UltiMaker PET CF

Technical data sheet

General overview

Chemical composition	See UltiMaker PET CF safety data sheet, section 3
Description	UltiMaker PET CF is a composite material that is much easier to print than other carbon fiber-based materials while still retaining excellent performance properties. These can be further enhanced by annealing your printed part to greatly improve the strength, stiffness, thermal, and chemical resistance of your finished model.
Key features	PET CF is easier to print than most composites. It is more resistant to moisture and when kept in an UltiMaker Material Station, it should remain dry. Unlike other composite materials, PET CF is also available in multiple colors: black, blue, and gray. PET CF is compatible with UltiMaker support materials (PVA and Breakaway) giving full geometric freedom when designing parts. Finally, parts printed with PET CF can be annealed to improve their temperature resistance from 80 °C to a phenomenal 181 °C, as well as increasing their strength by 30% and stiffness by 10%. All of this can be done using the recommended and validated BINDER FP115 programmable oven.
Applications	Functional prototyping, tooling, manufacturing aids
Non-suitable for	In vivo parts applications. Applications where the printed parts are exposed to temperatures higher than 76°C or the annealed printed parts are exposed to temperatures higher than 181°C.

Filament specifications

	Method (standard)	**Value**
Diameter	-	2.85 +/- 0.1 mm
Max. roundness deviation	-	0.1 mm
Net filament weight	-	750 g
Filament length	-	~85 m

Color information

Color	**Color code**
Black	RAL 9017
Blue	RAL 5009
Gray	RAL 7042

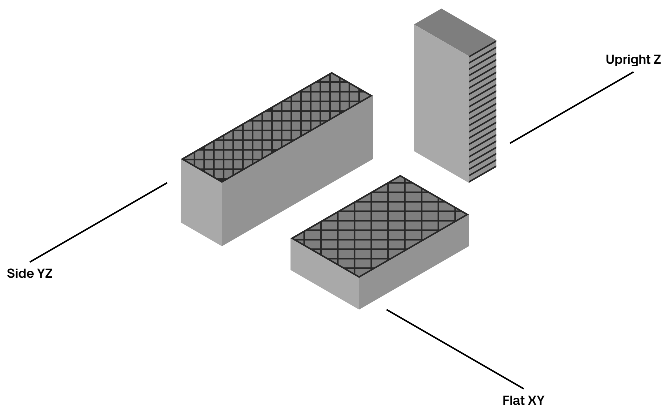
Mechanical properties

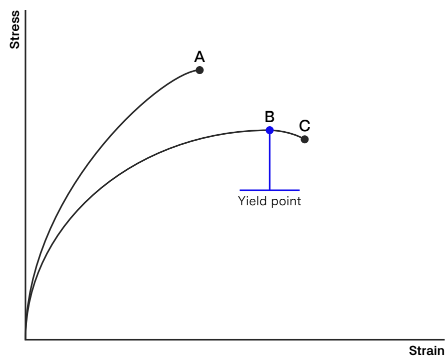
All samples where 3D printed, see notes section.

	Test Method	Typical value XY (flat)	Typical value YZ (side)	Typical value Z (up)
Tensile (Young's) modulus	ASTM D3039 (1 mm / min)	4342 ± 89 MPa	8568 ± 130 Mpa	2230 ± 102 MPa
Tensile stress at yield	ASTM D3039 (5 mm / min)	50.6 ± 0.6 MPa	75.2 ± 0.8 MPa	-
Tensile stress at break	ASTM D3039 (5 mm / min)	49.3 ± 0.6 MPa	72.3 ± 1.0 MPa	17.8 ± 1.2 MPa
Elongation at yield	ASTM D3039 (5 mm / min)	3.9 ± 0.1%	3.5 ± 0.1%	-
Elongation at break	ASTM D3039 (5 mm / min)	5.5 ± 0.6%	5.9 ± 1.3%	1.3 ± 0.1%
Flexural modulus	ISO 178 (1 mm / min)	5743 ± 150 MPa	7667 ± 90 MPa	2675 ± 33 MPa
Flexural strength	ISO 178 (5 mm / min)	102.8 ± 2.6 MPa at 4.4% strain	122.3 ± 2.2 MPa at 4.0% strain	41.9 ± 3.2 MPa at 1.5% strain
Flexural strain at break	ISO 178 (5 mm / min)	No break (>10%)	No break (> 10%)	1.5 ± 0.1%
Charpy impact strenght (at 23 °C)	ISO 179-1 / 1eB (notched)	8.6 ± 0.5 kJ/m²		
Hardness	ISO 7619-1 (Durometer, Shore D)	76 Shore D		

