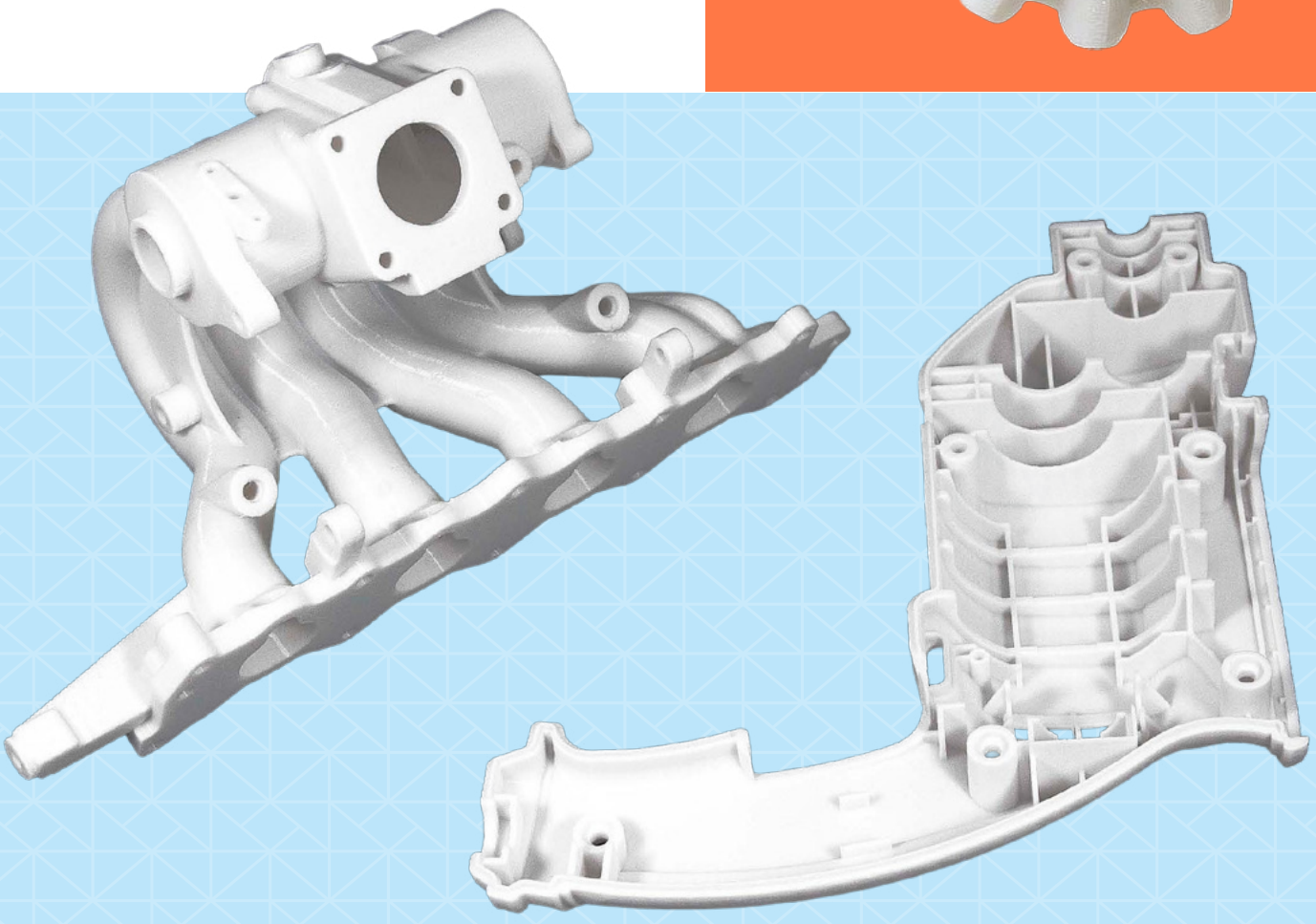
stratasys

MATERIAL DATA SHEET
FDM

PC (Polycarbonate)

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

PC is a polycarbonate FDM® filament that brings the attributes of this industrial plastic to 3D printing applications. PC is characterized by its high strength and impact resistance, coupled with dimensional stability and heat resistance.

