formlabs

MATERIALS LIBRARY

Industry-leading materials to tackle any application

2025 VERSION

formlabs

MATERIALS LIBRARY

Industry-leading materials to tackle any application

If there are any other tests that you want us to consider for future versions of a material's technical data sheet, please fill out this survey form. For specific questions about how to evaluate the fit of the current material for your application, please reach out to the sales and support teams at Formlabs.

2025 VERSION

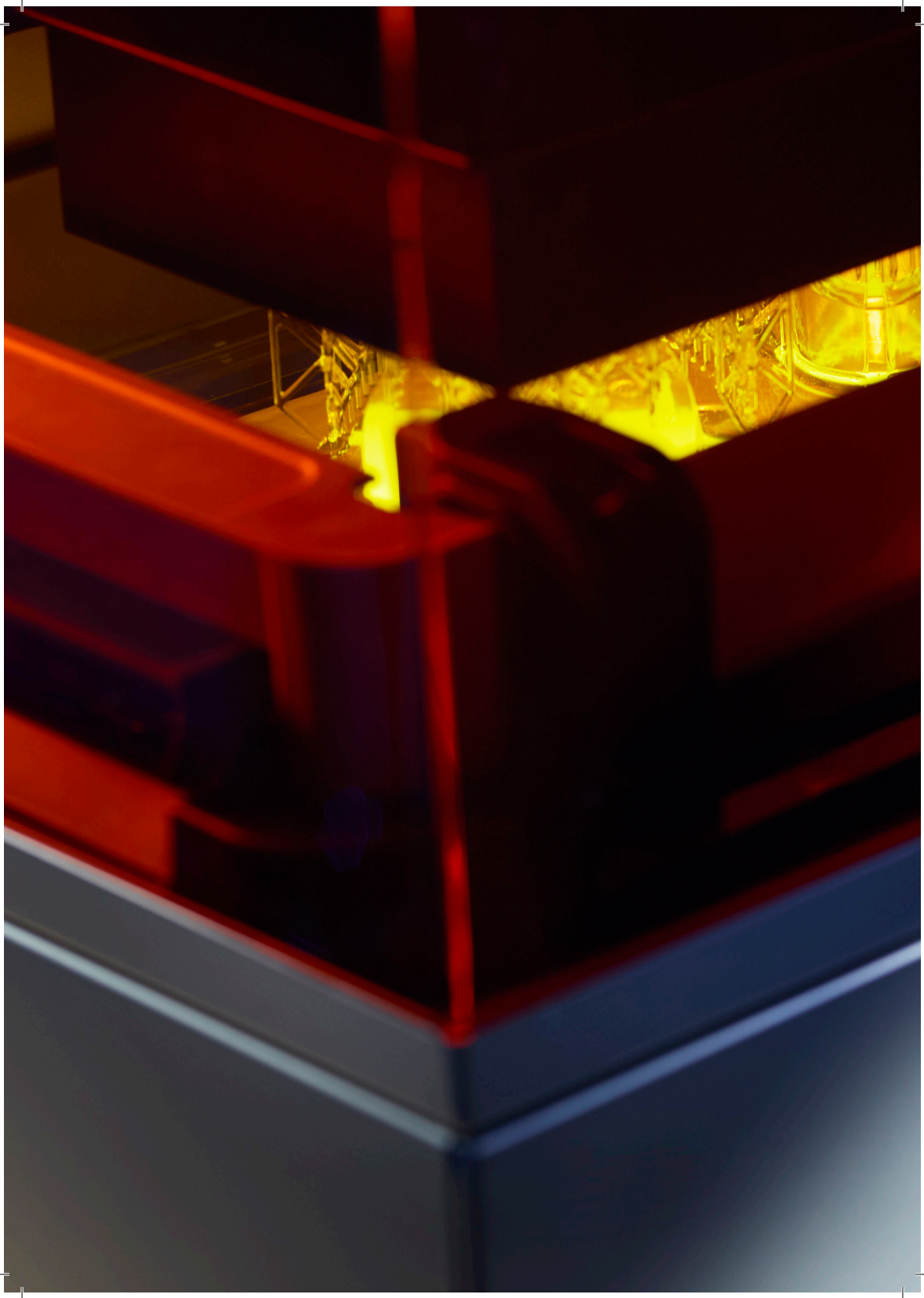
This document is updated annually. Please check Formlabs.com for the latest product information.

SLA MATERIALS

GENERAL PURPOSE RESINS

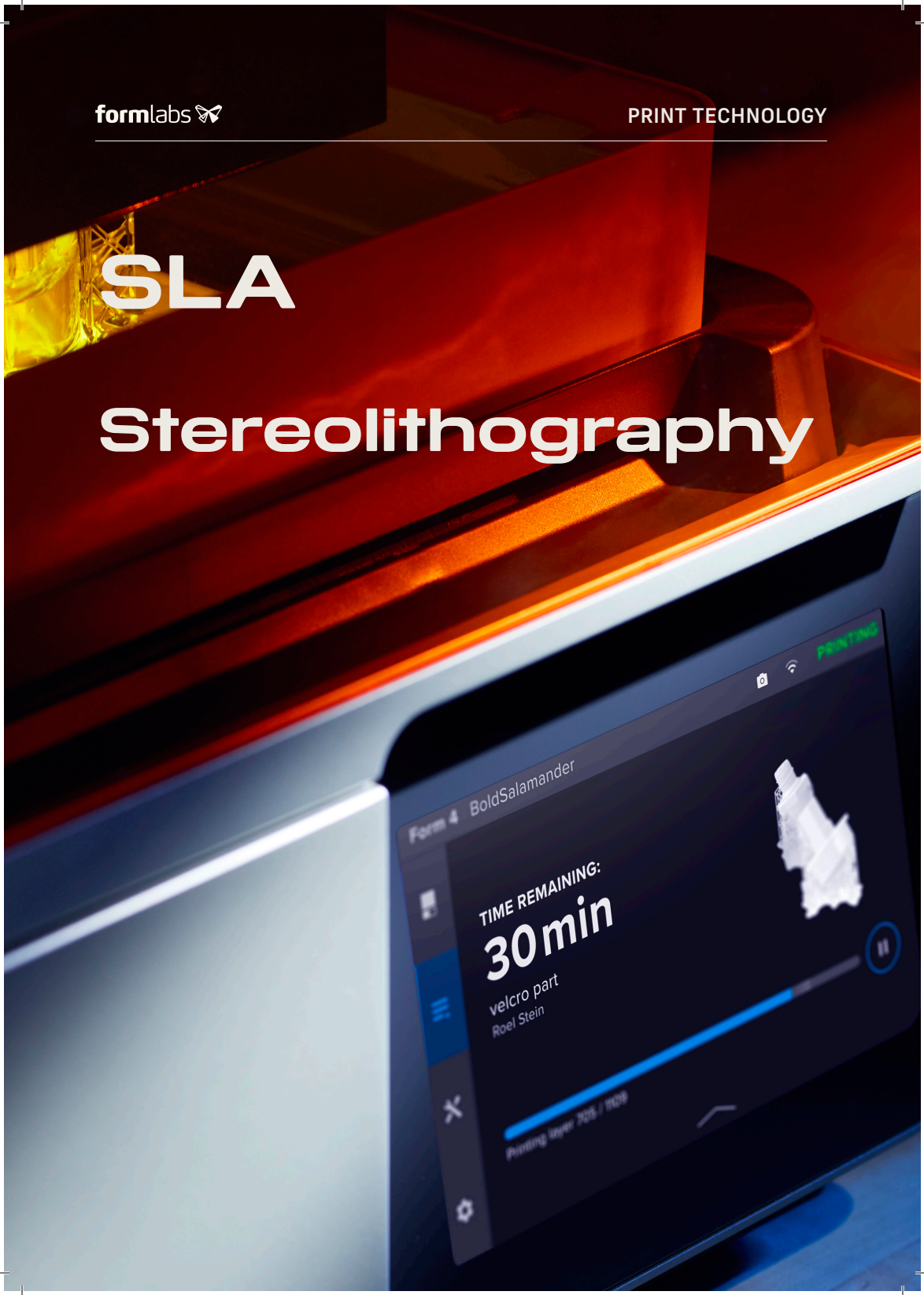
ENGINEERING RESINS

DENTAL RESINS



SLA

Stereolithography



formlabs

GENERAL PURPOSE RESIN

Clear Resin V5

An optimally-balanced Clear Resin for transparent applications

Clear Resin V5 is an exceptionally clear and color-neutral General Purpose Resin, offering an optimal balance of fast print speed, high dimensional accuracy, and presentation-ready appearance.

Clear Resin V5 creates highly transparent and colorless parts that can be polished to near optical transparency. Create parts that are stiff and strong with a smooth surface finish that rivals acrylic.

Clear Resin V5 is a new material formulation that leverages the Form 4 ecosystem to print three times faster than the previous version.

Transparent enclosures, optical components, and lighting prototypes

Parts showcasing internal features

Molds, masters, and other rapid tooling

Fluidic devices

V5 **FLGPCL05**

Prepared 20/03/2024

Rev. 01 20/03/2024

Material Properties	METRIC [1]			IMPERIAL [1]			METHOD
	Green	Post-Cured for 5 min at ambient temperature [2]	Post-Cured for 15 min at 60 °C [3]	Green	Post-Cured for 5 min at ambient temperature [2]	Post-Cured for 15 min at 140 °F [3]	
Tensile Properties	METRIC [1]			IMPERIAL [1]			METHOD
Ultimate Tensile Strength	46 MPa	51 MPa	60 MPa	6672 psi	7340 psi	8702 psi	ASTM D638-14
Tensile Modulus	2200 MPa	2575 MPa	2750 MPa	319 ksi	373 ksi	399 ksi	ASTM D638-14
Elongation at Break	13%	10%	8%	13%	10%	8%	ASTM D638-14
Flexural Properties	METRIC [1]			IMPERIAL [1]			METHOD
Flexural Strength	82 MPa	91 MPa	103 MPa	11893 psi	13198 psi	14938 psi	ASTM D790-15
Flexural Modulus	2000 MPa	2450 MPa	2750 MPa	290 ksi	355 ksi	399 ksi	ASTM D790-15
Impact Properties	METRIC [1]			IMPERIAL [1]			METHOD
Notched Izod	31 J/m	29 J/m		0.580 ft-lb/in	0.542 ft-lb/in		ASTM D4812-11
Thermal Properties	METRIC [1]			IMPERIAL [1]			METHOD
Heat Deflection Temp. @ 1.8 MPa	54 °C		57 °C	129 °F		135 °F	ASTM D648-16
Heat Deflection Temp. @ 0.45 MPa	61 °C		69 °C	142 °F		156 °F	ASTM D648-16

Polished Optical Properties	Post-Cured for 5 min at ambient temperature [2]	Post-Cured for 15 min at 60 °C [3]	
Transmission @ 2 mm	**85%**	**85%**	ASTM D1003-21
a* @ 2 mm	-4.02	-4.31	ASTM E1348-15
b* @ 2 mm	7.52	5.58	ASTM E1348-15
Transmission @ 10 mm	**59%**	**59%**	ASTM D1003-21
a* @ 10 mm	-4.25	-3.98	ASTM E1348-15
b* @ 10 mm	5.98	5.94	ASTM E1348-15

Transmission refers to the amount of visible light that passes through the part
a* and b* are more commonly associated with the CIELAB color space, where they denote axes for color measurement:
a* axis: Ranges from green to red, with negative values indicating green and positive values indicating red.
b* axis: Ranges from blue to yellow, with negative values indicating blue and positive values indicating yellow.

SOLVENT COMPATIBILITY

Percent weight gain over 24 hours for a printed and post-cured 1 x 1 x 1 cm cube immersed in respective solvent:

Solvent	24 hr weight gain, %	Solvent	24 hr weight gain, %	Solvent	24 hr weight gain, %
Acetic Acid 5%	0.9	Hydrogen peroxide (3%)	0.9	Sodium Hydroxide solution (0.025% PH 10)	0.8
Acetone	5.1	Isooctane (aka gasoline)	< 0.1	Strong Acid (HCl conc)	0.5
Bleach ~5% NaOCl	0.7	Isopropyl Alcohol	0.3	Tripropylene glycol monomethyl ether	0.5
Butyl Acetate	0.3	Mineral oil (Heavy)	0.2	Water	0.9
Diesel Fuel	0.1	Mineral oil (Light)	0.2	Xylene	< 0.1
Diethyl glycol Monomethyl Ether	1.1	Salt Water (3.5% NaCl)	0.8		
Hydraulic Oil	0.1	Skydrol 5	0.7		

[1] Material properties may vary based on part geometry, print orientation, print settings, temperature, and disinfection or sterilization methods used.

[2] Data was obtained from parts printed on a Form 4 printer with 100 µm Clear Resin V5 settings, washed in a Form Wash for 5 minutes in ≥99% Isopropyl Alcohol, and post-cured at room temperature for 5 minutes in a Form Cure.

[3] Data was obtained from parts printed on a Form 4 printer with 100 µm Clear Resin V5 settings, washed in a Form Wash for 5 minutes in ≥99% Isopropyl Alcohol, and post-cured at 60°C for 15 minutes in a Form Cure.

formlabs

GENERAL PURPOSE RESIN

White Resin V5

An optimally-balanced White Resin for versatile applications

White Resin V5 is an exceptionally bright white General Purpose Resin, offering an optimal balance of fast print speed, high accuracy, presentation-ready appearance, strong mechanical properties, and an easy, reliable workflow.

Create parts that are stiff and strong with a surface finish that rivals injection molding. White Resin V5 is a matte, bright white that captures fine features accurately.

White Resin V5 is a new material formulation that leverages the Form 4 ecosystem to print three times faster than the previous version.

Form and fit prototyping

Presentation-ready models with fine features and intricate details

Anatomical models

Jigs and fixtures

V5 **FLGPWH05**

Prepared 20/03/2024

Rev. 01 20/03/2024

Material Properties	METRIC [1]			IMPERIAL [1]			METHOD
	Green	Post-Cured for 5 min at ambient temperature [2]	Post-Cured for 15 min at 60 °C [3]	Green	Post-Cured for 5 min at ambient temperature [2]	Post-Cured for 15 min at 140 °F [3]	
Tensile Properties		METRIC [1]			IMPERIAL [1]		METHOD
Ultimate Tensile Strength	46 MPa	54 MPa	62 MPa	6672 psi	7832 psi	8992 psi	ASTM D638-14
Tensile Modulus	2200 MPa	2500 MPa	2675 MPa	319 ksi	363 ksi	388 ksi	ASTM D638-14
Elongation at Break	22%	15%	13%	22%	15%	13%	ASTM D638-14
Flexural Properties		METRIC [1]			IMPERIAL [1]		METHOD
Flexural Strength	82 MPa	91 MPa	103 MPa	11893 psi	13198 psi	14938 psi	ASTM D790-15
Flexural Modulus	2000 MPa	2450 MPa	2750 MPa	290 ksi	355 ksi	399 ksi	ASTM D790-15
Impact Properties		METRIC [1]			IMPERIAL [1]		METHOD
Notched Izod	36 J/m	34 J/m	32 J/m	0.673 ft-lb/in	0.636 ft-lb/in	0.598 ft-lb/in	ASTM D4812-11
Thermal Properties		METRIC [1]			IMPERIAL [1]		METHOD
Heat Deflection Temp. @ 1.8 MPa	47 °C	54 °C	59 °C	117 °F	129 °F	138 °F	ASTM D648-16
Heat Deflection Temp. @ 0.45 MPa	55 °C	62 °C	71 °C	131 °F	144 °F	160 °F	ASTM D648-16

SOLVENT COMPATIBILITY

Percent weight gain over 24 hours for a printed 1 x 1 x 1 cm cube immersed in respective solvent:

Solvent	24 hr weight gain, %	Solvent	24 hr weight gain, %
Acetic Acid 5%	0.9	Mineral oil (Heavy)	0.2
Acetone	4.9	Mineral oil (Light)	0.2
Bleach ~5% NaOCl	0.7	Salt Water (3.5% NaCl)	0.8
Butyl Acetate	0.3	Skydrol 5	0.5
Diesel Fuel	0.1	Sodium Hydroxide solution (0.025% PH 10)	0.8
Diethyl glycol Monomethyl Ether	1.0	Strong Acid (HCl conc)	0.5
Hydraulic Oil	0.2	Tripropylene glycol monomethyl ether	0.3
Hydrogen peroxide (3%)	0.9	Water	0.8
Isooctane (aka gasoline)	< 0.1	Xylene	< 0.1
Isopropyl Alcohol	0.3		

[1] Material properties may vary based on part geometry, print orientation, print settings, temperature, and disinfection or sterilization methods used.

[2] Data was obtained from parts printed on a Form 4 printer with 100 µm White Resin V5 settings, washed in a Form Wash for 5 minutes in ≥99% Isopropyl Alcohol, and post-cured at room temperature for 5 minutes in a Form Cure.

[3] Data was obtained from parts printed on a Form 4 printer with 100 µm White Resin V5 settings, washed in a Form Wash for 5 minutes in ≥99% Isopropyl Alcohol, and post-cured at 60°C for 15 minutes in a Form Cure.

formlabs

GENERAL PURPOSE RESIN

Grey Resin V5

An optimally-balanced Grey Resin for versatile applications

Grey Resin V5 is an exceptionally versatile General Purpose Resin, offering an optimal balance of fast print speed, high accuracy, presentation-ready appearance, strong mechanical properties, and an easy, reliable workflow.

