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SOLUTIONS FOR A 3D WORLD®

MATERIAL DATA SHEET
FDM

FDM
TPU 92A

Overview

FDM® TPU 92A is a thermoplastic polyurethane with a Shore A value of 92. The material exhibits high elongation, superior toughness, durability and abrasion resistance. FDM TPU 92A brings the benefits of elastomers to the F123 and F123CR Series FDM 3D printers and offers the capability to quickly produce large and complex elastomer parts. The available colors are Black (Preferred Material) and Red (Validated Material).

Typical applications include flexible hoses, tubes, air ducts, seals, protective covers and vibration dampeners.

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Product Information

Table 1: Printer and Support Material Capability

Printer	Model Tip	Layer Height	Support Material	Support Tip
F170™	F123 Series Elastomer Extrusion Head (blue cover)	0.178 mm (0.007 in.)[1] 0.254 mm (0.010 in.)	QSR™ Support (soluble)	F123 Standard Head (black cover)
F190™CR	F123 Series Elastomer Extrusion Head (blue cover)	0.178 mm (0.007 in.)[1] 0.254 mm (0.010 in.)	QSR™ Support (soluble)	F123 Standard Head (black cover)
F370™	F123 Series Elastomer Extrusion Head (blue cover)	0.178 mm (0.007 in.)[1] 0.254 mm (0.010 in.)	QSR™ Support (soluble)	F123 Standard Head (black cover)
F370®CR	F123 Series Elastomer Extrusion Head (blue cover)	0.178 mm (0.007 in.)[1] 0.254 mm (0.010 in.)	QSR™ Support (soluble)	F123 Standard Head (black cover)

Support Material

- QSR soluble support

Build Tray

- F170 build tray
- F190CR build tray
- F370/F370CR build tray

Colors

- Black (Preferred Material)
- Red (Validated Material)

System Requirements[2]

F123/F123CR

- F123 Series Elastomer Extrusion Head (blue cover, 750 hour head life)
- F123 Series Standard Head (black cover, used for support, 1,500 hour head life)

Table 2: FDM TPU 92A Ordering Information

Part Number	Description	System Compatibility
Filament Consumables		
F123/F123CR Series Spools		
333-60201	F123 TPU 92A Black, 60 cu. in.	F170, F190CR, F370, F370CR
333-70001	F123 TPU 92A Red, 60 cu. in.	
333-63500	QSR Soluble Support, 60 cu. in. - F123	
Printer Consumables		
F123/F123CR Series		
123-00302-S	F170 Build Tray, Standard	F170
123-00303-S	F190CR Build Tray, Standard	F190CR
123-00304	F370/F370CR Build Tray, Standard	F370, F370CR
Print Heads		
F123/F123CR Series		
123-00321-S	F123 Elastomer Extrusion Head (blue cover)	F170, F190CR, F370, F370CR
123-00402-S	Standard Extrusion Head (black cover)	

[1] Only available with TPU 92A Black

[2] Contact your Stratasys representative for ordering information

Physical Properties

Values are measured as printed. XY, XZ, and ZX orientations were tested. For full details refer to the Stratasys Materials Test Report. DSC and TMA curves can be found in the Appendix.

Table 3: FDM TPU 92A Black Physical Properties

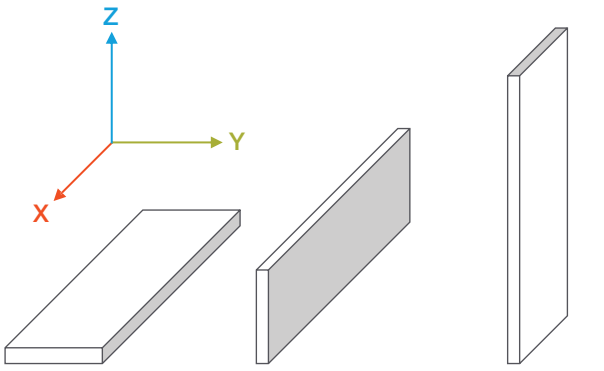
Property	Test Method	Typical Values	
		XY	XZ/ZX
Shore Hardness (molded)	ASTM D2240	92 Shore A	
HDT @ 66 psi (molded)	ASTM D648 Method B	38 °C (100.4 °F)	
HDT @ 15 psi (molded)	ASTM D648 Method B	56 °C (132.8 °F)	
Tg	ASTM D7426 Inflection Point	-42 °C (-43.6 °F)	
CTE (X-direction)	ASTM E831	139 µm/(m*°C) $7.72*10^{-5}$ in/(in*°F)	
CTE (Y-direction)	ASTM E831	159 µm/(m*°C) $8.83*10^{-5}$ in/(in*°F)	
CTE (Z-direction)	ASTM E831	176 µm/(m*°C) $9.78*10^{-5}$ in/(in*°F)	
Volume Resistivity	ASTM D257	$6.09*10^{10}$ Ω*cm	$7.17*10^{13}$ Ω*cm
Vicat Softening Temperature	ASTM D1525 Rate B/50	95 °C (203 °F)	
Specific Gravity	ASTM D257 @23 °C	1.135	

Mechanical Properties

FDM TPU 92A Black samples were printed with a 0.254 mm (0.010 in.) layer height on the F370 using the F123 Elastomer Extrusion Head. For the full test procedure please see the Stratasys Materials Test Procedure.