These attributes make it a good choice for 3D printed prototypes, parts and tools that demand higher material properties than ABS or ASA.

FDM PC is available in white as a Preferred Material and black and red as Validated Materials.

Contents:

Ordering Information

Table 1: Printer and Support Material Compatibility

Printer	Model Tip	Layer Height	Support Material	Support Tip
Fortus 450mc™	T10	0.127 mm (0.005 in.)	SR-100	T12SR100
	T12	0.1778 mm (0.007 in.)	SR-100, PC BASS	T12SR100 (SR-100), T12 (PC BASS)
	T16	0.254 mm (0.010 in.)		T12SR100 (SR-100), T16 (PC BASS)
	T20	0.3302 mm (0.013 in.)	PC BASS	T16
F900®	T12	0.1778 mm (0.007 in.)	SR-100, PC BASS	T12SR100 (SR-100), T12 (PC BASS)
	T16	0.254 mm (0.010 in.)		T12SR100 (SR-100), T16 (PC BASS)
	T20	0.3302 mm (0.013 in.)		
F3300™	N500	0.250 mm (0.010 in.)	SR-110	N410

BASS = breakaway support system.
PC Red is available on the Fortus 450mc and F900 with the T16 model tip and SR-100 support material.
PC Black is only available on the Fortus 450mc with the T16 model tip and SR-100 support material.

Build Sheet

Fortus Low 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 Low Temperature Build Sheets

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

System Requirements[1]

Fortus 450mc

- Hardened machine upgrade (only required for hardened head)
- Standard Fortus 450mc head (white, PC-ISO, and Validated Material colors)
- Hardened Fortus 450mc head (Validated Material colors)
- PC material license (required for Preferred Materials, included if new system)
- All Materials license (required for Validated Material colors, included if new system)

F900

- Standard F900 head (white, PC-ISO, Validated Material colors)
- Hardened F900 head (Validated Material colors)
- PC material license (required for Preferred Materials)
- Validated Materials license (required for Validated Material colors)

F3300

- F3300 Series Extruder Drive
- Standard Hot Ends
- No material licenses required

1 - Contact your Stratasys representative for ordering information

Table 2. PC Ordering Information

Part Number	Description	System Compatibility
Filament Consumables		
Fortus Plus Canister (black snout)		
355-02210	PC, 92.3 cu in. - Plus	Fortus 450mc, F900, Fortus 900mc (S/N L502 and up)
355-08210	PC, 184 cu in. - Plus	
355-70060	PC Red, 92 cu in. - Plus	
355-03210	PC BASS, 92.3 cu in. - Plus	
355-03120	SR-100 Soluble Support, 92.3 - Plus	
355-70061	PC Black, 92 cu in. - Plus	Fortus 450mc
Fortus Plus Xtend 500 Box		
360-50210	PC, XTEND 500 - Plus	Fortus 450mc, F900
360-53210	PC BASS, XTEND 500 - Plus	
Fortus Classic Canister (gray snout)		
310-20100	PC, 92.3 cu in. - Classic	Fortus 900mc (S/N prior to L502)
310-20118	PC, 184 cu in. - Classic	
310-30100	PC BASS, 92.3 cu in. - Classic	
310-31100	SR-100 Soluble Support, 92.3 - Classic	
F3000 Series Spools		
363-00200	MTRL, F3000 Series, (M), PC, 4100cc	F3300
363-00710	MTRL, F3000 Series, (S), SR-110, 4100cc	
Printer Consumables		
Fortus		
511-10501	T10 tip	Fortus 450mc
511-10301	T12 tip	Fortus 450mc, F900
511-10401	T16 tip	
511-10701	T20 tip	
511-10100	T12SR100 support tip	
325-00100	Low Temperature build sheet, 0.02 x 16 x 18.5 in.	
325-00300	Low Temperature build sheet, 0.02 x 26 x 38 in.	
F3000 Series		
533-00500-S	FDM, N500 Hot End (0.25 mm/0.010 in. layer height)	F3300
533-00410-S	FDM, N410 Support Hot End (0.25 mm/0.010 in. layer height)	
363-30000-S	F3300 sheet bundle, standard 0.02 x 26 x 28 in., 10	