Create parts that are stiff and strong with a surface finish that rivals injection molding. Grey Resin V5 has a rich, matte color that captures fine features accurately.

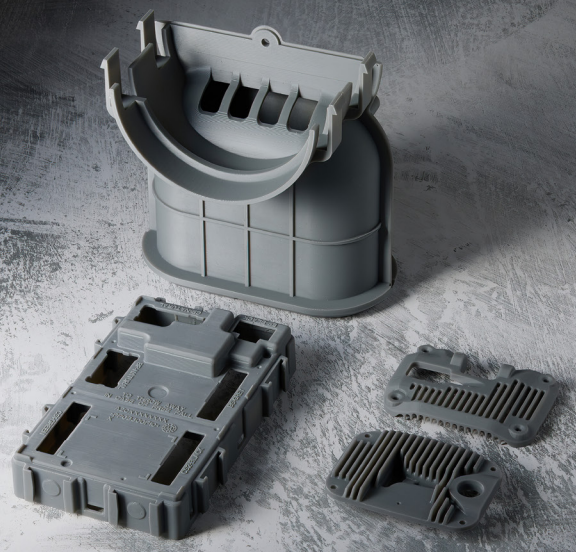
Grey Resin V5 is a new material formulation that leverages the Form 4 ecosystem to print three times faster than the previous version.

Form and fit prototyping

Presentation-ready models with fine features and intricate details

General dental models

Jigs and fixtures



V5 **FLGPGR05**

Prepared 20/03/2024

Rev. 01 20/03/2024

Material Properties	METRIC [1]			IMPERIAL [1]			METHOD
	Green	Post-Cured for 5 min at ambient temperature [2]	Post-Cured for 15 min at 60 °C [3]	Green	Post-Cured for 5 min at ambient temperature [2]	Post-Cured for 15 min at 140 °F [3]	
Tensile Properties	METRIC [1]			IMPERIAL [1]			METHOD
Ultimate Tensile Strength	46 MPa	54 MPa	62 MPa	6672 psi	7832 psi	8992 psi	ASTM D638-14
Tensile Modulus	2200 MPa	2500 MPa	2675 MPa	319 ksi	363 ksi	388 ksi	ASTM D638-14
Elongation at Break	22%	15%	13%	22%	15%	13%	ASTM D638-14
Flexural Properties	METRIC [1]			IMPERIAL [1]			METHOD
Flexural Strength	82 MPa	91 MPa	103 MPa	11893 psi	13198 psi	14938 psi	ASTM D790-15
Flexural Modulus	2000 MPa	2450 MPa	2750 MPa	290 ksi	355 ksi	399 ksi	ASTM D790-15
Impact Properties	METRIC [1]			IMPERIAL [1]			METHOD
Notched Izod	36 J/m	34 J/m	32 J/m	0.673 ft-lb/in	0.636 ft-lb/in	0.598 ft-lb/in	ASTM D4812-11
Thermal Properties	METRIC [1]			IMPERIAL [1]			METHOD
Heat Deflection Temp. @ 1.8 MPa	54 °C	54 °C	59 °C	129 °F	129 °F	138 °F	ASTM D648-16
Heat Deflection Temp. @ 0.45 MPa	62 °C	62 °C	71 °C	144 °F	144 °F	160 °F	ASTM D648-16

SOLVENT COMPATIBILITY

Percent weight gain over 24 hours for a printed and post-cured 1 x 1 x 1 cm cube immersed in respective solvent:

Solvent	24 hr weight gain, %	Solvent	24 hr weight gain, %
Acetic Acid 5%	0.9	Mineral oil (Heavy)	0.2
Acetone	4.9	Mineral oil (Light)	0.2
Bleach ~5% NaOCl	0.7	Salt Water (3.5% NaCl)	0.8
Butyl Acetate	0.3	Skydrol 5	0.5
Diesel Fuel	0.1	Sodium Hydroxide solution (0.025% PH 10)	0.8
Diethyl glycol Monomethyl Ether	1.0	Strong Acid (HCl conc)	0.5
Hydraulic Oil	0.2	Tripropylene glycol monomethyl ether	0.3
Hydrogen peroxide (3%)	0.9	Water	0.8
Isooctane (aka gasoline)	< 0.1	Xylene	< 0.1
Isopropyl Alcohol	0.3		

[1] Material properties may vary based on part geometry, print orientation, print settings, temperature, and disinfection or sterilization methods used.

[2] Data was obtained from parts printed on a Form 4 printer with 100 µm Grey Resin V5 settings, washed in a Form Wash for 5 minutes in ≥99% Isopropyl Alcohol, and post-cured at room temperature for 5 minutes in a Form Cure.

[3] Data was obtained from parts printed on a Form 4 printer with 100 µm Grey Resin V5 settings, washed in a Form Wash for 5 minutes in ≥99% Isopropyl Alcohol, and post-cured at 60°C for 15 minutes in a Form Cure.

formlabs

GENERAL PURPOSE RESIN

Black Resin V5

An optimally-balanced Black Resin for versatile applications

Black Resin V5 is an exceptionally rich, deep black General Purpose Resin, offering an optimal balance of fast print speed, high accuracy, presentation-ready appearance, strong mechanical properties, and an easy, reliable workflow.

Create parts that are stiff and strong with a surface finish that rivals injection molding. Black Resin V5 has a rich, matte color that captures fine features accurately.

Black Resin V5 is a new material formulation that leverages the Form 4 ecosystem to print three times faster than the previous version.

Form and fit prototyping

Presentation-ready models with fine features and intricate details

Enclosures and housings

Jigs and fixtures

V5 **FLGPBK05**

Prepared 20/03/2024

Rev. 01 20/03/2024

Material Properties	METRIC [1]			IMPERIAL [1]			METHOD
	Green	Post-Cured for 5 min at ambient temperature [2]	Post-Cured for 15 min at 60 °C [3]	Green	Post-Cured for 5 min at ambient temperature [2]	Post-Cured for 15 min at 140 °F [3]	
Tensile Properties	METRIC [1]			IMPERIAL [1]			METHOD
Ultimate Tensile Strength	48 MPa	57 MPa	61 MPa	6962 psi	8267 psi	8847 psi	ASTM D638-14
Tensile Modulus	2200 MPa	2450 MPa	2700 MPa	319 ksi	363 ksi	388 ksi	ASTM D638-14
Elongation at Break	19%	14%	10%	19%	14%	10%	ASTM D638-14
Flexural Properties	METRIC [1]			IMPERIAL [1]			METHOD
Flexural Strength	82 MPa	91 MPa	103 MPa	11893 psi	13198 psi	14938 psi	ASTM D790-15
Flexural Modulus	2000 MPa	2450 MPa	2750 MPa	290 ksi	355 ksi	399 ksi	ASTM D790-15
Impact Properties	METRIC [1]			IMPERIAL [1]			METHOD
Notched Izod	31 J/m	29 J/m		0.580 ft-lb/in	0.542 ft-lb/in		ASTM D4812-11
Thermal Properties	METRIC [1]			IMPERIAL [1]			METHOD
Heat Deflection Temp. @ 1.8 MPa	54 °C		57 °C	129 °F		135 °F	ASTM D648-16
Heat Deflection Temp. @ 0.45 MPa	61 °C		69 °C	142 °F		156 °F	ASTM D648-16

SOLVENT COMPATIBILITY

Percent weight gain over 24 hours for a printed and post-cured 1 x 1 x 1 cm cube immersed in respective solvent:

Solvent	24 hr weight gain, %	Solvent	24 hr weight gain, %
Acetic Acid 5%	0.9	Mineral oil (Heavy)	0.2
Acetone	4.9	Mineral oil (Light)	0.2
Bleach ~5% NaOCl	0.7	Salt Water (3.5% NaCl)	0.8
Butyl Acetate	0.3	Skydrol 5	0.5
Diesel Fuel	0.1	Sodium Hydroxide solution (0.025% PH 10)	0.8
Diethyl glycol Monomethyl Ether	1.0	Strong Acid (HCl conc)	0.5
Hydraulic Oil	0.2	Tripropylene glycol monomethyl ether	0.3
Hydrogen peroxide (3%)	0.9	Water	0.8
Isooctane (aka gasoline)	< 0.1	Xylene	< 0.1
Isopropyl Alcohol	0.3		

[1] Material properties may vary based on part geometry, print orientation, print settings, temperature, and disinfection or sterilization methods used.

[2] Data was obtained from parts printed on a Form 4 printer with 100 µm Black Resin V5 settings, washed in a Form Wash for 5 minutes in ≥99% Isopropyl Alcohol, and post-cured at room temperature for 5 minutes in a Form Cure.

[3] Data was obtained from parts printed on a Form 4 printer with 100 µm Black Resin V5 settings, washed in a Form Wash for 5 minutes in ≥99% Isopropyl Alcohol, and post-cured at 60°C for 15 minutes in a Form Cure.

formlabs

GENERAL PURPOSE RESIN

Fast Model Resin

Formlabs' fastest resin, capable of printing at speeds up to 100mm/hr

Fast Model Resin is capable of printing dental models in less than 10 minutes or large prototypes in less than 2 hours. This highly accurate resin leverages the Form 4 ecosystem to print three times faster than previous formulations of Draft Resin. Use 200 micron settings for fastest print speeds, or use 100 micron settings for more detailed models.

Initial prototypes

Rapid design iterations

Dental models for thermoforming aligners

V1 **FLFMGR01**

Prepared 20/03/2024

Rev. 01 20/03/2024

Material Properties	METRIC [1]			IMPERIAL [1]			METHOD
	Green	Post-Cured for 5 min at ambient temperature [2]	Post-Cured for 15 min at 60 °C [3]	Green	Post-Cured for 5 min at ambient temperature [2]	Post-Cured for 15 min at 140 °F [3]	
Tensile Properties	METRIC [1]			IMPERIAL [1]			METHOD
Ultimate Tensile Strength	46 MPa	55 MPa	62 MPa	6670 psi	7980 psi	8990 psi	ASTM D638-14
Tensile Modulus	2.18 GPa	2.48 GPa	2.67 GPa	320 ksi	360 ksi	390 ksi	ASTM D638-14
Elongation at Break	22%	15%	11%	22%	15%	11%	ASTM D638-14
Flexural Properties	METRIC [1]			IMPERIAL [1]			METHOD
Flexural Strength	74 MPa	98 MPa	106 MPa	10700 psi	14200 psi	15400 psi	ASTM D790-15
Flexural Modulus	1.96 GPa	2.60 GPa	2.74 GPa	280 ksi	380 ksi	400 ksi	ASTM D790-15
Impact Properties	METRIC [1]			IMPERIAL [1]			METHOD
Notched Izod	34 J/m	30 J/m	37 J/m	0.64 ft-lb/in	0.56 ft-lb/in	0.69 ft-lb/in	ASTM D4812-11
Thermal Properties	METRIC [1]			IMPERIAL [1]			METHOD
Heat Deflection Temp. @ 1.8 MPa	47 °C	49 °C	61 °C	117 °F	120 °F	142 °F	ASTM D648-16
Heat Deflection Temp. @ 0.45 MPa	55 °C	58 °C	76 °C	131 °F	136 °F	167 °F	ASTM D648-16

SOLVENT COMPATIBILITY

Percent weight gain over 24 hours for a printed and post-cured 1 x 1 x 1 cm cube immersed in respective solvent:

Solvent	24 hr weight gain, %	Solvent	24 hr weight gain, %
Acetic Acid 5%	0.6	Mineral oil (Heavy)	0.2
Acetone	8.9	Mineral oil (Light)	0.1
Bleach ~5% NaOCl	0.7	Salt Water (3.5% NaCl)	0.8
Butyl Acetate	0.5	Skydrol 5	1.0
Diesel Fuel	< 0.1	Sodium Hydroxide solution (0.025% PH 10)	0.8
Diethyl glycol Monomethyl Ether	3.1	Strong Acid (HCl conc)	0.5
Hydraulic Oil	0.2	Tripropylene glycol monomethyl ether	0.7
Hydrogen peroxide (3%)	0.9	Water	0.8
Isooctane (aka gasoline)	< 0.1	Xylene	0.2
Isopropyl Alcohol	0.8		

[1] Material properties may vary based on part geometry, print orientation, print settings, temperature, and disinfection or sterilization methods used.

[2] Data was obtained from green parts printed on a Form 4 printer with 100 µm Fast Model Resin settings, washed in a Form Wash for 5 minutes in ≥99% Isopropyl Alcohol, and air dried without post-cure.

[3] Data was obtained from parts printed on a Form 4 printer with 100 µm Fast Model Resin settings, washed in a Form Wash for 5 minutes in ≥99% Isopropyl Alcohol, and post-cured at room temperature for 5 minutes in a Form Cure.

[4] Data was obtained from parts printed on a Form 4 printer with 100 µm Fast Model Resin settings, washed in a Form Wash for 5 minutes in ≥99% Isopropyl Alcohol, and post-cured at 60°C for 15 minutes in a Form Cure.

[5] Fast Model Resin was tested at NAMSA World Headquarters, OH, USA.

formlabs

ENGINEERING RESIN

Tough 2000 Resin

Resin for Rugged Prototyping

Tough 2000 Resin is the strongest and stiffest material in our functional family of Tough and Durable Resins. Choose Tough 2000 Resin for prototyping strong and sturdy parts that should not bend easily.

Strong and stiff prototypes

Sturdy jigs and fixtures

ABS-like strength and stiffness

V1 **FLTO2001**

V1.1 **FLTO2001**

Prepared 10/07/2020

Rev. 02 26/06/2024

Material Properties	METRIC [1]		IMPERIAL [1]		METHOD
	Green [2]	Post-Cured [3]	Green [2]	Post-Cured [3]	
Tensile Properties	METRIC [1]		IMPERIAL [1]		METHOD
Ultimate Tensile Strength	29 MPa	46 MPa	4206 psi	6671 psi	ASTM D638-14
Tensile Modulus	1.2 GPa	2.2 GPa	174 ksi	329 ksi	ASTM D638-14
Elongation at Break	74%	48%	74%	48%	ASTM D638-14
Flexural Properties	METRIC [1]		IMPERIAL [1]		METHOD
Flexural Strength	17 MPa	65 MPa	2465 psi	9427 psi	ASTM D790-15
Flexural Modulus	0.45 GPa	1.9 GPa	65 ksi	275 ksi	ASTM D790-15
Impact Properties	METRIC [1]		IMPERIAL [1]		METHOD
Notched Izod	79 J/m	40 J/m	1.5 ft-lb/in	0.75 ft-lb/in	ASTM D256-10
Unnotched Izod	208 J/m	715 J/m	3.9 ft-lb/in	13 ft-lb/in	ASTM D4812-11
Thermal Properties	METRIC [1]		IMPERIAL [1]		METHOD
Heat Deflection Temp. @ 1.8 MPa	42 °C	53 °C	108 °F	127 °F	ASTM D648-16
Heat Deflection Temp. @ 0.45 MPa	48 °C	63 °C	118 °F	145 °F	ASTM D648-16
Thermal Expansion (0-150°C)	107 µm/m/°C	91 µm/m/°C	59 µin/in/°F	50 µin/in/°F	ASTM E831-13

SOLVENT COMPATIBILITY

Percent weight gain over 24 hours for a printed 1 x 1 x 1 cm cube immersed in respective solvent:

Solvent	24 hr weight gain, %	Solvent	24 hr weight gain, %
Acetic Acid 5%	0.7	Isooctane (aka gasoline)	< 0.1
Acetone	18.8	Mineral oil (light)	0.1
Isopropyl Alcohol	3.7	Mineral oil (Heavy)	0.2
Bleach ~5% NaOCl	0.6	Salt Water (3.5% NaCl)	0.6
Butyl Acetate	6.2	Sodium Hydroxide solution (0.025% PH 10)	0.6
Diesel Fuel	0.1	Water	0.6
Diethyl glycol Monomethyl Ether	5.3	Xylene	4.1
Hydraulic Oil	< 0.1	Strong Acid (HCl conc)	3.0
Skydrol 5	0.9		
Hydrogen peroxide (3%)	0.6		

[1] Material properties can vary with part geometry, print orientation, print settings, and temperature.

[2] Data was obtained from green parts, printed using Form 2, 100 µm, Tough 2000 settings, without additional treatments.

[3] Data was obtained from parts printed using Form 2, 100 µm, Tough 2000 settings and post-cured with a Form Cure for 60 minutes at 70 °C.

formlabs

ENGINEERING RESIN

Tough 1500 Resin

Resin for Resilient Prototyping

Tough 1500 Resin is the most resilient material in our functional family of Tough and Durable Resins. This resin produces stiff and pliable parts that bend and spring back quickly under cyclic loading.

