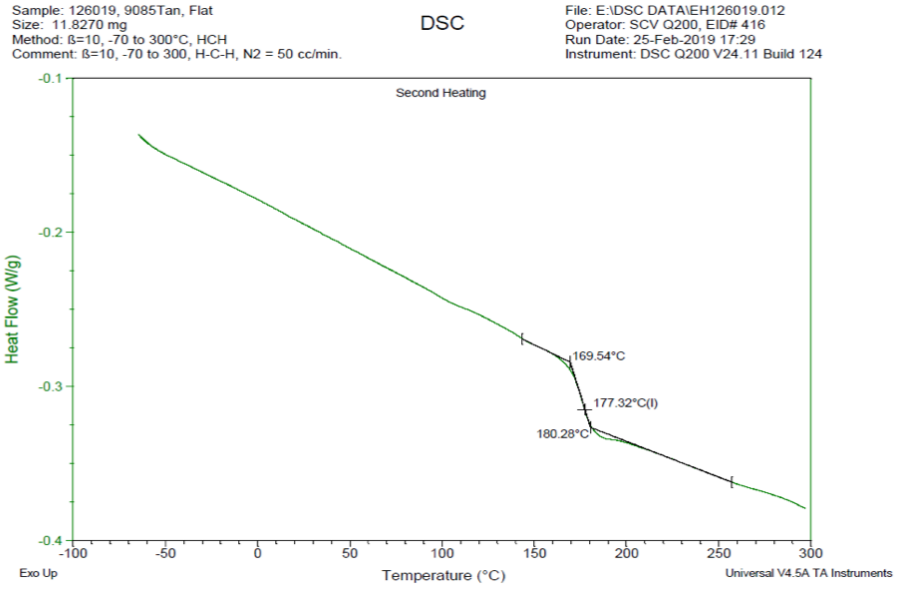


Figure 2. 2nd heating scan DSC data for ULTEM™ 9085 resin, black

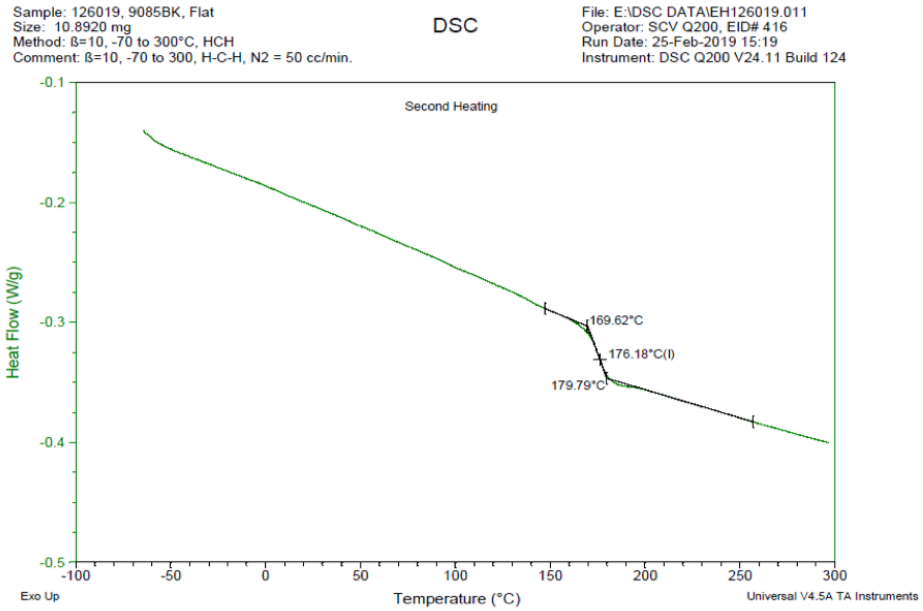


Figure 3. Dimension change data as a function of temperature for ULTEM™ 9085 resin, natural, flat (XY)