Part Number	Description	System Compatibility
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)	
821726-XXXX	Hardened Fortus 450mc head (blue handle)	Fortus 450mc (Validated Materials only)
380-30400-S	OpenAM Hardened Fortus 450mc head (blue handle, additional sticker)	
404210-XXXX	OpenAM Standard F900 head (formed rod handle)	F900
380-63600-S	Standard F900 head (formed rod handle, additional sticker)	
325-63500	Hardened F900 head (folded sheet metal handle)	F900 (Validated Materials only)
380-63500-S	OpenAM Hardened F900 head (folded sheet metal handle, additional sticker)	
F3000 Series		
533-10000-S	F3000 Series Extruder Drive	F3300

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. PC Physical Properties

Property	Test Method	XY	ZX
HDT @ 66 psi	ASTM D648 Method B	144.0 °C (291.2 °F)	144.3 °C (291.7 °F)
HDT @ 264 psi	ASTM D648 Method B	140.7 °C (285.3 °F)	141.1 °C (286.0 °F)
Molded HDT @ 66 psi	ASTM D648 Method B	143.7 °C (290.7 °F)	
Molded HDT @ 264 psi	ASTM D648 Method B	142.2 °C (288.0 °F)	
Tg	ASTM D7426 Inflection Point	142.5 °C (288.6 °F)	
Mean CTE	ASTM E831 (-50 °C to 120 °C)	-	49.19 µm/[m*°C] (27.33 µin./[in.*°F])
	ASTM E831 (-50 vC to 30 °C)	51.64 µm/[m*°C] (28.69 µin./[in.*°F])	-
	ASTM E831 (30 °C to 75 °C)	35.79 µm/[m*°C] (19.88 µin./[in.*°F])	-
	ASTM E831 (75 °C to 130 °C)	11.51 µm/[m*°C] (6.394 µin./[in.*°F])	-
Volume Resistivity	ASTM D257	> 6.78*10^14 Ω*cm	
Dielectric Constant	ASTM D150 1 kHz test condition	2.66	2.84
	ASTM D150 2 MHz test condition	2.53	2.69
Dissipation Factor	ASTM D150 1 kHz test condition	-0.002	-0.002
	ASTM D150 2 MHz test condition	0.003	0.008
Thermal Conductivity	ASTM E1952 @0C	0.2802 W/m*K 0.1619 BTU/(hr*ft*F)	
	ASTM E1952 @30C	0.2845 W/m*K 0.1644 BTU/(hr*ft*F)	
	ASTM E1952 @60C	0.2902 W/m*K 0.1677 BTU/(hr*ft*F)	
	ASTM E1952 @90C	0.2888 W/m*K 0.1669 BTU/(hr*ft*F)	

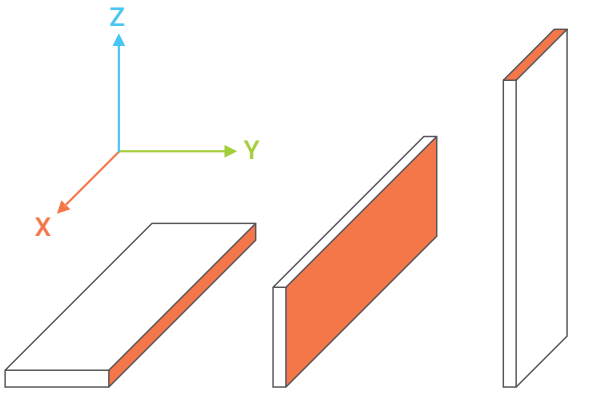
Property	Test Method	XY	ZX
Thermal Diffusivity	ASTM E1952 @0C	0.189 mm^2/s 2.93*10^-4 in.^2/s	
	ASTM E1952 @30C	0.171 mm^2/s 2.65*10^-4 in.^2/s	
	ASTM E1952 @60C	0.159 mm^2/s 2.46*10^-4 in.^2/s	
	ASTM E1952 @90C	0.146 mm^2/s 2.26*10^-4 in.^2/s	
Specific Gravity	ASTM D792 @23 °C	1.20	