Springy prototypes and assemblies

Polypropylene-like strength and stiffness

Snap fit and press fit connectors

Certified biocompatible for extended skin-contact

V1 **FLTO1501**

V1.1 **FLTO1511**

Prepared 10/07/2020

Rev. 03 26/06/2024

Material Properties	METRIC [1]		IMPERIAL [1]		METHOD
	Green [2]	Post-Cured [3]	Green [2]	Post-Cured [3]	
Tensile Properties	METRIC [1]		IMPERIAL [1]		METHOD
Ultimate Tensile Strength	26 MPa	33 MPa	3771 psi	4786 psi	ASTM D638-14
Tensile Modulus	0.94 GPa	1.5 GPa	136 ksi	218 ksi	ASTM D638-14
Elongation at Break	69%	51%	69%	51%	ASTM D638-14
Flexural Properties	METRIC [1]		IMPERIAL [1]		METHOD
Flexural Strength	15 MPa	39 MPa	2175 psi	5656 psi	ASTM D790-15
Flexural Modulus	0.44 GPa	1.4 GPa	58 ksi	203 ksi	ASTM D790-15
Impact Properties	METRIC [1]		IMPERIAL [1]		METHOD
Notched Izod	72 J/m	67 J/m	1.3 ft-lb/in	1.2 ft-lb/in	ASTM D256-10
Unnotched Izod	902 J/m	1387 J/m	17 ft-lb/in	26 ft-lb/in	ASTM D4812-11
Thermal Properties	METRIC [1]		IMPERIAL [1]		METHOD
Heat Deflection Temp. @ 1.8 MPa	34 °C	45 °C	93 °F	113 °F	ASTM D648-16
Heat Deflection Temp. @ 0.45 MPa	42 °C	52 °C	108 °F	126 °F	ASTM D648-16
Thermal Expansion (0-150 °C)	114 µm/m/°C	97 µm/m/°C	63 µin/in/°F	54 µin/in/°F	ASTM E831-13

Tough 1500 Resin has been evaluated as a **skin contacting device** in accordance with ISO 10993-1, and passed the requirements for the following biocompatibility endpoints:

ISO Standard	Description [4,5]
ISO 10993-5	Not Cytotoxic
ISO 10993-10	Not an Irritant
ISO 10993-10	Not a Sensitizer

SOLVENT COMPATIBILITY

Percent weight gain over 24 hours for a printed 1 x 1 x 1 cm cube immersed in respective solvent:

Solvent	24 hr weight gain, %	Solvent	24 hr weight gain, %
Acetic acid (5%)	0.8	Mineral oil (heavy)	< 0.1
Acetone	19.0	Mineral oil (light)	< 0.1
Bleach (5% NaOCl)	0.6	Salt water (3.5% NaCl)	0.7
Butyl acetate	5.0	Skydrol 5	0.5
Diesel	0.1	Sodium Hydroxide solution (0.025% pH=10)	0.7
Diethyl glycol monomethyl ether	5.3	Strong acid (HCl conc)	4.4
Hydraulic oil	0.2	Tripropylene glycol monomethyl ether	0.6
Hydrogen peroxide (3%)	0.7	Water	0.7
Isooctane (aka gasoline)	< 0.1	Xylene	3.2
Isopropyl alcohol	3.2		

[1] Material properties can vary with part geometry, print orientation, print settings, and temperature.

[2] Data was obtained from green parts, printed using Form 2, 100 µm, Tough 1500 settings, without additional treatments.

[3] Data was obtained from parts printed using Form 2, 100 µm, Tough 1500 settings and post-cured with a Form Cure for 60 minutes at 70 °C.

[4] ISO 10993 standard testing samples were printed on a Form 3 with 100um Tough 1500 Resin settings, washed in a Form Wash for 20 minutes in ≥99% Isopropyl Alcohol, dried for at least 30 minutes and post-cured at 70°C for 60 minutes in a Form Cure.

[5] Tough 1500 Resin was tested at NAMSA World Headquarters, OH, USA.

formlabs

ENGINEERING RESIN

Durable Resin

Resin for Pliable Prototyping

Durable Resin is the most pliable, impact resistant, and lubricious material in our functional family of Tough and Durable Resins. Choose Durable Resin for squeezable parts and low-friction assemblies.

Squeezable prototypes

Impact resistant jigs

Low friction and non-degrading surfaces

Polyethylene-like strength and stiffness

V2 **FLDUCL02**

V2.1 **FLDUCL21**

Prepared 10/07/2020

Rev. 02 26/06/2024

Material Properties	METRIC [1]		IMPERIAL [1]		METHOD
	Green [2]	Post-Cured [3]	Green [2]	Post-Cured [3]	
Tensile Properties	METRIC [1]		IMPERIAL [1]		METHOD
Ultimate Tensile Strength	13 MPa	28 MPa	1900 psi	3980 psi	ASTM D638-14
Tensile Modulus	0.24 GPa	1.0 GPa	34 ksi	149 ksi	ASTM D638-14
Elongation at Break	75%	55%	75%	55%	ASTM D638-14
Flexural Properties	METRIC [1]		IMPERIAL [1]		METHOD
Flexural Strength	1.0 MPa	24 MPa	149 psi	3420 psi	ASTM D790-15
Flexural Modulus	0.04 GPa	0.66 GPa	5.58 ksi	94.1 ksi	ASTM D790-15
Impact Properties	METRIC [1]		IMPERIAL [1]		METHOD
Notched Izod	127 J/m	114 J/m	2.37 ft-lb/in	2.13 ft-lb/in	ASTM D256-10
Unnotched Izod	972 J/m	710 J/m	18.2 ft-lb/in	13.3 ft-lb/in	ASTM D4812-11
Thermal Properties	METRIC [1]		IMPERIAL [1]		METHOD
Heat Deflection Temp. @ 0.45 MPa	< 30 °C	41 °C	< 86 °F	105 °F	ASTM D648-16
Thermal Expansion (0-150°C)	124 µm/m/°C	106 µm/m/°C	69.1 µin/in/°F	59 µin/in/°F	ASTM E831-13

SOLVENT COMPATIBILITY

Percent weight gain over 24 hours for a printed and post-cured 1 x 1 x 1 cm cube immersed in respective solvent:

Solvent	24 hr weight gain, %	Solvent	24 hr weight gain, %
Acetic Acid 5%	1.3	Isooctane (aka gasoline)	< 1
Acetone	Sample cracked	Mineral oil (light)	< 1
Isopropyl Alcohol	5.1	Mineral oil (Heavy)	< 1
Bleach ~5% NaOCl	< 1	Salt Water (3.5% NaCl)	< 1
Butyl Acetate	7.9	Sodium Hydroxide solution (0.025% PH 10)	< 1
Diesel Fuel	< 1	Water	< 1
Diethyl glycol monomethyl ether	7.8	Xylene	6.5
Hydraulic Oil	< 1	Strong Acid (HCl conc)	Distorted
Skydrol 5	1.3		
Hydrogen peroxide (3%)	1		

[1] Material properties can vary with part geometry, print orientation, print settings, and temperature.

[2] Data was obtained from green parts, printed using Form 2, 100 µm, Durable settings, without additional treatments.

[3] Data was obtained from parts printed using Form 2, 100 µm, Durable settings and post-cured with a Form Cure for 60 minutes at 60 °C..

formlabs

ENGINEERING RESIN

Flexible 80A Resin

Resin for Hard Flexible Prototypes

Flexible 80A Resin is the most stiff soft-touch material in our library of Flexible and Elastic Resins, with an 80A Shore durometer to simulate the flexibility of rubber or TPU.

Balancing softness with strength, Flexible 80A Resin can withstand bending, flexing, and compression, even through repeated cycles. This material is well-suited for cushioning, damping, and shock absorption.

Cartilage and ligament anatomy

Seals, gaskets, masks

Handles, grips, overmolds

V1 **FLFL8001**

V1.1 **FLFL8011**

Prepared 10/07/2020

Rev. 02 26/06/2024

Material Properties	METRIC [1]		IMPERIAL [1]		METHOD
	Green	Post-Cured [2]	Green	Post-Cured [2]	
Tensile Properties	METRIC [1]		IMPERIAL [1]		METHOD
Ultimate Tensile Strength [3]	3.7 MPa	8.9 MPa	539 psi	1290 psi	ASTM D412-06 (A)
Stress at 50% Elongation	1.5 MPa	3.1 MPa	218 psi	433 psi	ASTM D412-06 (A)
Stress at 100% Elongation	3.5 MPa	6.3 MPa	510 psi	909 psi	ASTM D412-06 (A)
Elongation at Break	100%	120%	100%	120%	ASTM D412-06 (A)
Shore Hardness	70A	80A	70A	80A	ASTM 2240
Compression Set (23 °C for 22 hours)	Not Tested	3%	Not Tested	3%	ASTM D395-03 (B)
Compression Set (70 °C for 22 hours)	Not Tested	5%	Not Tested	5%	ASTM D395-03 (B)
Tear Strength [4]	11 kN/m	24 kN/m	61 lb/in	137 lb/in	ASTM D624-00
Ross Flex Fatigue at 23 °C	Not Tested	>200,000 cycles	Not Tested	>200,000 cycles	ASTM D1052, (notched), 60° bending, 100 cycles/minute
Ross Flex Fatigue at -10 °C	Not Tested	>50,000 cycles	Not Tested	>50,000 cycles	ASTM D1052, (notched), 60° bending, 100 cycles/minute
Bayshore Resilience	Not Tested	28%	Not Tested	28%	ASTM D2632
Thermal Properties	METRIC [1]		IMPERIAL [1]		METHOD
Glass transition temperature (Tg)	Not Tested	27 °C	Not Tested	27 °C	DMA

SOLVENT COMPATIBILITY

Percent weight gain over 24 hours for a printed and post-cured 1 x 1 x 1 cm cube immersed in respective solvent:

Solvent	24 hr weight gain, %	Solvent	24 hr weight gain, %
Acetic Acid 5%	0.9	Isooctane (aka gasoline)	1.6
Acetone	37.4	Mineral oil (light)	0.1
Isopropyl Alcohol	11.7	Mineral oil (Heavy)	< 0.1
Bleach ~5% NaOCl	0.6	Salt Water (3.5% NaCl)	0.5
Butyl Acetate	51.4	Sodium Hydroxide solution (0.025% PH 10)	0.6
Diesel Fuel	2.3	Water	0.7
Diethyl Glycol Monomethyl Ether	19.3	Xylene	64.1
Hydraulic Oil	1.0	Strong Acid (HCl conc)	28.6
Skydrol 5	10.7	Tripropylene Glycol Methyl Ether (TPM)	13.6
Hydrogen peroxide (3%)	0.7		

[1] Material properties can vary with part geometry, print orientation, print settings, and temperature.

[2] Data was obtained from parts printed using Form 3, 100 µm, Flexible 80A settings, washed in Form Wash for 10 minutes and post-cured with Form Cure at 60 °C for 10 minutes.

[3] Tensile testing was performed after 3+ hours at 23 °C, using a Die C specimen cut from sheets.

[4] Tear testing was performed after 3+ hours at 23 °C, using a Die C tear specimen directly printed.

formlabs

ENGINEERING RESIN

Elastic 50A Resin V2

Resin for Soft Flexible Parts

This pliable material is suitable for prototyping transparent parts normally produced with softer rubbers and silicones. Choose Elastic 50A Resin V2 for parts that will bend, stretch, compress, and require transparency.

Compliant features for robotics

Wearables and consumer goods prototyping

Medical models and devices

Special effects props and models

V2 **FLELCL02**

Prepared 24/01/2024

Rev. 01 24/01/2024

Material Properties	METRIC [1]		IMPERIAL [1]		METHOD
	Green [2]	Post-Cured [3]	Green [2]	Post-Cured [3]	
Mechanical Properties	METRIC [1]		IMPERIAL [1]		METHOD
Ultimate Tensile Strength [3]	1.7 MPa	3.4 MPa	249 psi	487 psi	ASTM D412-06 (A)
Stress at 50% Elongation	0.5 MPa	0.9 MPa	74 psi	134 psi	ASTM D412-06 (A)
Stress at 100% Elongation	0.9 MPa	1.7 MPa	133 psi	246 psi	ASTM D412-06 (A)
Elongation at Break	160%				ASTM D412-06 (A)
Shore Hardness	44	55	44	55	ASTM 2240
Compression Set (23 °C for 22 hours)	Not Tested	2.1%	Not Tested	2.1%	ASTM D395-03 (B)
Compression Set (70 °C for 22 hours)	Not Tested	3.1%	Not Tested	3.1%	ASTM D395-03 (B)
Tear Strength [4]	8.2 kN/m	12.3 kN/m	46.8 lb/in	70.2 lb/in	ASTM D624-00
Ross Flex Fatigue at 23 °C	Not Tested	800	Not Tested	800	ASTM D1052, (notched), 60° bending, 100 cycles/minute
Bayshore Resilience	Not Tested	18%	Not Tested	18%	ASTM D2632
Thermal Properties	METRIC [1]		IMPERIAL [1]		METHOD
Glass transition temperature (Tg)	Not Tested	-34.5 °C	Not Tested	-30.1 °F	DMA
General Properties					
Density	1.01				
Color	Clear				
Viscosity (35 °C)	1400 cPs				

SOLVENT COMPATIBILITY

Percent weight gain over 24 hours for a printed and post-cured 1 x 1 x 1 cm cube immersed in respective solvent:

Solvent	24 hr weight gain, %	Solvent	24 hr weight gain, %
Acetic Acid 5%	1.5	Isooctane (aka gasoline)	15.6
Acetone	43.4	Mineral oil (light)	0.7
Isopropyl Alcohol	39.2	Mineral oil (Heavy)	0.4
Bleach ~5% NaOCl	0.6	Salt Water (3.5% NaCl)	0.6
Butyl Acetate	133.1	Sodium Hydroxide solution (0.025% PH 10)	0.7
Diesel Fuel	7.9	Water	0.7
Diethyl Glycol Monomethyl Ether	31.4	Xylene	163.9
Hydraulic Oil	3.9	Strong Acid (HCl conc)	45.6
Skydrol 5	41.2	Tripropylene Glycol Methyl Ether (TPM)	43.6
Hydrogen peroxide (3%)	0.9		

[1] Material properties can vary with part geometry, print orientation, print settings, and temperature.

[2] Data was obtained from parts printed using Form 3, 100 µm, Elastic 50A Resin V2 settings, Elastic 50A Resin V2 post-processing steps.

[3] Tensile testing was performed after 3+ hours at 23 °C, using a Die C specimen cut from sheets.

[4] Tear testing was performed after 3+ hours at 23 °C, using a Die C tear specimen directly printed.

formlabs

ENGINEERING RESIN

Silicone 40A Resin

100% Silicone Material for Soft, Pliable, and Durable Parts

Enabled by Formlabs' Pure Silicone Technology™, Silicone 40A Resin produces 100% silicone parts with excellent elasticity, chemical resistance, and thermal stability.

Seals, gaskets, and connectors for industrial and automotive applications requiring high thermal and chemical resistance

Medical device components, patient-matched prothesis, and audiology applications

Wearables, grippers, and consumer goods prototypes requiring excellent tear strength and rebound resilience

Soft and Flexible fixtures and casting molds for repeated use

V1 **FLSI4001**

Prepared 18/08/2023

Rev. 02 01/07/2024

Material Properties	METRIC	IMPERIAL	METHOD
	Post-Cured [1, 2, 3]	Post-Cured [1, 2, 3]	
Mechanical Properties	**METRIC**	**IMPERIAL**	**METHOD**
Ultimate Tensile Strength	5 MPa	725 psi	ASTM D412-06 Type C, 500 mm/min
Elongation at Break	230%	230%	ASTM D412-06 Type C, 500 mm/min
Tear Strength	12 kN/m	68 lb/in	ASTM D624-00, Type C
Stress at 50% elongation	0.4 MPa	58 psi	ASTM D412-06 Type C, 500 mm/min
Stress at 100% elongation	1 MPa	145 psi	ASTM D412-06 Type C, 500 mm/min
Stress at 150% elongation	2.1 MPa	305 psi	ASTM D412-06 Type C, 500 mm/min
Compression Set 23 °C for 22 hours	20%		ASTM D395-03 (B)
Bayshore Resilience	34%		ASTM D2632
Ross Flexing Fatigue at 23 °C	> 500,000 cycles		ASTM D1052, (notched), 60° bending, 100 cycles/minute
Ross Flexing Fatigue at -10 °C	> 500,000 cycles		ASTM D1052, (notched), 60° bending, 100 cycles/minute
General Properties	**METRIC**	**IMPERIAL**	**METHOD**
Shore Hardness	40A		ASTM 2240
Color	Dark grey		
Viscosity (@ 35 °C)	7800 cP		
Thermal Properties	**METRIC**	**IMPERIAL**	**METHOD**
Glass Transition Temperature	-107 °C	-161 °F	ASTM D4065

BIOCOMPATABILITY

Silicone 40A Resin has been evaluated as a skin contacting device in accordance with ISO 10993-1, and passed the requirements for the following biocompatibility endpoints:

ISO Standard	Description [4,5]
ISO 10993-5:2009	Not cytotoxic
ISO 10993-23:2021	Not an irritant
ISO 10993-10:2021	Not a sensitizer

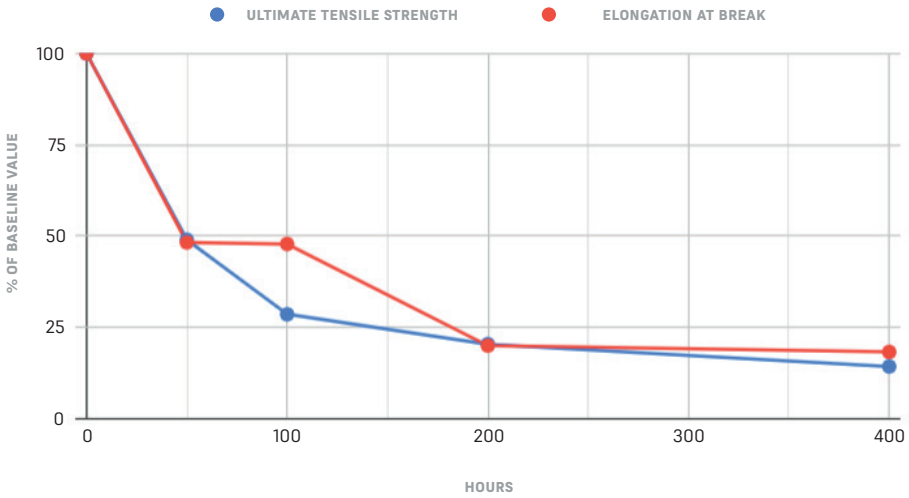
[1] The measured properties have been determined through internal testing and will be updated with results from an external lab.