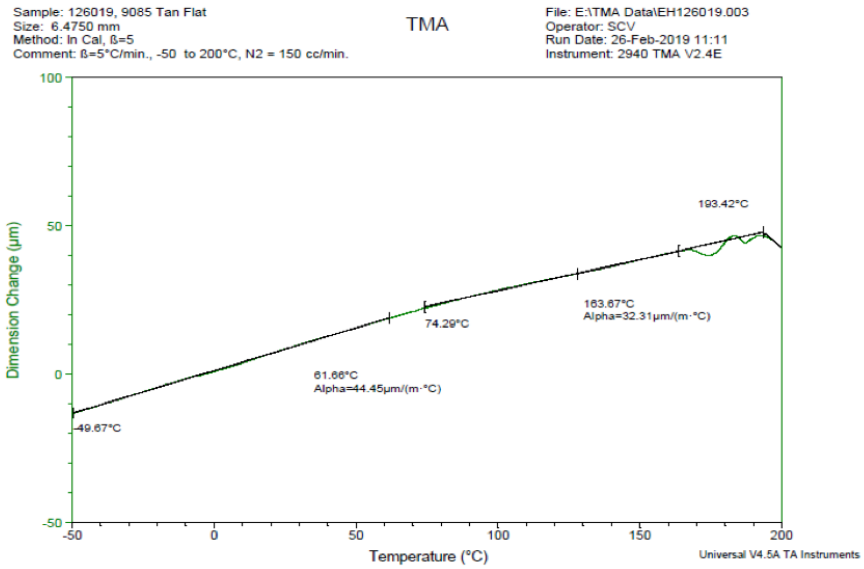


Figure 4. Dimension change data as a function of temperature for ULTEM™ 9085 resin, natural, upright (XZ)

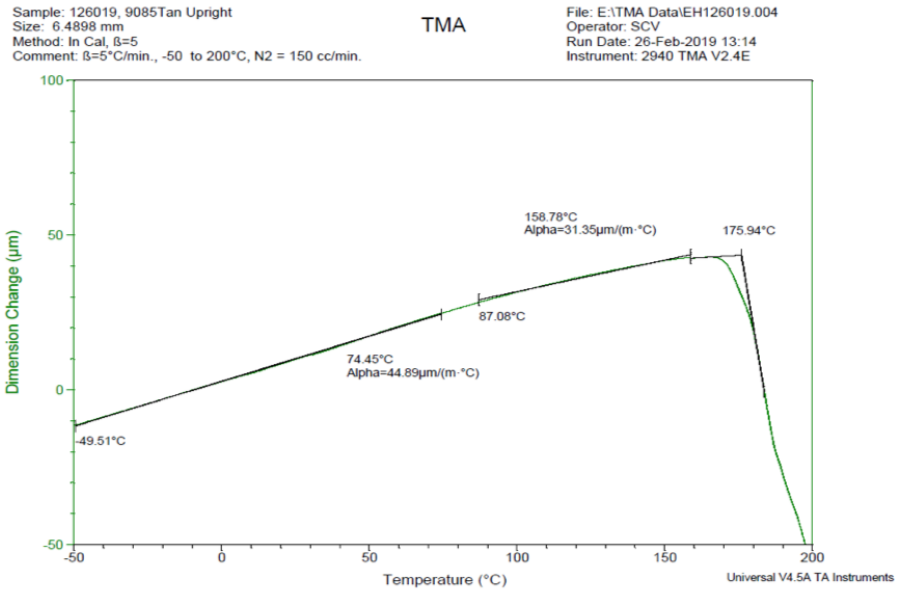


Figure 5. Dimension change data as a function of temperature for ULTEM™ 9085 resin, black, flat (XY)