Print Orientation

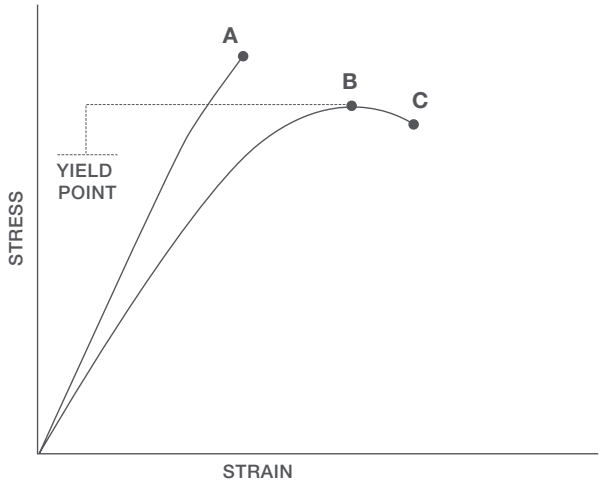
Parts created using FDM are anisotropic as a result of the printing process. Below is a reference of the different orientations used to characterize the material.



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: FDM TPU 92A Black Mechanical Properties - F370 - Elastomer Head

0.254 mm (0.010 in.) Layer Height		XY Orientation	XZ Orientation
Tensile Properties: ASTM D638			
Yield Strength	MPa	15.6	16.1
	psi	2,265	2,332
Elongation @ Yield	%	466	385
Strength @ Break	MPa	16.8	17.4
	psi	2,432	2,519
Elongation @ Break	%	552	482
Modulus (Elastic)	GPa	15.3	20.7
	ksi	2,212	3,000
Tensile Stress @ 100% Elongation	MPa	6.9	7.6
	psi	999	1,096
Tensile Stress @ 300% Elongation	MPa	11.0	11.9
	psi	1,598	1,722
Tear Properties: ASTM D624-C			
Tear Strength (Stamped)	N/mm	84.6	-
	lbf/in	483	-
Compression Properties: ASTM D395			
Compression Set - 22 Hours @ 23C	-	21%	-
Compression Set - 22 Hours @ 70C	-	44%	-

UV Aging

FDM TPU 92A Black samples were printed on the F370 using the F123 Elastomer Extrusion Head with the 0.254 mm (0.010 in.) layer height. FDM TPU 92A Black was tested before and after UV exposure. Ten ASTM D638 upright (XY) dogbones were tested in tensile after UV exposure and an additional 10 ASTM D638 XY 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 Light Apparatus for UV exposure of Nonmetallic Materials) for 1000 hours, alternating for 8 hours at 60 °C (140 °F) and 4 hours at 50 °C (122 °F) with humidity and condensation. The increase in ultimate strength is from the control samples. For more information see the Impact of UV Exposure on FDM Materials white paper.

Table 5: UV Aging of FDM TPU92A Black

Material	Conditioning	Yield Strength		Ultimate Strength		Elongation at Ultimate Strength	Increase in Ultimate Strength	Modulus	
		(psi)	(MPa)	(psi)	(MPa)	%	%	(ksi)	(GPa)
TPU 92A	No UV Exposure	2,730	18.5	2,740	18.9	512	-	3.23	0.0223
	UV Exposure	2,330	16.0	2,330	16.0	470	-15.30	3.16	0.0218

Appendix

Validated Materials - Physical Properties

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.

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

Table 6: FDM TPU 92A Red Physical Properties

Property	Test Method	Typical Values	
		XY	XZ
Shore Hardness (molded)	ASTM D2240	92 Shore A	
HDT @ 66 psi (printed)	ASTM D648 Method B	29.8 °C (84 °F)	31.8 °C (89.2 °F)
HDT @ 15 psi (printed)	ASTM D648 Method B	45.1 °C (113.2 °F)	48.9 °C (120 °F)
Tg	ASTM D7426 Inflection Point	-43 °C (-45.4 °F)	
Vicat Softening Temperature	ASTM D1525 Rate B/50	97.8 °C (208 °F)	
Specific Gravity	ASTM D257 @23 °C	1.141	

Validated Materials - Mechanical Properties

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.

FDM TPU 92A Red samples were printed with a 0.254 mm (0.010 in.) layer height on the F370 using the F123 Elastomer Extrusion Head.

Table 7: FDM TPU 92A Red Mechanical Properties - F370 - Elastomer Head

0.254 mm (0.010 in.) Layer Height		XY Orientation[1]	XZ Orientation[1]
Tensile Properties: ASTM D638			
Yield Strength	MPa	19.2 (0.37)	18.8 (0.78)
	psi	2,780 (54)	2,730 (110)
Elongation @ Yield	%	16 (0.61)	560 (39)
Strength @ Break	MPa	19.2 (0.37)	18.7 (0.86)
	psi	2,780 (54)	2,710 (120)
Elongation @ Break	%	560 (27)	570 (43)
Modulus (Elastic)	GPa	0.02 (0.00053)	0.0184 (0.0014)
	ksi	2.9 (0.077)	2.66 (0.21)
Tensile Stress @ 100% Elongation	MPa	8,088	8,343
	psi	1,173	1,210
Tensile Stress @ 300% Elongation	MPa	12.60	12.58
	psi	1,827	1,825
Tear Properties: ASTM D624-C			
Tear Strength (Stamped)	N/mm	99.59 (2.13)	-
	lbf/in	568.7 (12.17)	-
Compression Properties: ASTM D395			
Compression Set - 22 Hours @ 23 °C	-	19%	18%
Compression Set - 22 Hours @ 70 °C	-	57%	60%

[1] Values in parenthesis are standard deviations.