[2] Material properties may vary based on part geometry, print orientation, print settings, temperature, and disinfection or sterilization methods used..

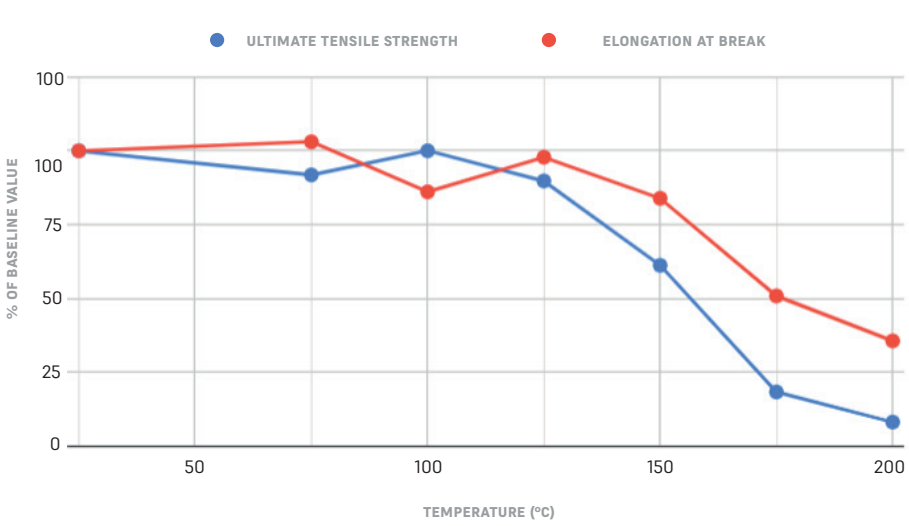
[3] Data for post-cured samples were measured on Type C tensile bars printed on a Form 3 printer with 100 µm Silicone 40A Resin settings, washed in a Form Wash for 20 minutes in 80% Isopropyl Alcohol / 20% Butyl Acetate, and post-cured at 60°C for 30 minutes submerged in water in a Form Cure.

[4] Silicone 40A Resin was tested at NAMSA World Headquarters, OH, USA.

MECHANICAL PROPERTIES AFTER UV AGING

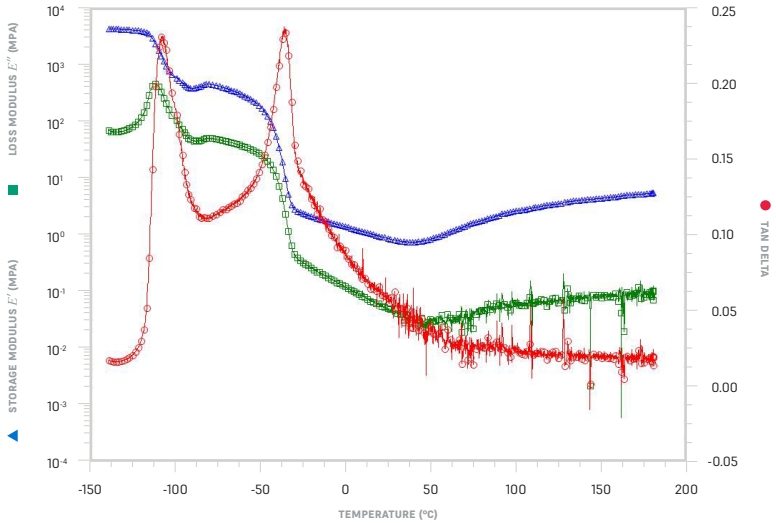


MECHANICAL PROPERTIES AFTER 24 HOURS THERMAL AGING



Aerospace Specific Testing		
Outgassing	"Total Mass Loss (TML): 1.34% Collected Volatile Condensable Material (CVCM): 0.61% Water Vapor Recovered (WVR): 0.2%"	ASTM E595-15

SILICONE 40A RESIN DYNAMIC MECHANICAL ANALYSIS (DMA)



A DMA curve from -150 °C to 180 °C at 3 °C/min is shown. A glass transition is observed at -107 °C, and a crystalline melting transition is observed at -37 °C followed by a rubbery plateau to the conclusion of the test at 180 °C.

SOLVENT COMPATIBILITY

Percent weight gain over 24 hours for a printed and post-cured 1 x 1 x 1 cm cube immersed in respective solvent:

Cleaning Chemicals	**24 hr weight gain, %**	**Industrial Fluids**	**24 hr weight gain, %**
Acetone	11.5	Gasoline (ISO 1817, liquid C)	69.8
Bleach ~5% NaOCl	< 0.1	Diesel (Chevron #2)	32.9
Distilled Water	< 0.1	Skydrol 5	23.2
Strong Acid/Base/Alcohol	**24 hr weight gain, %**	Hydraulic Oil	10
Acetic Acid (5%)	< 0.1	Diethyl glycol monomethyl ether	2.5
Hydrochloric Acid (10%)	0.4	Mineral oil (Heavy)	1.6
Sodium hydroxide solution (0.025% pH = 10)	< 0.1	Mineral oil (Light)	2
Salt Water (3.5% NaCl)	< 0.1		-3.0
Isopropyl Alcohol	5.9		0.3
Hydrogen peroxide (3%)	< 0.1		2.0
Butyl Acetate	92.3		

formlabs

ENGINEERING RESIN

Rigid 10K Resin

Resin for Rigid, Strong, Industrial-Grade Prototypes

This highly glass-filled resin is the stiffest material in our engineering portfolio. Choose Rigid 10K Resin for precise industrial parts that need to withstand significant load without bending. Rigid 10K Resin has a smooth matte finish and is highly resistant to heat and chemicals.

Short-run injection molds and inserts

Heat resistant and fluid exposed components, jigs, and fixtures

Simulates stiffness of glass and fiber-filled thermoplastics

Aerodynamic test models

V1 **FLRG1001**

V1.1 **FLRG1011**

Prepared 10/07/2020

Rev. 06 26/06/2024

Material Properties	METRIC				METHOD
	Green	**Post-Cured** for 60 min at 70 °C[1]	**Post-Cured** for 60 min at 70 °C and 125 min at 120 °C [2]	**Post-Cured** for 60 min at 70 °C, 125 min at 120 °C, and Media Blasted	
Tensile Properties	METRIC				METHOD
Ultimate Tensile Strength	55 MPa	65 MPa	53 MPa	88 MPa	ASTM D638-14
Tensile Modulus	7.5 GPa	10 GPa		11 GPa	ASTM D638-14
Elongation at Break	2%	1%		1.7%	ASTM D638-14
Flexural Properties	METRIC				METHOD
Flexural Strength	84 MPa	126 MPa	103 MPa	158 MPa	ASTM D790-15
Flexural Modulus	6 GPa	9 GPa	10 GPa	9.9 GPa	ASTM D790-15
Impact Properties	METRIC				METHOD
Notched Izod	16 J/m	16 J/m	18 J/m	20 J/m	ASTM D256-10
Unnotched Izod	41 J/m	47 J/m	41 J/m	130 J/m	ASTM D4812-11
Thermal Properties	METRIC				METHOD
Heat Deflection Temp. @ 0.45 MPa	65 °C	163 °C	218 °C	238 °C	ASTM D648-16
Heat Deflection Temp. @ 1.8 MPa	56 °C	82 °C	110 °C	92 °C	ASTM D648-16
Thermal Expansion, 0-150 °C	48 µm/m/°C	47 µm/m/°C	46 µm/m/°C	41 µm/m/°C	ASTM E831-13

Material Properties	IMPERIAL				METHOD
	Green	**Post-Cured for 60 min at 70 °C**[1]	**Post-Cured** for 60 min at 70 °C and 125 min at 120 °C [2]	**Post-Cured** for 60 min at 70 °C, 125 min at 120 °C, and Media Blasted	
Tensile Properties	IMPERIAL				METHOD
Ultimate Tensile Strength	7980 psi	9460 psi	7710 psi	12700 psi	ASTM D638-14
Tensile Modulus	1090 ksi	1480 ksi	1460 ksi	1600 ksi	ASTM D638-14
Elongation at Break	2%	1%		1.70%	ASTM D638-14
Flexural Properties	IMPERIAL				METHOD
Flexural Strength	12200 psi	18200 psi	15000 psi	22900 psi	ASTM D790-15
Flexural Modulus	905 ksi	1360 ksi	1500 ksi	1440 ksi	ASTM D790-15
Impact Properties	IMPERIAL				METHOD
Notched Izod	0.3 ft-lb/in			0.37 ft-lb/in	ASTM D256-10
Unnotched Izod	0.8 ft-lb/in	0.9 ft-lb/in	0.7 ft-lb/in	2.5 ft-lb/in	ASTM D4812-11
Thermal Properties	IMPERIAL				METHOD
Heat Deflection Temp. @ 0.45 MPa	149 °F	325 °F	424 °F	460 °F	ASTM D648-16
Heat Deflection Temp. @ 1.8 MPa	133 °F	180 °F	230 °F	198 °F	ASTM D648-16
Thermal Expansion, 0-150 °C	27 µin/in/°F	26 µin/in/°F	26 µin/in/°F	23 µin/in/°F	ASTM E831-13

ELECTRICAL CHARACTERIZATION

Property	Frequency	Value	Standard
Dielectric Constant (D_k)	1 GHz	3.4	ASTM D150-22
Dielectric Constant (D_k)	10 GHz	3.3	ASTM D2520-21
Loss Tangent (D_f)	1 GHz	0.036	ASTM D150-22
Loss Tangent (D_f)	10 GHz	0.0074	ASTM D2520-21
Volume Resistivity	-	1.1×10^{15} Ω•cm	ASTM D257-14
Surface Resistivity	-	6.9×10^{13} Ω	ASTM D257-14
Dielectric Strength	-	458 V/mil	ASTM D149-20

TOXIC GAS GENERATION

Testing Standard BSS 7239 (comparable to NFPA No. 258)	Maximum allowed concentration per BSS 7239 (ppm)	Flaming Mode (ppm)	Non-Flaming Mode (ppm)
Hydrogen Cyanide (HCN)	150	1	0.5
Carbon Monoxide (CO)	3500	50	10
Nitrous Oxides (NOx)	100	< 2	
Sulfur Dioxide (SO2)	100	< 1	
Hydrogen Fluoride (HF)	200	< 1.5	
Hydrogen Chloride (HCl)	500	1	< 1

SMOKE DENSITY **SPECIFIC OPTICAL DENSITY**

Testing Standard	@ 90 sec	@ 4 min	Maximum
ASTM E662 Flaming Mode	2	95	132
ASTM E662 Non-Flaming Mode	0	1	63

FLAMMABILITY

Testing Standard	Rating
UL 94 Section 7 (3 mm)	HB

SOLVENT COMPATIBILITY

Percent weight gain over 24 hours for a printed and post-cured 1 x 1 x 1 cm cube immersed in respective solvent:

Solvent	24 hr weight gain, %	Solvent	24 hr weight gain, %
Acetic Acid 5%	< 0.1	Isooctane (aka gasoline)	0
Acetone	< 0.1	Mineral oil (light)	0.2
Isopropyl Alcohol	< 0.1	Mineral oil (Heavy)	< 0.1
Bleach ~5% NaOCl	0.1	Salt Water (3.5% NaCl)	0.1
Butyl Acetate	0.1	Sodium Hydroxide solution (0.025% PH 10)	0.1
Diesel Fuel	0.1	Water	< 0.1
Diethyl glycol Monomethyl Ether	0.4	Xylene	< 0.1
Hydraulic Oil	0.2	Strong Acid (HCl conc)	0.2
Skydrol 5	0.6	Tripropylene glycol monomethyl ether	0.4
Hydrogen peroxide (3%)	< 0.1		

All testing specimens were printed using Form 3.

[1] Data was obtained from parts printed using Form 3, 100 µm and post-cured with a Form Cure for 60 minutes at 70 °C.

[2] Data was obtained from parts printed using Form 3, 100 µm and post-cured with a Form Cure for 60 minutes at 70 °C and an additional thermal cure at 90 °C for 125 minutes.

formlabs

ENGINEERING RESIN

Rigid 4000 Resin

Resin for Stiff, Strong, Engineering-Grade Prototypes

Glass-filled Rigid 4000 Resin prints with a smooth, polished finish and is ideal for stiff and strong parts that can withstand minimal deflection. Consider Rigid 4000 Resin for general load-bearing applications.

Mounts and brackets

Jigs and fixtures

Thin-walled parts

Simulates stiffness of PEEK

V1 **FLRGWH01**

Prepared 10/07/2020

Rev. 01 10/07/2020

Material Properties	METRIC [1]		IMPERIAL [1]		METHOD
	Green [2]	Post-Cured [3]	Green [2]	Post-Cured [3]	
Tensile Properties	METRIC [1]		IMPERIAL [1]		METHOD
Ultimate Tensile Strength	33 MPa	69 MPa	4786 psi	10007 psi	ASTM D638-14
Tensile Modulus	2.1 GPa	4.1 GPa	305 ksi	595 ksi	ASTM D638-14
Elongation at Break	23%	5.3%	23%	5.3%	ASTM D638-14
Flexural Properties	METRIC [1]		IMPERIAL [1]		METHOD
Flexural Stress at 5% Strain	43 MPa	105 MPa	6236 psi	15229 psi	ASTM D790-15
Flexural Modulus	1.4 GPa	3.4 GPa	203 ksi	493 ksi	ASTM D790-15
Impact Properties	METRIC [1]		IMPERIAL [1]		METHOD
Notched Izod	16 J/m	23 J/m	0.3 ft-lb/in	0.43 ft-lb/in	ASTM D256-10
Thermal Properties	METRIC [1]		IMPERIAL [1]		METHOD
Heat Deflection Temp. @ 1.8 MPa	41 °C	60 °C	105 °F	140 °F	ASTM D648-16
Heat Deflection Temp. @ 0.45 MPa	48 °C	77 °C	118 °F	170 °F	ASTM D648-16
Thermal Expansion (0-150 °C)	64 µm/m/°C	63 µm/m/°C	36 µin/in/°F	35 µin/in/°F	ASTM E831-13

SOLVENT COMPATIBILITY

Percent weight gain over 24 hours for a printed and post-cured 1 x 1 x 1 cm cube immersed in respective solvent:

Solvent	24 hr weight gain, %	Solvent	24 hr weight gain, %
Acetic Acid 5%	0.8	Isooctane (aka gasoline)	< 0.1
Acetone	3.3	Mineral oil (light)	0.2
Isopropyl Alcohol	0.4	Mineral oil (Heavy)	0.2
Bleach ~5% NaOCl	0.7	Salt Water (3.5% NaCl)	0.7
Butyl Acetate	< 0.1	Sodium Hydroxide solution (0.025% PH 10)	0.7
Diesel Fuel	< 0.1	Water	0.7
Diethyl glycol Monomethyl Ether	1.4	Xylene	< 0.1
Hydraulic Oil	0.2	Strong Acid (HCl conc)	5.3
Skydrol 5	1.1		
Hydrogen peroxide (3%)	0.9		

[1] Material properties can vary with part geometry, print orientation, print settings, and temperature.

[2] Data was obtained from green parts, printed using Form 3, 100 µm, Rigid settings, without additional treatments.

[3] Data was obtained from parts printed using Form 3, 100 µm, Rigid settings and post-cured with a Form Cure for 15 minutes at 80 °C.

formlabs

ENGINEERING RESIN

High Temp Resin

Resin for Heat Resistance

High Temp Resin offers a heat deflection temperature (HDT) of 238 °C @ 0.45 MPa, the highest among Formlabs resins. Use it to print detailed, precise prototypes with high temperature resistance.