Mechanical Properties

PC samples were printed with a 0.254 mm (0.010 in.) layer height on the F900. For the full test procedure please see the Stratasys Materials Test Procedure.

Print Orientation

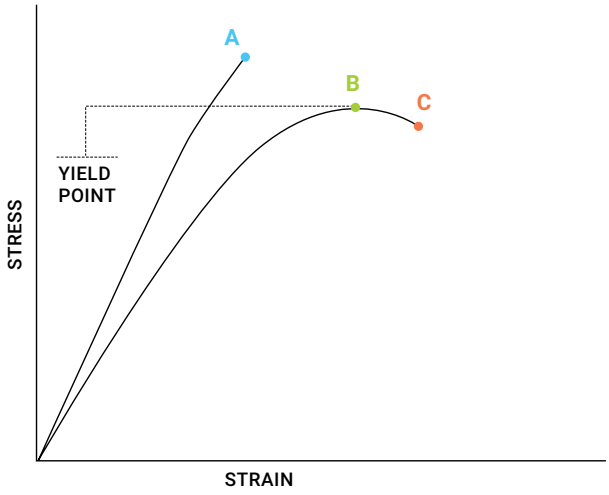
Parts created using FDM are anisotropic as a result of the printing process. Below is a reference of the different orientations used to characterize the material.



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. PC White Mechanical Properties (F900 - T16 Tip)

0.254 mm (0.010 in.) Layer Height		XZ Orientation[1]	ZX Orientation[1]
Tensile Properties: ASTM D638			
Yield Strength	MPa	93.9 (2.15)	53.1 (4.1)
	psi	13,600 (310)	7,690 (600)
Elongation @ Yield	%	4.8	1.9
Strength @ Break	MPa	54.1 (11)	52.6 (4.0)
	psi	7,850 (1,500)	7,630 (580)
Elongation @ Break	%	12	1.9
Modulus (Elastic)	GPa	2.94 (0.05)	2.88 (0.07)
	ksi	426 (7.5)	418 (11)
Flexural Properties: ASTM D790, Procedure A			
Strength @ Break	MPa	No Break	85.3 (14)
	psi		12,400 (2,100)
Strength @ 5% Strain	MPa	144 (4.6)	-
	psi	20,800 (670)	-
Strain @ Break	%	No Break	3.1
Modulus	GPa	3.43 (0.09)	2.80 (0.06)
	ksi	498 (13)	405 (9.2)
Compression Properties: ASTM D695			
Yield Strength	MPa	106 (3.3)	106 (3.1)
	psi	15,400 (480)	15,400 (440)
Modulus	GPa	2.60 (0.04)	2.56 (0.03)
	ksi	377 (6.0)	371 (4.5)
Impact Properties: ASTM D256, ASTM D4812			
Notched	J/m	45.8 (5.9)	30.7 (4.4)
	ft*lb/in.	0.858 (0.11)	0.575 (0.08)
Unnotched	J/m	1,930 (950)	143.2 (32)
	ft*lb/in.	36.2 (18)	2.68 (0.61)

[1] Values in parentheses are standard deviations.