Mechanical properties (annealed)

	Test Method	Typical value XY (flat)	Typical value YZ (side)	Typical value Z (up)
Tensile (Young's) modulus	ASTM D3039 (1 mm / min)	5530 ± 124 MPa	9810 ± 208 MPa	2655 ± 130 MPa
Tensile stress at yield	ASTM D3039 (5 mm / min)	-	-	-
Tensile stress at break	ASTM D3039 (5 mm / min)	72.8 ± 2.0 MPa	104 ± 2.0 MPa	18.2 ± 1.8 MPa
Elongation at yield	ASTM D3039 (5 mm / min)	-	-	-
Elongation at break	ASTM D3039 (5 mm / min)	3.4 ± 0.2 %	3.4 ± 0.2%	1.0 ± 0.1 %
Flexural modulus	ISO 178 (1 mm / min)	6280 ± 114 Mpa	8691 ± 96 MPa	2913 ± 58 MPa
Flexural strength	ISO 178 (5 mm / min)	136.6 ± 2.8 MPa at 2.9% strain	170.4 ± 1.3 MPa at 2.8% strain	44.3 ± 4.9 MPa at 1.5% strain
Flexural strain at break	ISO 178 (5 mm / min)	3.0 ± 0.1 %	2.8 ± 0.1 %	1.5 ± 0.1 %
Charpy impact strenght (at 23 °C)	ISO 179-1 / 1eB (notched)	5.3 ± 0.9 kJ/m²		
Hardness	ISO 7619-1 (Durometer, Shore D)	81 Shore D		





A. Tensile stress at break, elongation at break (no yield point)
B. Tensile stress at yield, elongation at yield
C. Tensile stress at break. elongation at break

Print orientation

As the FFF process produces part in a layered structure, mechanical properties of the part vary depending on orientation of the part. In-plane there are differences between walls (following the contours of the part) and infill (layer of 45° lines). These differences can be seen in the the data for XY (printed flat on the build plate - mostly infill) and YZ (printed on its side - mostly walls). Additionally, the upright samples (Z direction) give information on the strength of the interlayer adhesion of the material. Typically the interlayer strength (Z) has the lowest strength in FFF. Note: All samples are printed with 100% infill - black lines in the ilustration indicate typical directionality of infill and walls in a printed part.

Tensile properties

Printed parts can yield before they break, where the material is deforming (necking) before it breaks completely. When this is the case, both the yield and break points will be reported. Typical materials that yield before breaking are materials with high toughness like Tough PLA, Nylon and CPE+. If the material simply breaks without yielding, only the break point will be reported. This is the case for brittle materials like PLA and PC Transparant, as well as elastomers (like TPU).

Thermal properties

	Test Method	Typical value
Melt mass-flow rate (MFR)	ISO 1133 (280 °C, 2.16 kg)	2.6 g / 10 min
Heat Deflection(HDT) at 0.455 MPa*	ISO 75-2 / B	76.0 °C (non-annealed) / 181.0 °C (annealed)
Vicat softening temperature*	ISO 306 / A120	92.0 °C (non-annealed) / > 235 °C (annealed)
Glass transition	ISO 11357 (DSC, 10 °C/min)	78 °C
Melting temperature	ISO 11357 (DSC, 10 °C/min)	222.3 °C

Other properties

	Test Method	Typical value
Density	ISO 1183-1	Black 1.33 g/cm³ Blue 1.39 g/cm³ Gray 1.45 g/cm³

Notes

*3D Printing: all samples were printed using a new spool of material loaded in an UltiMaker S7 with Material Station with normal intent profiles using 0.15 mm layer height with CC0.6 printcore and 100% infill, using UltiMaker Cura 5.3. Samples were printed 'one-at-a-time'. Printed samples were conditioned in room temperature for at least 24h before measuring.

Specimen dimensions (L x W x H):

- Tensile test: 215 x 20 x 4 mm
- Flexural/Vicat/HDT: 80 x 10 x 4 mm
- Charpy: 80 x 10 x 4 mm with printed Notch (Type 1eB)

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