Hot air, gas, and fluid flow

Heat resistant mounts, housings, and fixtures

Molds and inserts

V2 **FLHTAM02**

Prepared 10/07/2020

Rev. 01 10/07/2020

Material Properties	METRIC [1]			IMPERIAL [1]			METHOD
	Green [2]	Post-Cured for 60 min at 60 °C [3]	Post-Cured for 120 min at 80 °C and 180 min at 160 °C [4]	Green [2]	Post-Cured for 60 min at 176 °F [3]	Post-Cured for 120 min at 248 °F and 180 min at 356 °F [4]	
Tensile Properties	METRIC [1]			IMPERIAL [1]			METHOD
Ultimate Tensile Strength	21 MPa	58 MPa	49 MPa	3031 psi	8456 psi	7063 psi	ASTM D638-14
Tensile Modulus	0.75 GPa	2.8 GPa	2.8 GPa	109 ksi	399 ksi	406 ksi	ASTM D638-14
Elongation at Break	14%	3.3%	2.3%	14%	3.3%	2.3%	ASTM D638-14
Flexural Properties	METRIC [1]			IMPERIAL [1]			METHOD
Flexural Strength at Break	24 MPa	95 MPa	97 MPa	3495 psi	13706 psi	14097 psi	ASTM D790-15
Flexural Modulus	0.7 GPa	2.6 GPa	2.8 GPa	100 ksi	400 ksi	406 ksi	ASTM D790-15
Impact Properties	METRIC [1]			IMPERIAL [1]			METHOD
Notched Izod	33 J/m	18 J/m	17 J/m	0.61 ft-lb/in	0.34 ft-lb/in	0.32 ft-lb/in	ASTM D256-10
Thermal Properties	METRIC [1]			IMPERIAL [1]			METHOD
Heat Deflection Temp. @ 1.8 MPa	44 °C	78 °C	101 °C	111 °F	172 °F	214 °F	ASTM D648-16
Heat Deflection Temp. @ 0.45 MPa	49 °C	120 °C	238 °C	120 °F	248 °F	460 °F	ASTM D648-16
Thermal Expansion	118 µm/m/°C	80 µm/m/°C	75 µm/m/°C	41 µin/in/°F	44 µin/in/°F	41 µin/in/°F	ASTM E831-13

SOLVENT COMPATIBILITY

Percent weight gain over 24 hours for a printed and post-cured 1 x 1 x 1 cm cube immersed in respective solvent:

Solvent	24 hr size gain, %	24 hr weight gain, %	Solvent	24 hr size gain, %	24 hr weight gain, %
Acetic Acid 5%	< 1	< 1	Mineral oil (Light)	< 1	< 1
Acetone	< 1	2	Mineral oil (Heavy)	< 1	< 1
Bleach ~5% NaOCl	< 1	< 1	Salt Water (3.5% NaCl)	< 1	< 1
Butyl Acetate	< 1	< 1	Skydrol 5	< 1	1.1
Diesel Fuel	< 1	< 1	Sodium Hydroxide solution (0.025% PH 10)	< 1	< 1
Diethyl glycol Monomethyl Ether	< 1	1	Strong Acid (HCl conc)	1.2	< 1
Hydraulic Oil	< 1	< 1	Tripropylene glycol monomethyl ether	< 1	< 1
Hydrogen peroxide (3%)	< 1	< 1	Water	< 1	< 1
Isooctane (aka gasoline)	< 1	< 1	Xylene	< 1	< 1
Isopropyl Alcohol	< 1	< 1			

[1] Material properties can vary with part geometry, print orientation, print settings, and temperature.

[2] Data was obtained from green parts, printed using Form 2, 100 µm, High Temp settings, washed for 5 minutes in Form Wash and air dried without post cure.

[3] Data was obtained from parts printed using a Form 2, 100 micron, High Temp settings, and post-cured with Form Cure at 60 °C for 60 minutes.

[4] Data was obtained from parts printed using a Form 2, 100 micron, High Temp settings, and post-cured with Form Cure at 80 °C for 120 minutes plus an additional thermal cure in a lab oven at 160 °C for 180 minutes.

formlabs

ENGINEERING RESIN

ESD Resin

A rugged ESD-safe material to improve your electronics manufacturing workflows.

Reduce risk and increase manufacturing yield by 3D printing custom tools, jigs, and fixtures with ESD Resin that protect your critical electronics components from static discharge. ESD Resin is a cost-effective solution for producing static-dissipative parts designed to endure use on the factory floor.

Anti-static prototypes and end-use parts

Housings for sensitive electronics

Tooling, jigs, and fixtures for electronics manufacturing

V1 **FLESDS01**

Prepared 12/01/2021

Rev. 01 12/01/2021

Material Properties	METRIC [1,2]	IMPERIAL [1,2]	METHOD
	Post-Cured	Post-Cured	
Mechanical Properties	**METRIC [1,2]**	**IMPERIAL [1,2]**	**METHOD**
Ultimate Tensile Strength	44.2 MPa	6410 psi	ASTM D638-14
Tensile Modulus	1.937 GPa	280.9 ksi	ASTM D638-14
Elongation at Break	12%		ASTM D638-14
Flexural Properties	**METRIC [1,2]**	**IMPERIAL [1,2]**	**METHOD**
Flexural Strength	61 MPa	8860 psi	ASTM D790-17
Flexural Modulus	1.841 GPa	267 ksi	ASTM D790-17
Impact Properties	**METRIC [1,2]**	**IMPERIAL [1,2]**	**METHOD**
Notched Izod	26 J/m	0.489 ft-lb/in	ASTM D256-10
Unnotched Izod	277 J/m	5.19 ft-lb/in	ASTM D4812-11
Thermal Properties	**METRIC [1,2]**	**IMPERIAL [1,2]**	**METHOD**
Heat Deflection Temp. @ 1.8 MPa	54.2 °C	129.6 °F	ASTM D648-18
Heat Deflection Temp. @ 0.45 MPa	62.2 °C	143.9 °F	ASTM D648-18
Thermal Expansion	123.7 µm/m/°C	68.7 µin/in/°F	ASTM E813-13
Electrical Properties	**METRIC [1,2]**	**IMPERIAL [1,2]**	**METHOD**
Surface Resistivity	10^5 - 10^8 Ω/sq		ANSI/ESD 11.11 [3]
Volume Resistivity	10^5 - 10^7 Ω-cm		ANSI/ESD 11.11 [3]
Physical Properties	**METRIC [1,2]**	**IMPERIAL [1,2]**	**METHOD**
Density	1.116 g/cm^3	69.67 lb/ft^3	ASTM D792
Hardness	90 Shore D		ASTM D2240

SOLVENT COMPATIBILITY

Percent weight gain over 24 hours for a printed and post-cured 1 x 1 x 1 cm cube immersed in respective solvent:

Solvent	24 hr weight gain, %	Solvent	24 hr weight gain, %
Acetic Acid 5%	0.5	Mineral oil, heavy	0.1
Acetone	13.1	Mineral oil, light	0.1
Bleach ~5% NaOCl	0.5	Salt Water (3.5% NaCl)	0.6
Butyl Acetate	3.8	Skydrol 5	0.5
Diesel Fuel	0.2	Sodium hydroxide solution (0.025% pH = 10)	0.7
Diethyl glycol monomethyl ether	3.6	Strong Acid (HCl Conc)	1.4
Hydraulic Oil	0.2	TPM	0.6
Hydrogen peroxide (3%)	0.6	Water	0.7
Isooctane	< 0.1	Xylene	1.60
Isopropyl Alcohol	2.6		

[1] Material properties may vary based on part geometry, print orientation, print settings, temperature, and disinfection or sterilization methods used.

[2] Data for post-cured samples were measured on Type IV tensile bars printed on a Form 3 printer with 100 µm ESD Resin settings, washed in a Form Wash for 20 minutes in ≥99% Isopropyl Alcohol, and post-cured at 70°C for X 60 minutes in a Form Cure.

[3] ESD Resin was tested at ETS 700 West Park Avenue, Perkasie, PA 18944.

formlabs

ENGINEERING RESIN

Flame Retardant Resin

For UL 94 V-0 Certified Parts With Excellent Part Quality and Heat Resistance

Easily and quickly create stiff, creep-resistant, and functional plastic parts that perform well long-term in indoor and industrial environments. FR Resin is self-extinguishing and halogen-free with favorable flame, smoke, and toxicity (FST) ratings.

Custom jigs, fixtures, and replacement parts for industrial environments with high temperatures or ignition sources

Interior parts in airplanes, automobiles, and railways with excellent surface finish

Protective and internal consumer or medical electronics components

V1 **FLFRGR01**

Prepared 13/04/2023

Rev. 02 26/07/2023

Flammability [1, 2]	Result			Method
UL 94	V-0 (3 mm)	V-1 (2.5 mm)	HB (1.5 mm)	Scan to view Blue Card
FAR 25.853 Appendix F, Part I (a) (1) (ii) 12 seconds Vertical Burn	Pass (2.5 mm)			

Smoke Toxicity [3, 4]	Result		Method
	Ds @ 1.5 min	Ds @ 4 min	
Smoke Generation: Flaming at 3 mm thickness	19.5	285	ASTM E662
Smoke Generation: Flaming at 5 mm thickness	5	114	ASTM E662

Gas Toxicity [3, 4]	Result				Method
Gas Toxicity at 3 mm thickness	Pass	CO: 56 PPM HCl: <1 PPM	HCN: 7 PPM HF: <1 PPM	SO2: <1 PPM (NO + NO2) NOx: <1 PPM	BSS 7239

Material Properties	METRIC [3,5]			IMPERIAL [3,5]			METHOD
	Green	Post-Cured for 60 min at 70 °C	Post-Cured for 120 min at 80 °C	Green	Post-Cured for 60 min at 70 °C	Post-Cured for 120 min at 80 °C	
Mechanical Properties [5, 6]	METRIC [3,5]			IMPERIAL [3,5]			METHOD
Ultimate Tensile Strength	24 MPa	38 MPa	41 MPa	3560 psi	5990 psi		ASTM D638-14
Tensile Modulus	1.8 GPa	2.9 GPa	3.1 GPa	263 ksi	430 ksi	446 ksi	ASTM D638-14
Elongation at Break	20%	9.4%	7.1%	20%	9.40%	7.10%	ASTM D638-14
Flexural Properties	METRIC [3,5]			IMPERIAL [3,5]			METHOD
Flexural Strength	36 MPa	72 MPa	75 MPa	5280 psi	10500 psi	10900 psi	ASTM D790-15
Flexural Modulus	1.3 GPa	2.7 GPa		188 ksi	392 ksi	401 ksi	ASTM D790-15
Impact Properties	METRIC [3,5]			IMPERIAL [3,5]			METHOD
Notched Izod	19 J/m	22 J/m		0.36 ft-lb/in	0.41 ft-lb/in	0.42 ft-lb/in	ASTM D256-10
Unnotched Izod	227 J/m	241 J/m	257 J/m	4.26 ft-lb/in	4.51 ft-lb/in	4.82 ft-lb/in	ASTM D4812-11
Fracture Properties	METRIC [3,5]			IMPERIAL [3,5]			METHOD
Maximum Stress Intensity Factor (Kmax)		1.05 MPa · $m^{1/2}$	1.11 MPa · $m^{1/2}$		956 psi · $in^{1/2}$	1009 psi · $in^{1/2}$	ISO 20795-1:2013(E), Section 8.6
Work of Fracture (Wf)		311 J/m^2	277 J/m^2		21 ft-lb/ft^2	19 ft-lb/ft^2	ISO 20795-1:2013(E), Section 8.6
Thermal Properties	METRIC [3,5]			IMPERIAL [3,5]			METHOD
Heat Deflection Temp. @ 1.8 MPa	45 °C	71 °C	83 °C	113 °F	160 °F	181 °F	ASTM D648-16
Heat Deflection Temp. @ 0.45 MPa	55 °C	94 °C	111 °C	131 °F	201 °F	232 °F	ASTM D648-16
Coefficient of Thermal Expansion, 20°- 80°C		98.6 µm/m/°C	68.1 µm/m/°C		54.8 µin/in/°F	37.8 µin/in/°F	ASTM E813-13
Glass Transition Temperature (Tg)	101 °C	130 °C	144 °C	214 °F	266 °F	291 °F	Peak of tan delta, Heating Rate: 3°Cpm

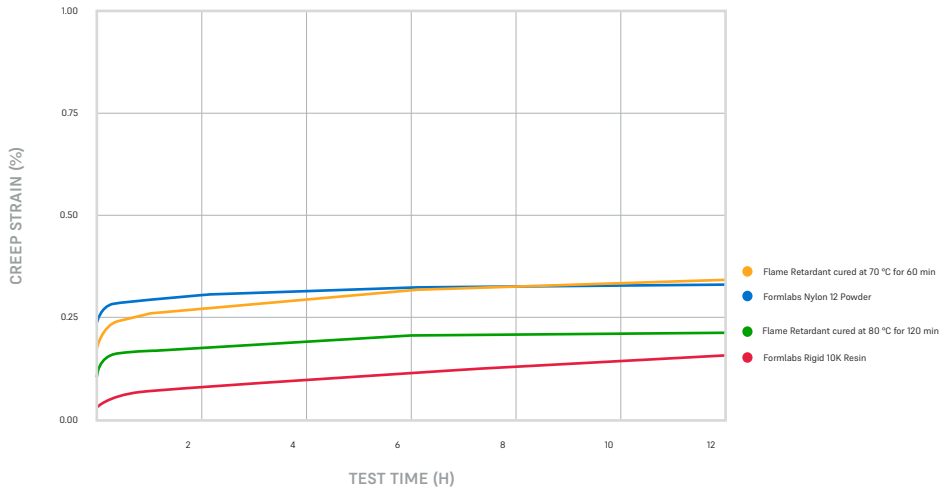
General Properties	Result		Method
Hardness	Green: 74D	Post Cured: 80D	ASTM D2240
Bulk Density	1.25 g/cm^3		ASTM D792-20
Viscosity (25 °C)	4500 - 5000 cP		
Color	Light grey		

Electrical Properties [3, 5]	Result	Method
Dielectric Strength	15.1 kV/mm	ASTM D149
Dielectric Constant	3.83	ASTM D150, 0.5 MHz
Dielectric Constant	3.82	ASTM D150, 1.0 MHz
Dissipation Factor	0.024	ASTM D150, 0.5 MHz
Dissipation Factor	0.025	ASTM D150, 1 MHz
Volume Resistivity	2.1 x 10^{15} ohm-cm	ASTM D257

Outgassing [3, 5]	Result	Method
Total Mass Loss and Collected Volatile Condensable Materials from Outgassing in a Vacuum Environment	Pass Total Mass Loss (TML): 0.87% Collected Volatile Condensable Material (CVCM): <0.01% Water Vapor Recovered (WVR): 0.2%	ASTM E595

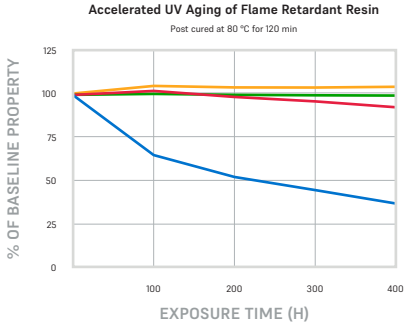
Tensile Creep Resistance (ASTM D2990-17)

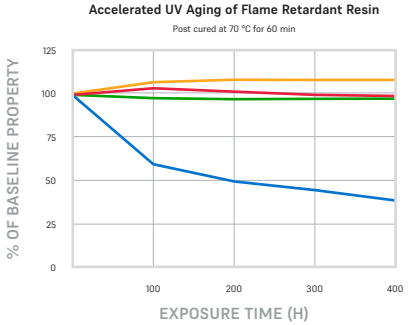
Creep resistance measurements of Formlabs materials tested at 65 °C and a 1.8 MPa load.



Formlabs Flame Retardant Resin parts have high creep resistance. Post-curing Flame Retardant Resin samples at 80 °C for 120 minutes shows improved creep resistance compared to post-curing at 70 °C for 60 minutes. Flame Retardant Resin samples post-cured at 80 °C and 120 minutes is slightly lower in creep resistance than Rigid 10K Resin samples. Flame Retardant Resin samples post-cured at 70 °C and 60 minutes showed similar creep behavior as Formlabs Nylon 12 SLS Powder.