UV Aging

PC coupons were built on the Stratasys F900 with a 0.254 mm (0.010 in.) layer height using PC White. PC was tested before and after UV exposure. Ten ASTM D638 upright (ZX) dogbones were tested in tensile after UV exposure and an additional ten 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 Operating Fluorescent UV Light Apparatus for Exposure of Nonmetallic Materials) for 1,000 hours, alternating for eight hours at 60 ˚C (140 ˚F) and 4 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 5. PC 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)
PC	No UV Exposure	6,370	43.9	5,940	40.9	3.0	-	258	1.78
	UV Exposure	4,230	29.2	4,200	29.0	1.6	-29.2%	289	1.99

Fire Protection for Devices and Appliances UL 94

Samples of PC White were 3D printed on a Stratasys F900 printer with a 0.254 mm (0.010 in.) layer height with default settings and tested per UL 94 flammability standards. The results showed that PC achieved an HB rating for samples printed at a thickness of 3mm as per UL 94 - Section 7.

Table 6: PC UL 94 Flammability Test Results

Material	Test	Thickness (mm)	Orientation	Classification
PC	Horizontal	3	XZ	HB
			ZX	

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 printer. For test procedures refer to the Stratasys Materials Test Report

Table 7. Mechanical Properties of PC Black, Fortus 450mc, T16

0.254 mm (0.010 in.) Layer Height		XZ Orientation[1]	ZX Orientation[1]
Tensile Properties: ASTM D638			
Yield Strength	MPa	64.6 (0.44)	43 (5.1)
	psi	9,370 (63)	6,230 (740)
Elongation @ Yield	%	5.3 (0.040)	2.4 (0.36)
Strength @ Break	MPa	61.0 (2.3)	44.5 (5.8)
	psi	8,840 (340)	6,460 (840)
Elongation @ Break	%	6.4 (0.58)	2.5 (0.39)
Modulus (Elastic)	GPa	1.93 (0.018)	2.01 (0.034)
	ksi	280 (2.6)	291 (4.9)

Values in parentheses are standard deviations.

Table 8. Mechanical Properties of PC Red, Fortus 450mc, T16

0.254 mm (0.010 in.) Layer Height		XZ Orientation[1]	ZX Orientation[1]
Tensile Properties: ASTM D638			
Yield Strength	MPa	62.5 (0.67)	37.1 (2.3)
	psi	9,060 (98)	5,380 (330)
Elongation @ Yield	%	4.8 (0.2)	1.9 (0.13)
Strength @ Break	MPa	61.7 (0.97)	36.9 (2.4)
	psi	8,950 (140)	5,350 (350)
Elongation @ Break	%	4.9 (0.24)	1.9 (0.13)
Modulus (Elastic)	GPa	1.95 (0.021)	2.07 (0.024)
	ksi	282 (3.0)	301 (3.5)

[1] Values in parentheses are standard deviations.

Table 9. Mechanical Properties of PC Red, F900, T16

0.254 mm (0.010 in.) Layer Height		XZ Orientation[1]	ZX Orientation[1]
Tensile Properties: ASTM D638			
Yield Strength	MPa	62.3 (0.46)	45.3 (4.9)
	psi	9,040 (67)	6,570 (700)
Elongation @ Yield	%	5.5 (0.07)	2.8 (0.41)
Strength @ Break	MPa	54.4 (2.4)	45.3 (4.9)
	psi	7,900 (340)	6,570 (700)
Elongation @ Break	%	7.6 (0.67)	2.8 (0.41)
Modulus (Elastic)	GPa	1.92 (0.026)	1.91 (0.036)
	ksi	278 (3.8)	277 (5.2)

[1] Values in parentheses are standard deviations.

