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Ultrafuse® PLA Tough

tough | impact resistant | strong

Extended TDS

Complete Technical Documentation and Testing Summary

Version 1.2

Contents

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Technical Data Sheet

Ultrafuse® PLA Tough is a highly versatile biocompatible and biobased material specially developed for the needs of professional users.

Filament Properties		
Filament Diameter	1.75 m	2.85 mm
Diameter Tolerance	±0.050 mm	±0.1 mm
Average ovality	<0.050 mm	<0.050 mm
Available Spool size	750 g, 2.0 kg, 4.0 kg, 8.0 kg	750 g, 2.0 kg, 4.0 kg, 8.0 kg
Available colors:		
	Natural	N.A.
	Black	RAL ca. 9005
	Grey	RAL ca. 7045

Spool Properties					
Spool size	750 g	750 g New Spool	2.0 kg	4.0 kg	8.0 kg
Outer diameter	200 mm	200 mm	300 mm	350 mm	355 mm
Inner diameter	50.5 mm	52 mm	51.5 mm	51.7 mm	36 mm
Width	55 mm	68 mm	103 mm	103 mm	167 mm

Recommended 3D-Print processing parameters		Used for test specimens
Printer	FFF printer	Ultimaker S5
Nozzle Temperature[1)]	200 – 220 °C / 392 – 428 °F	220 °C / 428 °F
Build Chamber Temperature	-	Indirect heating (cover)
Bed Temperature	50 – 70 °C / 122 – 158 °F	60 °C / 140 °F
Bed Material	Glass	Glass
Nozzle Diameter	≥ 0.4 mm	0.4 mm
Print Speed	40 – 300 mm/s1	40 mm/s

[1] Fast printing might require an additional increase of the nozzle temperature; the stated printing speed is based on current validations. As equipment and technology continues to evolve, it is possible that even higher printing speeds may be attainable in the future.

Max Volumetric Speed[2)]	21 mm^3/s	//

Please check your standard and/or high speed print profile availability for an easy start at www.forward-am.com.

Annealing Recommendations for Performance Enhancement		
Equipment	Use an oven which can heat up to ~120°C.	
Part preparation	Place the parts inside the oven. Fix larger parts to avoid potential deformation during the annealing process.	
Annealing Process[3)]	Heating	From room temperature to 120°C / 248 °F in ~15 min (ramp up time).
	Holding the temperature	120°C / 248 °F for 30 min (thicker parts might require a longer time).
	Cooling	From 120°C / 248 °F to room temperature in ~15 min (ramp down time).

Further Recommendations	
Drying recommendations to ensure printability and best mechanical properties[4)]	Ultrafuse® PLA Tough is in a printable condition, drying is not necessary.
Support material compatibility	Single material breakaway, Ultrafuse® BVOH
Warehousing	Ultrafuse® PLA Tough filament should be stored at 15 - 25°C in its originally sealed package in a clean and dry environment. If the recommended storage conditions are observed the products will have a minimum shelf life of 12 months.

General Properties	Standard	Average Values
Filament Density[5)]	ISO 1183-1	1215 kg/m^3

[2] Based on Bambu Lab X1C with a nozzle diameter of 0.4 mm
[3] The annealing process can lead to a minor deviation in the dimensional accuracy. It is observed for the cross section of DIN EN ISO 527 Type 1A tensile bars minor deviation of up to +2% in thickness (nominal value 4 mm) and -1% in width (nominal value 10 mm).
[4] Please note: To ensure constant material properties the material should always be kept dry.
[5] measured on filament

Tensile Properties[6]	Standard	Average Values		
		XY-Direction	XZ-Direction	ZX-Direction
Tensile strength[7]	ISO 527	40 MPa	-	28 MPa
Elongation at Break[7]	ISO 527	7.4%	-	2.5%
Young's Modulus[8]	ISO 527	2672 MPa	-	2576 MPa