Accelerated UV Aging [3, 5]	Method
Indoor UV Stability Formlabs evaluated the UV aging performance of Flame Retardant Resin using ASTM D4459, a test standard for xenon-arc exposure of plastics for indoor applications. This test simulates polymer aging due to solar radiation exposure through glass.	ASTM D4459 Standard practice for Xenon-Arc exposure of plastics intended for indoor applications



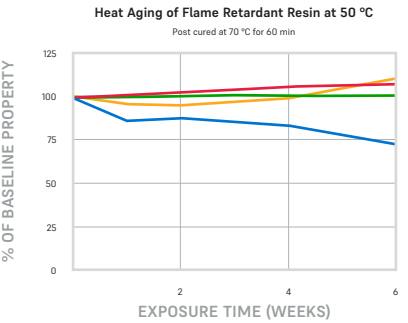


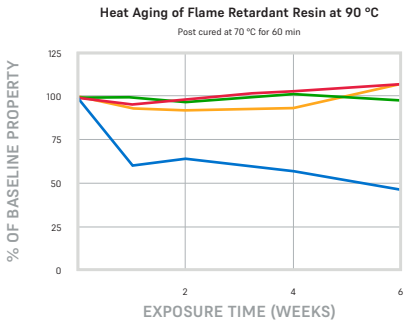
Accelerated UV Aging

ASTM 4459: Xenon-Arc, 0.8 W/m² at 420 nm, 55 °C, 50% RH
ASTM D638: Type 4, 5 mm/min

- EAB (%)
- Modulus (%)
- UTS (%)
- Impact (%)

Long Term Aging [3, 5]	Method
Heat Aging Formlabs evaluated the heat aging performance of Flame Retardant Resin using ASTM D3045, a test method for evaluating heat aging of plastics without load. In this test, mechanical properties of samples placed at 50 °C or 90 °C environments are measured at different durations of time for up to 6 weeks.	ASTM D3045 A test time of 6 weeks at 50 or 90 °C





Accelerated Heat Aging

ASTM D3045: 50 and 90 °C for 1, 2, 4 and 6 weeks each
ASTM D638: Type 4, 5 mm/min

- EAB (%)
- Modulus (%)
- UTS (%)
- Impact (%)

SOLVENT COMPATIBILITY

Percent weight gain over 24 hours for a printed and post-cured 1 x 1 x 1 cm cube immersed in respective solvent:

Cleaning Chemicals	24 hr weight gain, %
Acetone	2.1
Bleach ~5% NaOCl	0.3
Windex Powerized Formula	0.3
Hydrogen Peroxide (30%)	1
Soapy water	0.2
TPM	0.1
Distilled Water	0.2
Strong Acid/Base/Alcohol	
Hydrochloric Acid (10%)	< 0.1
Sodium Hypochlorite Solution	< 0.1
Sodium hydroxide solution (0.025% pH = 10)	0.3
Salt Water (3.5% NaCl)	0.2
Isopropyl Alcohol	0.2
Hydrogen peroxide (3%)	0.2
Butyl Acetate	0.4
Sulfuric Acid (30%)	Disintegrated
Industrial Fluids	
Gasoline ISO 1817, liquid C	< 0.1
Transmission Fluid (Havoline Synthetic ATF)	< 0.1
Engine Oil (Havoline SAE 5W-30	< 0.1
Brake Fluid (Castrol DOT-4)	< 0.1
Diesel (Chevron #2)	< 0.1
Power Steering Fluid	< 0.1
Skydrol 5	< 0.1
Hydraulic Oil	< 0.1
Diethyl glycol monomethyl ether	0.3
Mineral oil, heavy	< 0.1
Mineral oil, light	< 0.1

[1] UL flammability rating bars were printed on Form 3+/Form 3 printers with 50µm Flame Retardant Resin settings, washed in a Form Wash for (a) 10 minutes in ≥99% Isopropyl Alcohol or (b) 15 minutes in ≥99% Tripropylene glycol monomethyl ether, with a quick water rinse, and then post-cured at 70°C for 60 minutes in a Form Cure. This rating can be achieved printing in any orientation and any available layer height on a Form 3, Form 3+, Form 3B, Form 3B+, Form 3L or Form 3BL

[2] FAR 25.853 Appendix F Part I (a) bars were printed on a Form 3L printer with 100µm Flame Retardant Resin settings, washed in a Form Wash L for 10 min in ≥99% Isopropyl Alcohol, and then post-cured at 70°C for 60 min in a Form Cure L.

[3] Data for post-cured samples were printed on a Form3+ printer with 100 µm Flame Retardant Resin settings, washed in a Form Wash for 10 minutes in ≥99% Isopropyl Alcohol, and post-cured at 70°C for 60 minutes in a Form Cure unless specified otherwise.

[4] 5mm thickness samples pass Smoke Tests based on a passing criteria of <200 for Ds @ 4 min in flaming mode for ASTM E 662. Users can additionally test samples for thicknesses between 3mm-5mm based on their design constraints. Samples pass Gas Toxicity at 3mm thickness.

[5] Material properties may vary based on part geometry, print orientation, print settings, temperature, and disinfection or sterilization methods used.

[6] Data for tensile samples were measured on Type I tensile bars printed on a Form 3+ printer with 100 µm Flame Retardant Resin settings, washed in a Form Wash for 10 minutes in ≥99% Isopropyl Alcohol, and post-cured at 70°C for 60 minutes or 80°C for 120 minutes in a Form Cure.

The Full Testing Report is Available in the full version of Flame Retardant Resin Materials Data Sheet.

formlabs | dental

DENTAL RESIN

Precision Model Resin

Formlabs' most accurate material for printing high quality restorative models

Precision Model Resin is a high-accuracy material for creating restorative models with >99% of printed surface area within 100 µm of the digital model. Create beautiful models with crisp margin lines thanks to high opacity, beige color, and a smooth, matte finish to capture fine details.

Precision Model Resin is a new material that leverages the Form 4 ecosystem to print three times as fast as previous formulations of Model Resin.

Restorative models

Implant models

Crown fit test models

Removable die models

V1 **FLPMBE01**

Prepared 20/03/2024

Rev. 01 20/03/2024

Material Properties	METRIC [1]		IMPERIAL [1]		METHOD
	Green [2]	Post-Cured [3]	Green [2]	Post-Cured [3]	
Tensile Properties	METRIC [1]		IMPERIAL [1]		METHOD
Ultimate Tensile Strength	44 MPa	50 MPa	6390 psi	7190 psi	ASTM D638-14
Tensile Modulus	2.0 GPa	2.2 GPa	293 ksi	326 ksi	ASTM D638-14
Elongation at Break	11%	8.60%	11 %	8.60%	ASTM D638-14
Flexural Properties	METRIC [1]		IMPERIAL [1]		METHOD
Flexural Strength	68 MPa	87 MPa	9863 psi	12618 psi	ASTM D790-15
Flexural Modulus	1.7 GPa	2.3 GPa	247 ksi	334 ksi	ASTM D790-15
Impact Properties	METRIC [1]		IMPERIAL [1]		METHOD
Notched Izod	28 J/m	32 J/m	0.52 ft-lb/in	0.59 ft-lb/in	ASTM D256-10
Unnotched Izod	440 J/m	262 J/m	8.3 ft-lb/in	4.9 ft-lb/in	ASTM D4812-11
Thermal Properties	METRIC [1]		IMPERIAL [1]		METHOD
Heat Deflection Temp. @ 1.8 MPa	45.1 °C	46.3 °C	113.2 °F	115.3 °F	ASTM D648-16
Heat Deflection Temp. @ 0.45 MPa	51.7 °C	53.5 °C	125.1 °F	128.3 °F	ASTM D648-16
Thermal Expansion	80.2 µm/m/°C	81.1 µm/m/°C	44.6 µin/in/°F	45.1 µin/in/°F	ASTM E813-13

SOLVENT COMPATIBILITY

Percent weight gain over 24 hours for a printed 1 x 1 x 1 cm cube immersed in respective solvent:

Solvent	24 hr weight gain, %	Solvent	24 hr weight gain, %
Acetic Acid 5%	1.0	Mineral oil (Heavy)	0.2
Acetone	10.3	Mineral oil (Light)	0.3
Bleach ~5% NaOCl	0.8	Salt Water (3.5% NaCl)	0.9
Butyl Acetate	0.6	Skydrol 5	0.3
Diesel Fuel	0.2	Sodium Hydroxide solution (0.025% PH 10)	0.9
Diethyl glycol Monomethyl Ether	2.1	Strong Acid (HCl conc)	0.5
Hydraulic Oil	0.2	Tripropylene glycol monomethyl ether	0.3
Hydrogen peroxide (3%)	1.01	Water	0.9
Isooctane (aka gasoline)	-0.03	Xylene	< 0.1
Isopropyl Alcohol	0.6		

[1] Material properties may vary based on part geometry, print orientation, print settings, temperature, and disinfection or sterilization methods used.

[2] Data was obtained from green parts printed on a Form 4 printer with 50 µm Precision Model Resin settings, washed in a Form Wash for 5 minutes in ≥99% Isopropyl Alcohol, and air dried without post cure.

[3] Data for post-cured samples were measured on Type I tensile bars printed on a Form 4 printer with 50 µm Precision Model settings, washed in a Form Wash for 5 minutes in ≥99% Isopropyl Alcohol, and post-cured at 35°C for 5 minutes in a Form Cure.

formlabs

GENERAL PURPOSE RESIN

Fast Model Resin

Formlabs' fastest resin, capable of printing at speeds up to 100mm/hr

Fast Model Resin is capable of printing dental models in less than 10 minutes or large prototypes in less than 2 hours. This highly accurate resin leverages the Form 4 ecosystem to print three times faster than previous formulations of Draft Resin. Use 200 micron settings for fastest print speeds, or use 100 micron settings for more detailed models.

Initial prototypes

Rapid design iterations

Dental models for thermoforming aligners

V1 **FLFMGR01**

Prepared 20/03/2024

Rev. 01 20/03/2024

Material Properties	METRIC [1]			IMPERIAL [1]			METHOD
	Green	Post-Cured for 5 min at ambient temperature [3]	Post-Cured for 15 min at 60 °C [4]	Green	Post-Cured for 5 min at ambient temperature [3]	Post-Cured for 15 min at 140 °F [4]	
Tensile Properties	METRIC [1]			IMPERIAL [1]			METHOD
Ultimate Tensile Strength	46 MPa	55 MPa	62 MPa	6670 psi	7980 psi	8990 psi	ASTM D638-14
Tensile Modulus	2.18 GPa	2.48 GPa	2.67 GPa	320 ksi	360 ksi	390 ksi	ASTM D638-14
Elongation at Break	22%	15%	11%	22%	15%	11%	ASTM D638-14
Flexural Properties	METRIC [1]			IMPERIAL [1]			METHOD
Flexural Strength	74 MPa	98 MPa	106 MPa	10700 psi	14200 psi	15400 psi	ASTM D790-15
Flexural Modulus	1.96 GPa	2.60 GPa	2.74 GPa	280 ksi	380 ksi	400 ksi	ASTM D790-15
Impact Properties	METRIC [1]			IMPERIAL [1]			METHOD
Notched Izod	34 J/m	30 J/m	37 J/m	0.64 ft-lb/in	0.56 ft-lb/in	0.69 ft-lb/in	ASTM D4812-11
Thermal Properties	METRIC [1]			IMPERIAL [1]			METHOD
Heat Deflection Temp. @ 1.8 MPa	47 °C	49 °C	61 °C	117 °F	120 °F	142 °F	ASTM D648-16
Heat Deflection Temp. @ 0.45 MPa	55 °C	58 °C	76 °C	131 °F	136 °F	167 °F	ASTM D648-16

SOLVENT COMPATIBILITY

Percent weight gain over 24 hours for a printed and post-cured 1 x 1 x 1 cm cube immersed in respective solvent:

Solvent	24 hr weight gain, %	Solvent	24 hr weight gain, %
Acetic Acid 5%	0.6	Mineral oil (Heavy)	0.2
Acetone	8.9	Mineral oil (Light)	0.1
Bleach ~5% NaOCl	0.7	Salt Water (3.5% NaCl)	0.8
Butyl Acetate	0.5	Skydrol 5	1.0
Diesel Fuel	< 0.1	Sodium Hydroxide solution (0.025% PH 10)	0.8
Diethyl glycol Monomethyl Ether	3.1	Strong Acid (HCl conc)	0.5
Hydraulic Oil	0.2	Tripropylene glycol monomethyl ether	0.7
Hydrogen peroxide (3%)	0.9	Water	0.8
Isooctane (aka gasoline)	< 0.1	Xylene	0.2
Isopropyl Alcohol	0.8		

[1] Material properties may vary based on part geometry, print orientation, print settings, temperature, and disinfection or sterilization methods used.

[2] Data was obtained from green parts printed on a Form 4 printer with 100 µm Fast Model Resin settings, washed in a Form Wash for 5 minutes in ≥99% Isopropyl Alcohol, and air dried without post-cure.

[3] Data was obtained from parts printed on a Form 4 printer with 100 µm Fast Model Resin settings, washed in a Form Wash for 5 minutes in ≥99% Isopropyl Alcohol, and post-cured at room temperature for 5 minutes in a Form Cure.

[4] Data was obtained from parts printed on a Form 4 printer with 100 µm Fast Model Resin settings, washed in a Form Wash for 5 minutes in ≥99% Isopropyl Alcohol, and post-cured at 60°C for 15 minutes in a Form Cure.

[5] Fast Model Resin was tested at NAMSA World Headquarters, OH, USA.

formlabs | dental

DENTAL RESIN

Dental LT Comfort Resin

A Flexible And Durable Material For Optimally Comfortable Long-Term Splints, Night Guards, and Bleaching Trays

Directly print flexible occlusal splints in-house, more easily than ever. Printed splints are easily polished to high optical transparency, and offer enhanced comfort and durability that boosts patient adoption and compliance.

Occlusal Splints **Night Guards** **Bleaching Trays**

V1 **FLDLCO01**

V1.1 **FLDLCO11**

*** May not be available in all regions**

Prepared 23/05/2023

Rev. 02 26/05/2023

Material Properties	METRIC [1]	METHOD
	Post-Cured [2]	
Mechanical Properties	**METRIC [1]**	**METHOD**
Elongation at Break	33%	ASTM D638-14 (Type IV)
Flexural Properties	**METRIC [1]**	**METHOD**
Flexural Strength	21 MPa	ASTM D790-15 (Method B)
Flexural Modulus	643 MPa	ASTM D790-15 (Method B)
Hardness Properties	**METRIC [1]**	**METHOD**
Hardness Shore D	75D	ASTM D2240-15 (Type D)
Impact Properties	**METRIC [1]**	**METHOD**
Notched Izod	98 J/m	ASTM D256-10 (Method A)
Other Properties	**METRIC [1]**	**METHOD**
Water Sorption	31 ug/mm^3	ISO 20795-2
Water Solubility	4 ug/mm^3	ISO 20795-2

Dental LT Comfort Resin has been evaluated in accordance with ISO 10993-1:2018, Biological evaluation of medical devices - Part 1: Evaluation and testing within a risk management process, and ISO 7405:2018, Dentistry - Evaluation of biocompatibility of medical devices used in dentistry, and passed the requirements for the following biocompatibility risks:

ISO Standard	Description [3]
ISO 10993-5:2009	Not cytotoxic
ISO 10993-23: 2021	Not an irritant
ISO 10993-10:2021	Not a sensitizer
ISO 10993-11:2017	Not toxic
ISO 10993-3:2014	Not genotoxic

The product was developed and is in compliance with the following ISO Standards:

ISO Standard	Description
EN ISO 13485:2016	Medical Devices – Quality Management Systems – Requirements for Regulatory Purposes
EN ISO 14971:2012	Medical Devices – Application of Risk Management to Medical Devices

[1] Material properties may vary based on part geometry, print orientation, print settings, temperature, and disinfection or sterilization methods used.

[2] Data were measured on post-cured samples printed on a Form 3B with 100 µm Dental LT Comfort Resin settings, washed in a Form Wash for 10 minutes in 99% Isopropyl Alcohol, and post-cured at 60 C for 20 minutes in a Form Cure.

[3] Dental LT Comfort Resin was tested at NAMSA World Headquarters, OH, USA.

formlabs | dental

DENTAL RESIN

Dental LT Clear Resin V2

A durable, color-corrected material for printing hard occlusal splints

Directly print affordable, high-quality occlusal splints in-house with Dental LT Clear Resin (V2). Highly durable and resistant to fracture, this color-corrected material prints clear, polishes to high optical transparency, and resists discoloration over time for a finished appliance you'll be proud to deliver.

Occlusal guards

Splints

V1 **FLDLCL02**

* May not be available in all regions

Prepared 09/16/2020

Rev. 01 09/16/2020

Material Properties	METRIC [1]	METHOD
	Post-Cured [2]	
Tensile Properties	**METRIC [1]**	**METHOD**
Ultimate Tensile Strength	52 MPa	ASTM D638-10 (Type IV)
Young's Modulus	2080 MPa	ASTM D638-10 (Type IV)
Elongation at Break	12%	ASTM D638-10 (Type IV)
Flexural Properties	**METRIC [1]**	**METHOD**
Flexural Strength	84 MPa	ASTM D790-15 (Method B)
Flexural Modulus	2300 MPa	ASTM D790-15 (Method B)
Hardness Properties	**METRIC [1]**	**METHOD**
Hardness Shore D	78D	ASTM D2240-15 (Type D)
Impact Properties	**METRIC [1]**	**METHOD**
Unnotched Izod	449 J/m	ASTM D4812-11 (Unnotched)
Other Properties	**METRIC [1]**	**METHOD**
Water Absorption	0.54%	ASTM D570-98 (2018)

Dental LT Clear Resin (V2) has been evaluated in accordance with ISO 10993-1:2018, Biological evaluation of medical devices - Part 1: Evaluation and testing within a risk management process, and ISO 7405:2018, Dentistry - Evaluation of biocompatibility of medical devices used in dentistry, and passed the requirements for the following biocompatibility risks:

ISO Standard	Description [3]
ISO 10993-5:2009	Not cytotoxic
ISO 10993-10:2010/(R)2014	Not an irritant
ISO 10993-10:2010/(R)2014	Not a sensitizer
ISO 10993-3:2014	Not mutagenic
ISO 10993-17:2002, ISO 10993-18:2005	Not toxic (subacute / subchronic)

The product was developed and is in compliance with the following ISO Standards:

ISO Standard	Description
EN ISO 13485:2016	Medical Devices – Quality Management Systems – Requirements for Regulatory Purposes
EN ISO 14971:2012	Medical Devices – Application of Risk Management to Medical Devices

[1] Material properties may vary based on part geometry, print orientation, print settings, temperature, and disinfection or sterilization methods used.

[2] Data were measured on post-cured samples printed on a Form 3B printer with 100 µm Dental LT Clear Resin (V2) settings, washed in a Form Wash for 20 minutes in 99% isopropyl alcohol, and post-cured at 60 °C for 60 minutes in a Form Cure.