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

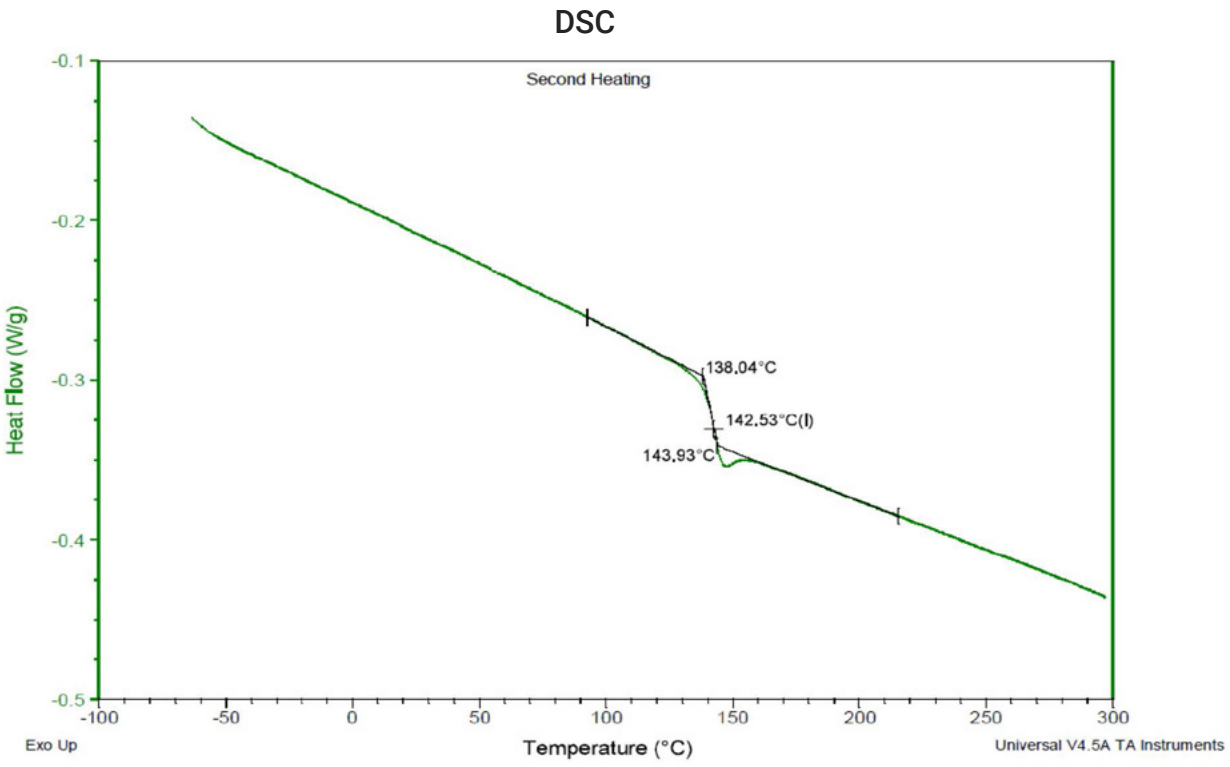


Figure 2. Dimension change data as a function of temperature for the PC Flat (XY) sample.