Flexural Properties[6] [9]	Standard	Average Values		
		XY-Direction	XZ-Direction	ZX-Direction
Flexural Strength	ISO 178	73 MPa	75 MPa	51 MPa
Flexural Modulus	ISO 178	2690 MPa	2410 MPa	2390 MPa
Flexural Elongation at Break	ISO 178	No break	No break	3.1%

Impact Properties[6]	Standard	Average Values		
		XY-Direction	XZ-Direction	ZX-Direction
Impact Strength Charpy (notched)	ISO 179-2	18.0 kJ/m²	8.6 kJ/m²	2.5 kJ/m²
Impact Strength Charpy (unnotched)	ISO 179-2	33.0 kJ/m²	34.0 kJ/m²	10.0 kJ/m²
Impact Strength Izod (notched)	ISO 180	18.0 J/m	7.1 J/m	2.4 J/m
Impact Strength Izod (unnotched)	ISO 180	28.0 J/m	27.0 J/m	10.0 J/m

For the diagrams on mechanical properties see Chapter: Mechanical Properties Diagrams

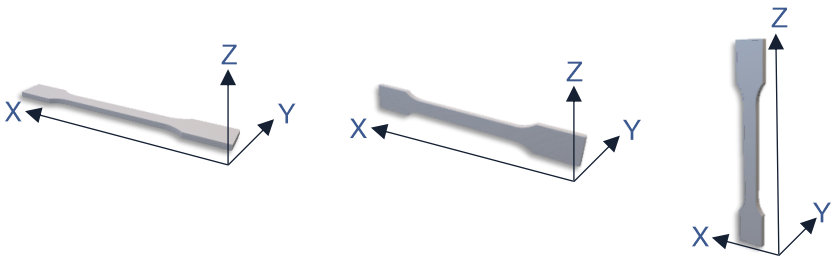
[6] Samples were conditioned in standard climate (23°C, 50% RH 72h)
[7] Testing speed: 5
[8] Testing speed: 1 mm/min
[9] Testing speed: 2 mm/min

Thermal Properties[6)]	Standard	Average Values
HDT A at 1.8 MPa	ISO 75-2	55 °C
HDT A at 1.8 MPa (annealed)	ISO 75-2	65 °C
HDT B at 0.45 MPa	ISO 75-2	57 °C
HDT B at 0.45 MPa (annealed)	ISO 75-2	94 °C
Vicat softening point at 50 N	ISO 306	59 °C
Vicat softening point at 50 N (annealed)	ISO 306	86 °C
Vicat softening point at 10 N	ISO 306	61 °C
Vicat softening point at 10 N (annealed)	ISO 306	157 °C
Glass Transition Temperature	ISO 11357-2	62 °C
Melting Temperature	ISO 11357-3	172 °C
Melt Volume-Flow Rate (MVR)	ISO 1133	5.31 cm^3/10 min (210 °C, 2.16 kg)
Melt Mass-Flow Rate (MFR)	ISO 1133	5.68 g/10 min (210 °C, 2.16 kg)
Coefficient of Thermal Expansion	ISO 11359-2	55 °C

For the diagrams on thermal properties see Chapter: Thermal Properties Diagrams.