[3] Dental LT Clear Resin (V2) was tested at NAMSA World Headquarters, OH, USA.

formlabs | dental

DENTAL RESIN

Surgical Guide Resin

A premium-quality material for printing surgical implant guides

Surgical Guide Resin is designed to print at 100 micron and 50 micron layer line resolutions on Formlabs SLA printers to produce dimensionally accurate dental implant guides and templates.

Surgical guides

Pilot drill guides

Device sizing templates

Drilling templates

V1 **FLSGAM01**

*** May not be available in all regions**

Prepared 11/04/2019

Rev. 02 21/07/2021

Material Properties	Post-Cured [1, 2]	Method
Elongation at Break	12%	ASTM D638
Flexural Strength	> 102 MPa	ASTM D790
Flexural Modulus	> 2400 MPa	ASTM D790

Sterilization Compatibility	
E-beam	35 kGy E-beam radiation
Ethylene Oxide	100% Ethylene oxide at 55 °C for 180 minutes
Gamma	29.4 - 31.2 kGy gamma radiation
Steam Sterilization	Autoclave at 134 °C for 20 minutes Autoclave at 121 °C for 30 minutes

For more details on sterilization compatibilities, visit formlabs.com

Disinfection Compatibility	
Chemical Disinfection	70% Isopropyl Alcohol for 5 minutes

Surgical Guide Resin is a Class I Medical Device as defined in Article 2 of the Medical Device Regulation 2017/74 (MDR) in the EU and in Section 201(h) of the Federal Food Drug & Cosmetic (FD&C) Act.

Surgical Guide Resin has been evaluated in accordance with ISO 10993-1, Biological evaluation of medical devices - Part 1: Evaluation and testing within a risk management process, and ISO 7405, Dentistry - Evaluation of biocompatibility of medical devices used in dentistry, and passed the requirements for the following biocompatibility risks:

ISO Standard	Description [3]
EN ISO 10993-5	Not cytotoxic
EN ISO 10993-10	Not an irritant
EN ISO 10993-10	Not a sensitizer

The product was developed and is in compliance with the following ISO Standards:

ISO Standard	Description
EN ISO 13485	Medical Devices – Quality Management Systems – Requirements for Regulatory Purposes
EN ISO 14971	Medical Devices – Application of Risk Management to Medical Devices

[1] Material properties may vary based on part geometry, print orientation, print settings, temperature, and disinfection or sterilization methods used.

[2] Data for post-cured samples were measured on Type IV tensile bars printed on a Form 2 printer with 100 µm Surgical Guide Resin settings, washed in a Form Wash for 20 minutes in ≥99% Isopropyl Alcohol, and post-cured at 60°C for 30 minutes in a Form Cure.

[3] Surgical Guide Resin was tested at NAMSA World Headquarters, OH, USA.

formlabs | dental

DENTAL RESIN

IBT Flex Resin

A Flexible, and Tear-Resistant Material for Printing Highly Accurate Indirect Bonding Trays and Direct Composite Restoration Guides with Enhanced Translucency

3D print flexible and tear-resistant translucent trays and guides that save you time and deliver consistent, predictable outcomes. IBT Flex Resin is a Class I biocompatible material with enhanced flexibility, strength, translucency, and color to guarantee optimal clinical outcomes while providing a great patient experience and for seamless and precise transfer of orthodontic brackets and restorative composite materials.

Direct Composite Restoration Guides **Indirect Bonding Trays**

V1 **FLIBFL01**

*** May not be available in all regions**

Prepared 14/09/2023

Rev. 01 14/09/2023

Material Properties		
	Post-Cured [1, 2]	Method
Disinfection Compatibility		
Tensile Strength	7.2 MPa	ASTM D412
Tensile Modulus	8 MPa	ASTM D412
Elongation at Break	135 %	ASTM D412
Hardness Shore A	77 - 80A	ASTM D2240
Transparency (2 mm sample)	85%	-

Disinfection Compatibility	
Chemical Disinfection	70% Isopropyl Alcohol for 5 minutes

IBT Flex Resin has been evaluated in accordance with ISO 10993-1:2018, Biological evaluation of medical devices - Part 1: Evaluation and testing within a risk management process, and ISO 7405:2018, Dentistry - Evaluation of biocompatibility of medical devices used in dentistry, and passed the requirements for the following biocompatibility risks:

ISO Standard	Description [3]
ISO 10993-5:2009	Met requirements of test
ISO 10993-23:2021	Met requirements of test
ISO 10993-10:2021	Met requirements of test

The product was developed and is in compliance with the following ISO Standards:

ISO Standard	Description
EN ISO 13485:2016	Medical Devices – Quality Management Systems – Requirements for Regulatory Purposes
EN ISO 14971:2012	Medical Devices – Application of Risk Management to Medical Devices

[1] Material properties may vary based on part geometry, print orientation, print settings, temperature, and disinfection or sterilization methods used.

[2] Data was obtained from parts printed using Form 3B(+), 100 µm, IBT Flex Resin settings, and using post-processing instructions listed in the IBT Flex Resin Manufacturing Guide.

[3] IBT Flex Resin was tested at NAMSA World Headquarters, OH, USA.

formlabs | dental

DENTAL RESIN

Premium Teeth Resin

For strong life-like denture teeth and temporary restorations

Premium Teeth Resin is a nano-ceramic filled biocompatible material with enhanced aesthetics, mechanical properties, and validated longevity to guarantee optimal clinical performance. 3D print denture teeth, temporary full-arch implant-supported restorations (All-on-X appliances), temporary single units (crowns, inlays, onlays, and veneers) and up to seven-unit bridges without compromising on intraoral mechanics, life-like aesthetics, and simplified workflows.

Temporary Single-units (crown, inlays, onlays, veneers) and Bridges (up to 7-units)

Temporary Full-Arch Implant-Supported Restorations (All-on-X Appliances)

Denture Teeth for Full and Partial Removable Dentures

Try-in Dentures

V1

FLPTA201
FLPTA301
FLPTB101
FLPTBL01

*** May not be available in all regions**

Prepared 20/12/2023

Rev. 05 05/06/2024

Material Properties

HT (High Translucency): A2, A3, B1, BL

Mechanical Properties	Post-Cured [1, 2]	Method
Flexural Strength	155 MPa	ASTM D790
Flexural Modulus	4300 MPa	ASTM D790
Hardness	90 D	ASTM D2240
Sorption	36.2 µg/mm³	ISO 10477:2018
Solubility	1.1 µg/mm³	ISO 10477:2018
Opacity at 1 mm thickness	54%	-
Density	1.23 g/mL	-
Viscosity	1100 cP @ 25 °C 450 cP @ 35 °C	-

Premium Teeth Resin has been evaluated in accordance with ISO 10993-1:2018, Biological evaluation of medical devices - Part 1: Evaluation and testing within a risk management process, and ISO 7405:2018, Dentistry - Evaluation of biocompatibility of medical devices used in dentistry, and passed the requirements for the following biocompatibility risks:

ISO Standard	Description [3]	
ISO 10993-5:2009	Cytotoxicity	Passed
ISO 10993-23:2021	Irritation	Passed
ISO 10993-10:2021	Sensitization	Passed
ISO 10993-11:2017	Toxicity	Passed
ISO 10993-3:2014	Genotoxicity	Passed

The product was developed and is in compliance with the following ISO Standards:

ISO Standard	Description
EN ISO 13485:2016	Medical Devices – Quality Management Systems – Requirements for Regulatory Purposes
EN ISO 14971:2012	Medical Devices – Application of Risk Management to Medical Devices

[1] Material properties may vary based on part geometry, print orientation, print settings, temperature, and disinfection or sterilization methods used.

[2] Data was obtained from parts printed using Form 3B(+), 50 µm, Premium Teeth Resin settings, and using post-processing instructions listed in the Premium Teeth Resin Manufacturing Guide.

[3] Premium Teeth Resin was tested at NAMSA World Headquarters, OH, USA.

formlabs | dental

DENTAL RESIN

Denture Base Resin

Long-lasting denture base material for truly lifelike permanent prosthetics

Denture Base Resin is a Class II long-term biocompatible material to enable dental professionals to produce 3D printed denture bases accurately and reliably. Denture Base Resin can be bonded to Premium Teeth Resin to create full or partial dentures with lifelike aesthetics.

V1 **FLDBLP01** **FLDBOP01** **FLDBDP01** *** May not be available in all regions**

Prepared 16/09/2020

Rev. 01 16/09/2020

Material Properties	METRIC [1]	METHOD
	Post-Cured [2]	
Mechanical Properties	**METRIC [1]**	**METHOD**
Flexural Strength	> 50 MPa	ISO 10477
Density	1.15 g/cm^3 < X <1.25 g/cm^3	ASTM D792-00

Denture Base resin was tested for biological evaluation of medical devices at WuXi Apptec, 2540 Executive Drive, St. Paul, MN, and is certified biocompatible per EN-ISO 10993-1:2009/ AC:2010:

ISO Standard	Description
EN-ISO 10993-3:2014	Not mutagenic
EN-ISO 10993-5:2009	Not cytotoxic
EN-ISO 10993-10:2010	Not an irritant
EN-ISO 10993-10:2010	Not a sensitizer
EN-ISO 10993-11:2006	Non toxic

The product was developed and is in compliance with the following ISO Standards:

Denture Base ISO Standards	Description
EN-ISO 22112:2017	Dentistry - Artificial teeth for dental prostheses
EN-ISO 10477	Dentistry - Polymer-based crown and veneering materials (Type 2 and Class 2)

[1] Material properties can vary with part geometry, print orientation, print settings, and temperature.

[2] Data refers to post-cured properties obtained after exposing green parts to 108 watts each of Blue UV-A (315 – 400 nm), in a heated environment at 80 °C (140 °F) and 1hr, with six (6) 18W/78 lamps (Dulux blue UV-A)

formlabs | dental

DENTAL RESIN

Custom Tray Resin

A production-ready material that enables highly accurate definitive impressions

Use Custom Tray Resin to directly print impression trays for implants, dentures, crowns and bridges, and other comprehensive cases. Digitally manufactured impression trays provide consistent, accurate impressions for high-quality dentistry. Custom Tray Resin prints full impression trays quickly using 200 micron layer heights, reducing labor time and enabling higher throughput.

Impression Trays

V1 **FLCTBL01**

* May not be available in all regions

Prepared 10/07/2020

Rev. 02 21/07/2024

Material Properties	Post-Cured [1, 2]	Method
Ultimate Tensile Strength	> 70 MPa	ASTM D638
Young's Modulus	> 2500 MPa	ASTM D638
Elongation at Break	> 3%	ASTM D638
Flexural Strength	≥ 100 MPa	ASTM D790
Flexural Modulus	≥ 2600 MPa	ASTM D790
Hardness Shore D	> 80D	ASTM D2240

Disinfection Compatibility	
Chemical Disinfection	70% Isopropyl Alcohol for 5 minutes

Custom Tray Resin is a Class I Medical Device as defined in Article 2 of the Medical Device Regulation 2017/74 (MDR) in the EU and in Section 201(h) of the Federal Food Drug & Cosmetic (FD&C) Act.

Custom Tray Resin has been evaluated in accordance with ISO 10993-1, Biological evaluation of medical devices - Part 1: Evaluation and testing within a risk management process, and ISO 7405, Dentistry - Evaluation of biocompatibility of medical devices used in dentistry, and passed the requirements for the following biocompatibility risks:

ISO Standard	Description [3]
EN ISO 10993-5	Not cytotoxic
EN ISO 10993-10	Not an irritant
EN ISO 10993-10	Not a sensitizer

[1] Material properties may vary based on part geometry, print orientation, print settings, temperature, and disinfection or sterilization methods used.

[2] Data for post-cured samples were measured on Type IV tensile bars printed on a Form 2 printer with 200 µm Custom Tray Resin settings, washed in a Form Wash for 10 minutes in ≥99% Isopropyl Alcohol, and post-cured at 60°C for 30 minutes in a Form Cure.

[3] Custom Tray Resin was tested at NAMSA World Headquarters, OH, USA.

formlabs | dental

DENTAL RESIN

Castable Wax Resin

A highly accurate material for casting and pressing crowns, bridges, and RPD frameworks

Tested at length by dental technicians, Castable Wax Resin provides accurate, sealed margins and contains 20% wax for reliable casting with clean burnout. Printed patterns are strong enough to handle with no post-cure required, allowing for a faster, simpler workflow.

Patterns for casting and pressing

Crowns

Removable partial denture frameworks

Bridges

V1 **FLCWPU01**

Prepared 10/02/2017

Rev. 02 29/04/2024

Material Properties	METRIC [1]	IMPERIAL [1]	METHOD
	Green [2]	Green [2]	
Tensile Properties	**METRIC [1]**	**IMPERIAL [1]**	**METHOD**
Ultimate Tensile Strength	12 MPa	1680 psi	ASTM D638-10
Tensile Modulus	220 MPa	32 ksi	ASTM D638-10
Elongation at Break	13%	13%	ASTM D638-10
Burnout Properties	**METRIC [1]**	**IMPERIAL [1]**	**METHOD**
Temp @ 5% Mass Loss	249 °C	480 °F	
Ash Content (TGA)	0.0 - 0.1%		

[1] Material properties can vary with part geometry, print orientation, print settings, and temperature.

[2] Data was obtained from parts printed using Form 2, Castable 50 µm Fine Detail settings and washed without post-cure.

formlabs

DENTAL RESIN

BEGO™ VarseoSmile® TriniQ® Resin

BEGO™ VarseoSmile® TriniQ® Resin is a versatile ceramic-filled biocompatibile material, indicated for temporary and permanent single units, bridges, and denture teeth.

Permanent Single-units (crown, inlays, onlays, veneers), Bridges (up to 3-units), and Implant Crowns

Temporary Single-units (crown, inlays, onlays, veneers), Bridges (up to 7-units), and Implant Crowns

Denture Teeth for Full and Partial Removable Dentures

V1 **BGTQA201** **BGTQA301** **BGTQB101**

Prepared 23/07/2024

Rev. 01 23/07/2024

Mechanical Properties [1,2]	POST-CURED	METHOD
Flexural Strength	120 MPa	ISO 10477:2020
Flexural Modulus	3600 MPa	ISO 10477:2020
Hardness	≥ 90 D	ISO 868:2003
Sorption	< 0.6 µg/mm³	ISO 10477:2020
Solubility	< 12 µg/mm³	ISO 10477:2020
Density @ 20 °C	1.29 g/cm³	-
Viscosity @ 22 °C	3300 cP	-

BEGO™ VarseoSmile® TriniQ® Resin has been evaluated in accordance with ISO 10993-1, Biological evaluation of medical devices - Part 1: Evaluation and testing within a risk management process, and ISO 7405, Dentistry - Evaluation of biocompatibility of medical devices used in dentistry, and passed the requirements for the following biocompatibility risks:

ISO Standard	Description
ISO 10993-1:2018	Biological safety confirmed
ISO 10993-5:2009	Not cytotoxic
ISO 10993-10:2010	Not a sensitizer
ISO 10993-18:2009	No critical observations
ISO 10993-23:2021	Not an irritant

The product was developed and is in compliance with the following ISO Standards:

ISO Standard	Description
EN ISO 13485	Medical Devices – Quality Management Systems – Requirements for Regulatory Purposes
EN ISO 14971	Medical Devices – Application of Risk Management to Medical Devices

[1] Material properties may vary based on part geometry, print orientation, print settings, temperature, and disinfection or sterilization methods used.

[2] Data for post-cured samples were verified and validated by BEGO™ for compatible Formlabs equipment using post-processing instructions listed in the BEGO™ VarseoSmile® TriniQ® Resin Instructions for Use.

formlabs | healthcare

MEDICAL RESIN

BioMed Clear Resin

Biocompatible Photopolymer Resin for Formlabs SLA Printers

BioMed Clear Resin is a rigid material for biocompatible applications requiring long-term skin or mucosal membrane contact. This USP Class VI certified material is suitable for applications that require wear resistance and low water absorption over time.

Parts printed with BioMed Clear Resin are compatible with common sterilization methods. BioMed Clear Resin is manufactured in our ISO 13485 facility and is supported with an FDA Device Master File.