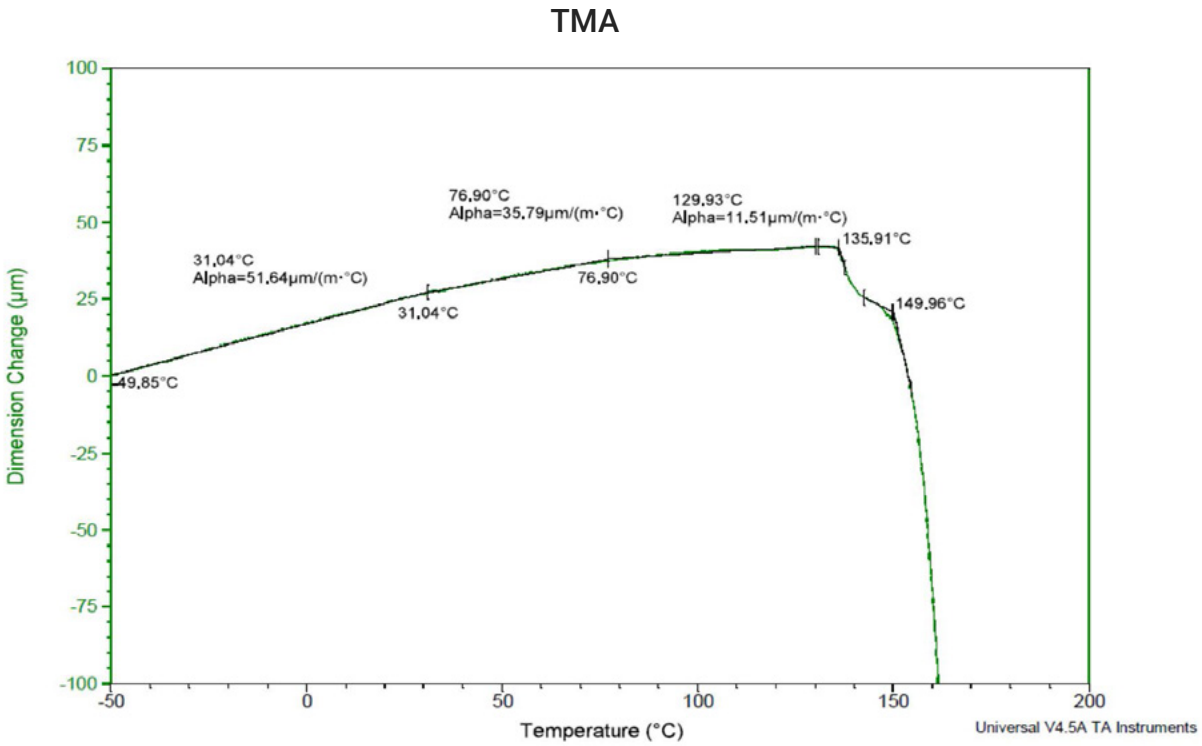


Figure 3. Dimension change data as a function of temperature for the PC On Edge (XZ) sample.Flat (XY) sample.