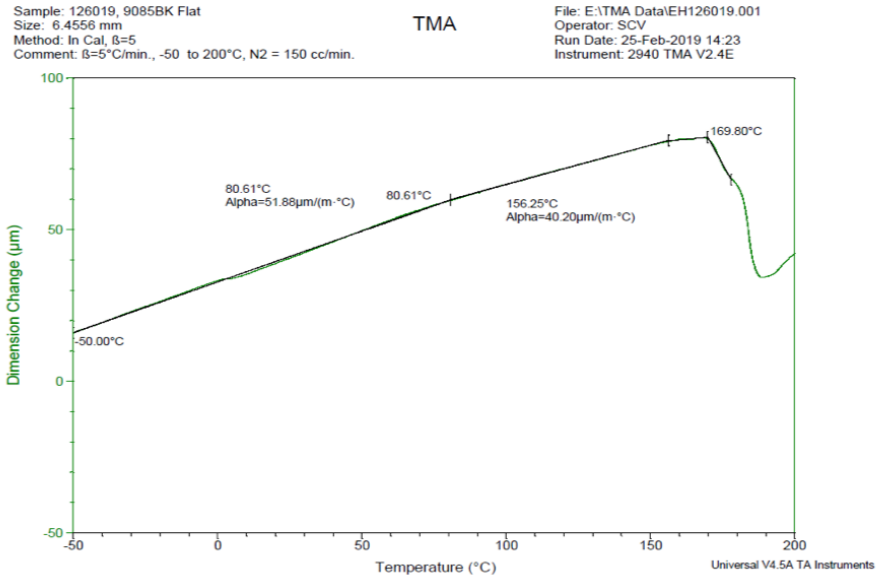


Figure 6. Dimension change data as a function of temperature for ULTEM™ 9085 resin, black, upright (XZ)

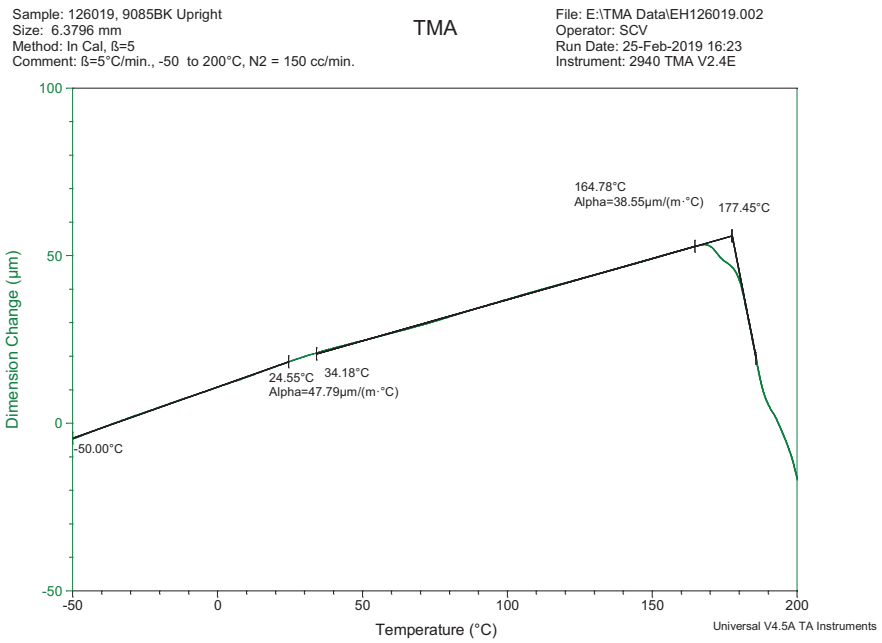
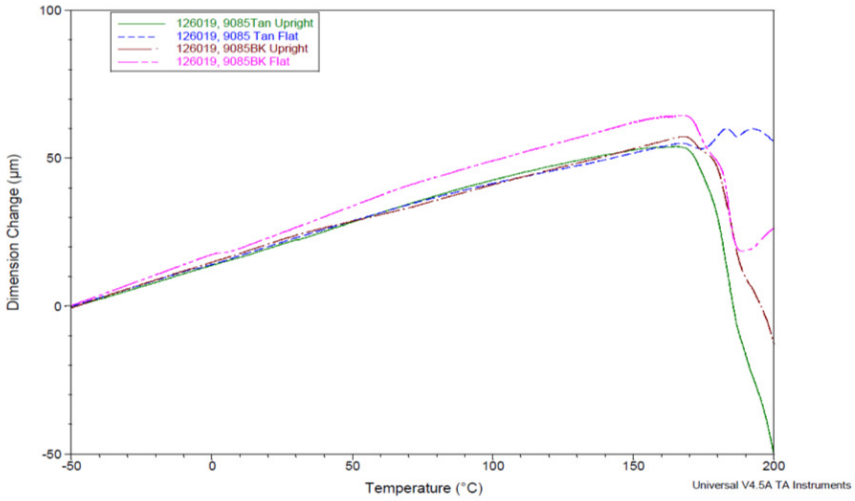


Figure 7. Overlay of the dimension change data for all the ULTEM™ 9085 resin samples



PROTOLAB
Manufacturing Total Solution (주)프로토랩

서울특별시 금천구 가산디지털1로 19(가산동 670-2),
대륭테크노타운18차 302호

TEL:02-6929-4117
E-mail:prototech_ae@prototech.co.kr

ISO 9001:2015 인증