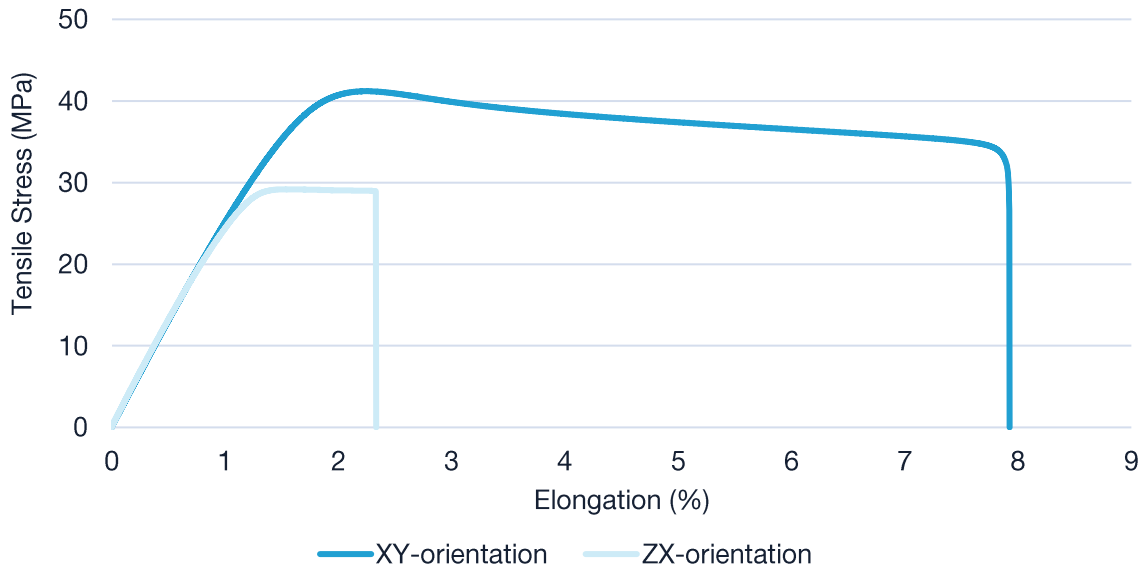
Print direction explanation

The orientation of the 3D printed part in the printer is always aligned with the longest axis first. The print direction is consistently along the Z-axis.