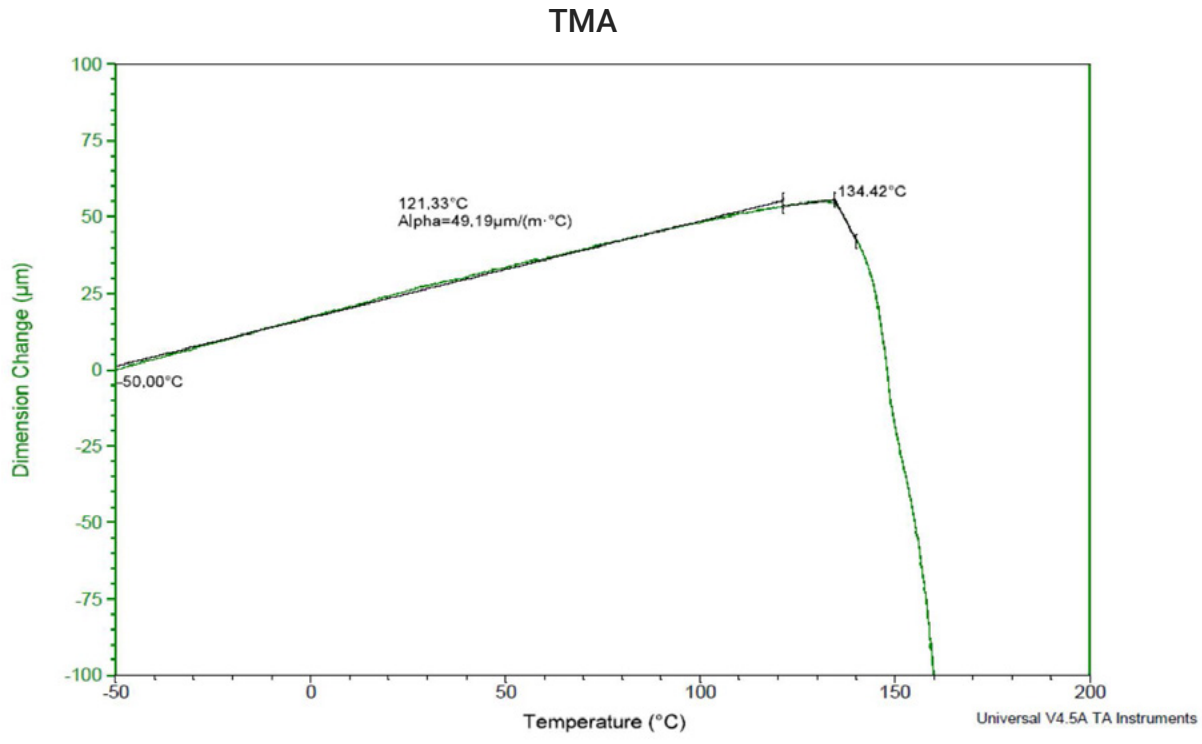
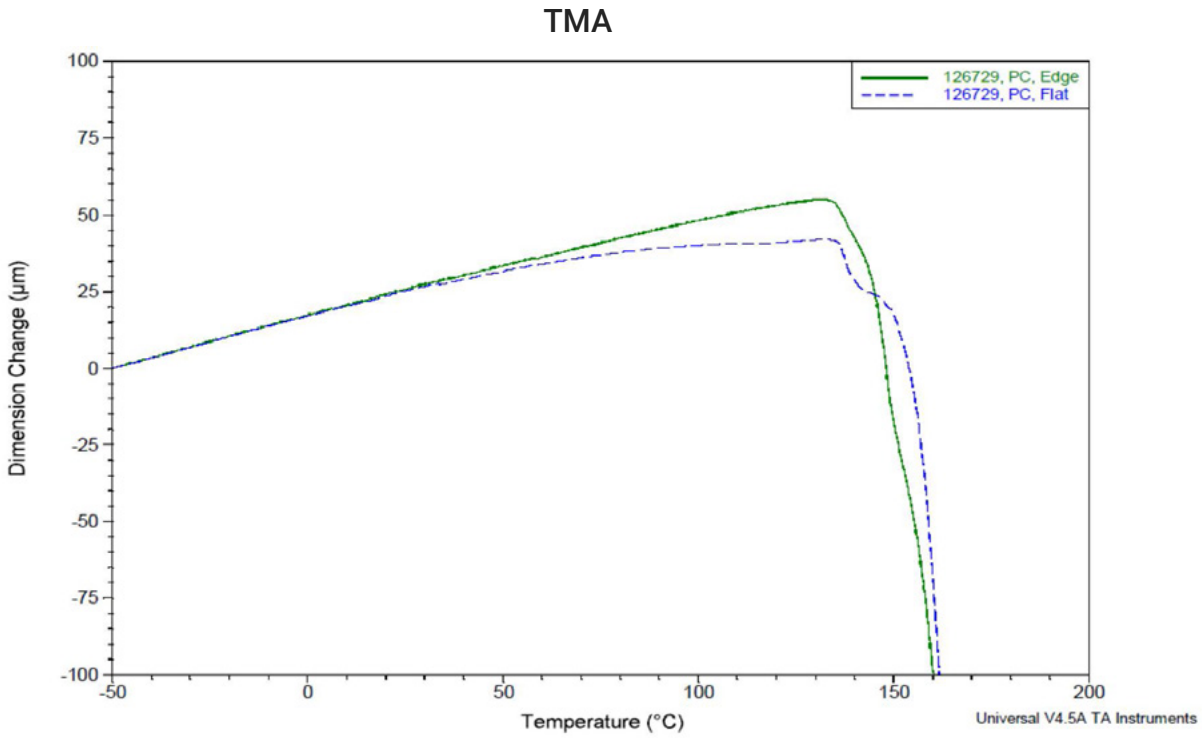


Figure 4. Overlay of the dimension change data for the Flat (XY) and On Edge (XZ) PC samples.



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