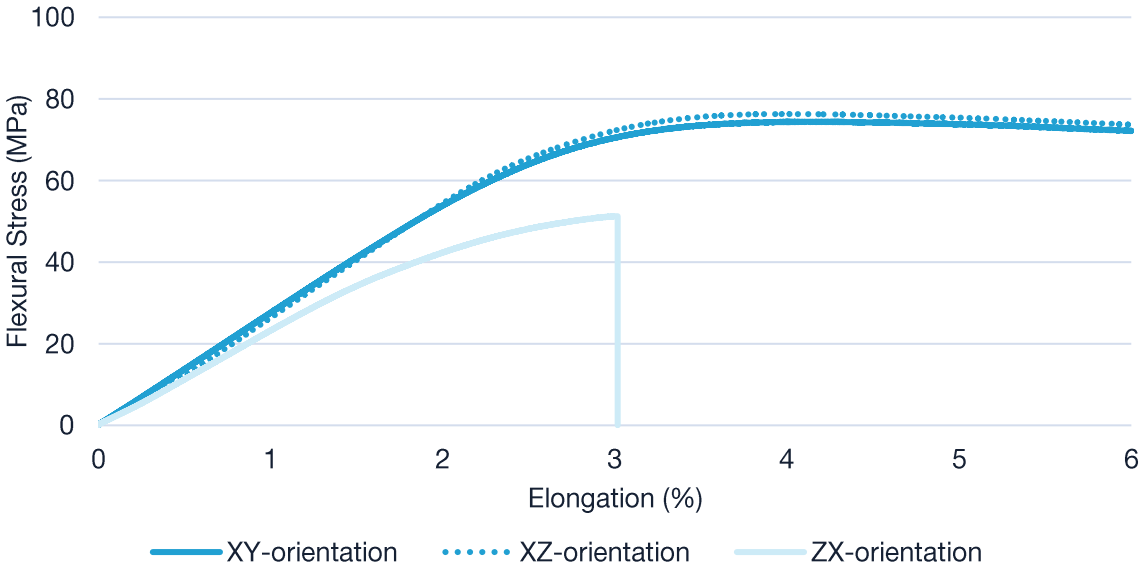
Mechanical Propertie Diagrams

Tensile Strength



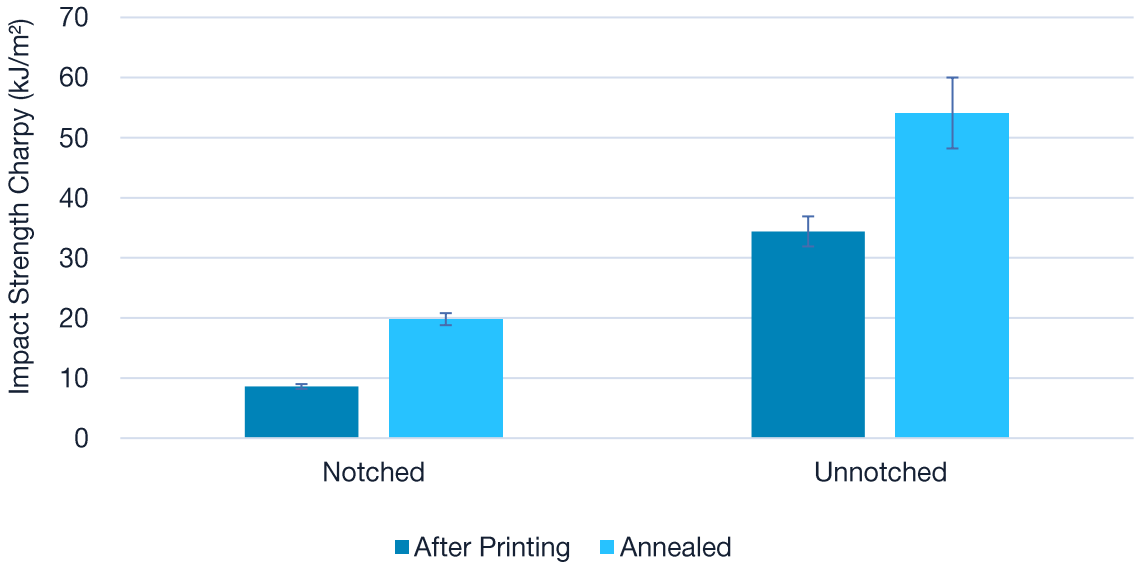
Typical Tensile Stress-Strain curves for the XY and ZX print orientation.

Flexural Strength



Typical Flexural Stress-Strain curves for the XY and ZX print orientation.

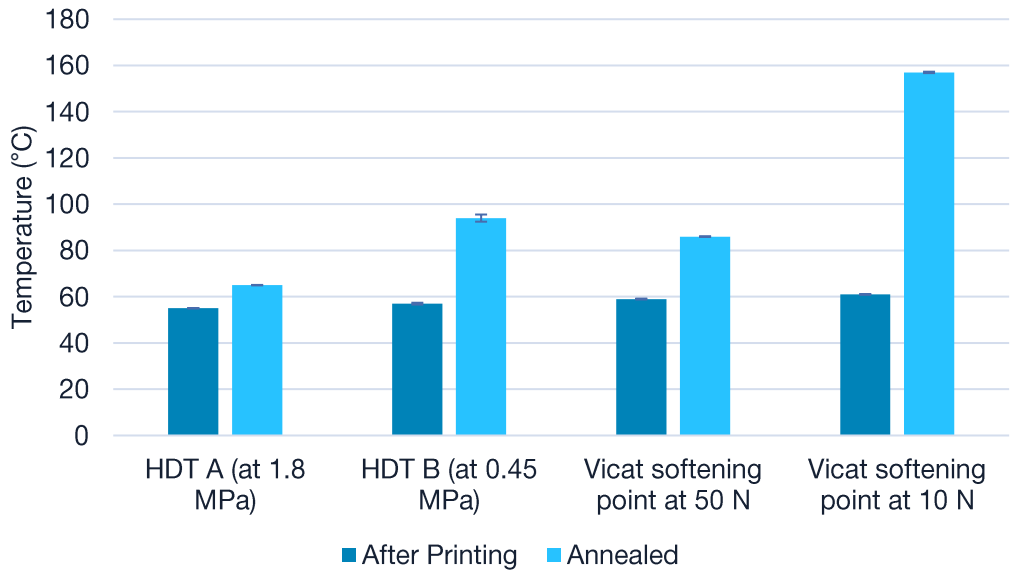
Impact Strength



Impact Strength Charpy after printing vs. annealed (Printed in XZ-orientation).

Thermal Properties Diagrams

HDT & Vicat Softening point



Heat resistance of the material after printing and annealed

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