V1 **FLBMCL01**

Prepared 06/12/2020

Rev. 04 24/04/2023

Material Properties	METRIC [1]	IMPERIAL [1]	METHOD
	Post-Cured [2]	Post-Cured [2]	
Tensile Properties	**METRIC [1]**	**IMPERIAL [1]**	**METHOD**
Ultimate Tensile Strength	52 MPa	7.5 ksi	ASTM D638-10 (Type IV)
Young's Modulus	2080 MPa	302 ksi	ASTM D638-10 (Type IV)
Elongation at Break	12%		ASTM D638-10 (Type IV)
Flexural Properties	**METRIC [1]**	**IMPERIAL [1]**	**METHOD**
Flexural Strength	84 MPa	12.2 ksi	ASTM D790-15 (Method B)
Flexural Modulus	2300 MPa	332 ksi	ASTM D790-15 (Method B)
Hardness Properties	**METRIC [1]**	**IMPERIAL [1]**	**METHOD**
Hardness Shore D	78D		ASTM D2240-15 (Type D)
Impact Properties	**METRIC [1]**	**IMPERIAL [1]**	**METHOD**
Notched Izod	35 J/m	0.658 ft-lb/in	ASTM D256-10 (Method A)
Unnotched Izod	449 J/m	8.41 ft-lb/in	ASTM D4812-11
Thermal Properties	**METRIC [1]**	**IMPERIAL [1]**	**METHOD**
Heat Deflection Temp. @ 1.8 MPa	54 °C	129 °F	ASTM D648-18 (Method B)
Heat Deflection Temp. @ 0.45 MPa	67 °C	152 °F	ASTM D648-18 (Method B)
Coefficient of Thermal Expansion	82 µm/m/°C	45 µin/in/°F	ASTM E831-14
Other Properties	**METRIC [1]**	**IMPERIAL [1]**	**METHOD**
Water Absorption	0.54%		ASTM D570-98 (2018)

Sterilization Compatibility	
E-beam	35 kGy E-beam radiation
Ethylene Oxide	100% Ethylene oxide at 55 °C for 180 minutes
Gamma	29.4 - 31.2 kGy gamma radiation
Steam Sterilization	Autoclave at 134 °C for 20 minutes Autoclave at 121 °C for 30 minutes

For more details on sterilization compatibilities, visit formlabs.com/medical

Disinfection Compatibility	
Chemical Disinfection	70% Isopropyl Alcohol for 5 minutes

Samples printed with BioMed Clear Resin have been evaluated in accordance with ISO 10993-1:2018, ISO 7405:2018, ISO 18562-1:2017 and have passed the requirements associated with the following biocompatibility endpoints:

ISO Standard	Description [3]	ISO Standard	Description [3]
ISO 10993-5:2009	Not cytotoxic	ISO 10993-3:2014	Not mutagenic
ISO 10993-10:2010/(R)2014	Not an irritant	ISO 18562-2:2017	Does not emit particulates
ISO 10993-10:2010/(R)2014	Not a sensitizer	ISO 18562-3:2017	Does not emit VOCs
ISO 10993-17:2002, ISO 10993-18:2005	Not toxic (subacute / subchronic)	ISO 18562-4:2017	Does not emit hazardous water-soluble substances
ISO 10993-11: 2017	No evidence of acute systemic toxicity	ISO 10993-11: 2017/USP, General Chapter <151>, Pyrogen Test	Non-pyrogenic

The product was developed and is in compliance with the following ISO Standards:

ISO Standard	Description
EN ISO 13485:2016	Medical Devices – Quality Management Systems – Requirements for Regulatory Purposes
EN ISO 14971:2012	Medical Devices – Application of Risk Management to Medical Devices

[1] Material properties may vary based on part geometry, print orientation, print settings, temperature, and disinfection or sterilization methods used.

[2] Data were measured on post-cured samples printed on a Form 3B printer with 100 µm BioMed Clear Resin settings, washed in a Form Wash for 20 minutes in 99% isopropyl alcohol, and post-cured at 60 °C for 60 minutes in a Form Cure.

[3] BioMed Clear Resin was tested at NAMSA World Headquarters, OH, USA.

formlabs | healthcare

MEDICAL RESIN

BioMed Amber Resin

Biocompatible Photopolymer Resin for Formlabs SLA Printers

BioMed Amber Resin is a rigid material for biocompatible applications requiring short-term contact. Parts printed with BioMed Amber Resin are compatible with common solvent disinfection and sterilization methods. BioMed Amber Resin is manufactured in our ISO 13485 facility.

Medical devices and device components

Research and development

Surgical planning and implant sizing tools

V1 **FLBMAM01**

Prepared 11/04/2019

Rev. 01 31/01/2023

Material Properties	METRIC [1]	IMPERIAL [1]	METHOD
	Post-Cured [2]	Post-Cured [2]	
Tensile Properties	**METRIC [1]**	**IMPERIAL [1]**	**METHOD**
Ultimate Tensile Strength	73 MPa	11 ksi	ASTM D638-10 (Type IV)
Young's Modulus	2900 MPa	420 ksi	ASTM D638-10 (Type IV)
Elongation at Break	12%		ASTM D638-10 (Type IV)
Flexural Properties	**METRIC [1]**	**IMPERIAL [1]**	**METHOD**
Flexural Strength	103 MPa	15 ksi	ASTM D790-15 (Method B)
Flexural Modulus	2500 MPa	363 ksi	ASTM D790-15 (Method B)
Hardness Properties	**METRIC [1]**	**IMPERIAL [1]**	**METHOD**
Hardness Shore D	67 D		ASTM D2240-15 (Type D)
Impact Properties	**METRIC [1]**	**IMPERIAL [1]**	**METHOD**
Notched Izod	28 J/m	0.53 ft-lb/in	ASTM D256-10 (Method A)
Unnotched Izod	142 J/m	2.6 ft-lb/in	ASTM D4812-11
Thermal Properties	**METRIC [1]**	**IMPERIAL [1]**	**METHOD**
Heat Deflection Temp. @ 1.8 MPa	65 °C	149 °F	ASTM D648-18 (Method B)
Heat Deflection Temp. @ 0.45 MPa	78 °C	172 °F	ASTM D648-18 (Method B)
Coefficient of Thermal Expansion	66 µm/m/°C	37 µin/in/°F	ASTM E831-14

Sterilization Compatibility	
E-beam	35 kGy E-beam radiation
Ethylene Oxide	100% Ethylene oxide at 55 °C for 180 minutes
Gamma	29.4 - 31.2 kGy gamma radiation
Steam Sterilization	Autoclave at 134 °C for 20 minutes Autoclave at 121 °C for 30 minutes

For more details on sterilization compatibilities, visit formlabs.com/medical

Disinfection Compatibility	
Chemical Disinfection	70% Isopropyl Alcohol for 5 minutes

BioMed Amber Resin has been evaluated in accordance with ISO 10993-1:2018, Biological evaluation of medical devices - Part 1: Evaluation and testing within a risk management process, and ISO 7405:2009/(R)2015, Dentistry - Evaluation of biocompatibility of medical devices used in dentistry, and passed the requirements for the following biocompatibility risks:

ISO Standard	Description [3]	ISO Standard	Description [3]
ISO 10993-5:2009	Not cytotoxic	ISO 10993-11: 2017	No evidence of acute systemic toxicity
ISO 10993-10:2010/(R)2014	Not an irritant	ISO 10993-11: 2017/USP, General Chapter <151>, Pyrogen Test	Non-pyrogenic
ISO 10993-10:2010/(R)2014	Not a sensitizer		

The product was developed and is in compliance with the following ISO Standards:

ISO Standard	Description
EN ISO 13485:2016	Medical Devices – Quality Management Systems – Requirements for Regulatory Purposes
EN ISO 14971:2012	Medical Devices – Application of Risk Management to Medical Devices

[1] Material properties may vary based on part geometry, print orientation, print settings, temperature, and disinfection or sterilization methods used.

[2] Data for post-cured samples were measured on Type IV tensile bars printed on a Form 2 and Form 3B (impact and thermal measurements) printers with 100 µm BioMed Amber Resin settings, washed in a Form Wash for 20 minutes in 99% Isopropyl Alcohol, and post-cured at 60 °C for 30 minutes in a Form Cure.

[3] BioMed Amber Resin was tested at NAMSA World Headquarters, OH, USA.

formlabs | healthcare

MEDICAL RESIN

BioMed White Resin

Medical-grade white material for 3D printing rigid, biocompatible parts

BioMed White Resin is an opaque white material for biocompatible applications requiring long-term skin contact or short-term mucosal contact. Unique in our portfolio, this medical-grade material is also USP <151> Pyrogen and Acute Systemic Toxicity tested and can be used in applications with short-term tissue, bone, dentin contact.

Parts printed with BioMed White Resin are compatible with common solvent disinfection and sterilization methods. BioMed White Resin is manufactured in our ISO 13485 facility and is also USP Class VI certified which makes it suitable for pharmaceutical and drug delivery applications.

Surgical guides and templates

Biocompatible molds, jigs, and fixtures

V1 **FLBMWH01**

Prepared 03/30/2022

Rev. 01 03/30/2022

Material Properties	METRIC [1]	IMPERIAL [1]	METHOD
	Post-Cured [2]	Post-Cured [2]	
Tensile Properties	METRIC [1]	IMPERIAL [1]	METHOD
Ultimate Tensile Strength	46 MPa	6640 psi	ASTM D638-14 (Type IV)
Young's Modulus	2000 MPa	293 ksi	ASTM D638-14 (Type IV)
Elongation at Break	10%		ASTM D638-14 (Type IV)
Flexural Properties	METRIC [1]	IMPERIAL [1]	METHOD
Flexural Stress at 5% Strain	74 MPa	10800 psi	ASTM D790-15 (Procedure B)
Flexural Modulus	2020.16 MPa	293 ksi	ASTM D790-15 (Procedure B)
Hardness Properties	METRIC [1]	IMPERIAL [1]	METHOD
Hardness Shore D	80 D	-	ASTM D2240-15 (Type D)
Impact Properties	METRIC [1]	IMPERIAL [1]	METHOD
Notched Izod	15 J/m	0.283 ft-lb/in	ASTM D256-10 (Method A)
Unnotched Izod	269 J/mm	5.04 ft-lb/in	ASTM D4812-11
Thermal Properties	METRIC [1]	IMPERIAL [1]	METHOD
Heat Deflection Temp. @ 1.8 MPa	52.4 °C	-	ASTM D648-18 (Method B)
Heat Deflection Temp. @ 0.45 MPa	67.0 °C	-	ASTM D648-18 (Method B)
Coefficient of Thermal Expansion	90.1 µm/m/°C	-	ASTM E831-13
Other Properties	METRIC [1]	IMPERIAL [1]	METHOD
Water Absorption	0.40 wt%	-	ASTM D570-98

Sterilization Compatibility	
E-beam	35 kGy E-beam radiation
Ethylene Oxide	100% Ethylene oxide at 55 °C for 180 minutes
Gamma	29.4 - 31.2 kGy gamma radiation
Steam Sterilization	Autoclave at 134 °C for 20 minutes Autoclave at 121 °C for 30 minutes

For more details on sterilization compatibilities, visit formlabs.com/medical

Disinfection Compatibility	
Chemical Disinfection	70% Isopropyl Alcohol for 5 minutes

Samples printed with BioMed White Resin have been evaluated in accordance with the following biocompatibility endpoints:

ISO Standard	Description [3]
ISO 10993-5:2009	Not cytotoxic
ISO 10993-10:2010/(R)2014	Not an irritant
ISO 10993-10:2010/(R)2014	Not a sensitizer
ISO 10993-11: 2017	No evidence of acute systemic toxicity
ISO 10993-11: 2017/ USP, General Chapter <151>, Pyrogen Test	Non-pyrogenic

[1] Material properties may vary based on part geometry, print orientation, print settings, temperature, and disinfection or sterilization methods used.

[2] Data were measured on post-cured samples printed on a Form3B with 100um BioMed White Resin settings, washed in a Form Wash for 5 minutes in 99% Isopropyl Alcohol, and post-cured at 60°C, 60 minutes in a Form Cure.

[3] BioMed White Resin was tested at NAMSA World Headquarters, OH, USA.

The product was developed and is in compliance with the following ISO Standards:

ISO Standard	Description
EN ISO 13485:2016	Medical Devices – Quality Management Systems – Requirements for Regulatory Purposes
EN ISO 14971:2012	Medical Devices – Application of Risk Management to Medical Devices

SOLVENT COMPATIBILITY

Percent weight gain over 24 hours for a printed and post-cured 1 x 1 x 1 cm cube immersed in respective solvent:

Solvent	24 hr weight gain, %	Solvent	24 hr weight gain, %
Acetic Acid 5%	0.4	Mineral oil, heavy	< 0.1
Acetone	2.9	Mineral oil, light	< 0.1
Bleach ~5% NaOCl	0.3	Salt Water (3.5% NaCl)	0.4
Butyl Acetate	0.4	Skydrol 5	0.5
Diesel Fuel	< 0.1	Sodium hydroxide solution (0.025% pH = 10)	0.3
Diethyl glycol monomethyl ether	1.0	Strong Acid (HCl Conc)	0.2
Hydraulic Oil	< 0.1	TPM	0.6
Hydrogen peroxide (3%)	0.3	Water	0.3
Isooctane	< 0.1	Xylene	0.3
Isopropyl Alcohol	0.2		

formlabs | healthcare

MEDICAL RESIN

BioMed Black Resin

Medical-grade matte black material for 3D printing rigid, biocompatible parts

BioMed Black Resin is a matte, opaque material for biocompatible applications requiring long-term skin contact or short-term mucosal membrane contact. This medical-grade material is suitable for applications that require high contrast for visualization, excellent definition and smooth surface quality.

Parts printed with BioMed Black Resin are compatible with common solvent disinfection and sterilization methods. BioMed Black Resin is manufactured in our ISO 13485 facility and is also USP Class VI certified which makes it suitable for pharmaceutical and drug delivery applications.

Medical devices and device components

Biocompatible molds, jigs, and fixtures

End-use parts requiring patient contact

Consumer goods

V1 **FLBMBL01**

Prepared 03/30/2022

Rev. 01 03/30/2022

Material Properties	METRIC [1]	IMPERIAL [1]	METHOD
	Post-Cured [2]	Post-Cured [2]	
Tensile Properties	**METRIC [1]**	**IMPERIAL [1]**	**METHOD**
Ultimate Tensile Strength	36 MPa	5180 psi	ASTM D638-14 (Type IV)
Young's Modulus	1500 MPa	221 ksi	ASTM D638-14 (Type IV)
Elongation at Break	14%		ASTM D638-14 (Type IV)
Flexural Properties	**METRIC [1]**	**IMPERIAL [1]**	**METHOD**
Flexural Stress at 5% Strain	57 MPa	8290 psi	ASTM D790-15 (Procedure B)
Flexural Modulus	1600 MPa	242 ksi	ASTM D790-15 (Procedure B)
Hardness Properties	**METRIC [1]**	**IMPERIAL [1]**	**METHOD**
Hardness Shore D	77 D	-	ASTM D2240-15 (Type D)
Impact Properties	**METRIC [1]**	**IMPERIAL [1]**	**METHOD**
Notched Izod	25 J/m	0.464 ft-lb/in	ASTM D256-10 (Method A)
Unnotched Izod	348 J/m	6.52 ft-lb/in	ASTM D4812-11
Thermal Properties	**METRIC [1]**	**IMPERIAL [1]**	**METHOD**
Heat Deflection Temp. @ 1.8 MPa	49.4 °C	-	ASTM D648-18 (Method B)
Heat Deflection Temp. @ 0.45 MPa	67.9 °C	-	ASTM D648-18 (Method B)
Coefficient of Thermal Expansion	106.9 µm/m/°C	-	ASTM E831-13
Other Properties	**METRIC [1]**	**IMPERIAL [1]**	**METHOD**
Water Absorption	0.44 wt%	-	ASTM D570-98

Sterilization Compatibility	
E-beam	35 kGy E-beam radiation
Ethylene Oxide	100% Ethylene oxide at 55 °C for 180 minutes
Gamma	29.4 - 31.2 kGy gamma radiation
Steam Sterilization	Autoclave at 134 °C for 20 minutes Autoclave at 121 °C for 30 minutes

For more details on sterilization compatibilities, visit formlabs.com/medical

Disinfection Compatibility	
Chemical Disinfection	70% Isopropyl Alcohol for 5 minutes

Samples printed with BioMed Black Resin have been evaluated in accordance with the following biocompatibility endpoints:

ISO Standard	Description [3]
ISO 10993-5:2009	Not cytotoxic
ISO 10993-10:2010/(R)2014	Not an irritant
ISO 10993-10:2010/(R)2014	Not a sensitizer

The product was developed and is in compliance with the following ISO Standards:

ISO Standard	Description
EN ISO 13485:2016	Medical Devices – Quality Management Systems – Requirements for Regulatory Purposes
EN ISO 14971:2012	Medical Devices – Application of Risk Management to Medical Devices

[1] Material properties may vary based on part geometry, print orientation, print settings, temperature, and disinfection or sterilization methods used.

[2] Data were measured on post-cured samples printed on a Form3B with 100um BioMed Black Resin settings, washed in a Form Wash for 5 minutes in 99% Isopropyl Alcohol, and post-cured at 70°C, 60 minutes in a Form Cure.

[3] BioMed Black Resin was tested at NAMSA World Headquarters, OH, USA.

formlabs | healthcare

MEDICAL RESIN

BioMed Durable Resin

For Strong and Impact Resistant Medical Devices and Instruments

BioMed Durable Resin is a clear material for biocompatible applications requiring impact, shatter, and abrasion resistance. This USP Class VI material is made in an FDA-registered, ISO 13485 facility and can be used in applications for long-term skin (>30 days), and short-term tissue, bone, and dentin contact (<24hrs)

Other biocompatibility endpoints have not been evaluated and may be added over time.

End-Use Devices and Components Requiring Biocompatibility and Impact Resistance

Patient-Specific Instruments

Single-Use Instruments

V1 **FLBMDU01**

V1.1 **FLDUCL21**

Prepared 19/05/2023

Rev. 02 26/06/2023

Material Properties	METRIC [1]	IMPERIAL [1]	METHOD
	Post-Cured [2]	Post-Cured [2]	
Tensile Properties	**METRIC [1]**	**IMPERIAL [1]**	**METHOD**
Ultimate Tensile Strength	29.1 MPa	4230 psi	ASTM D638-14 (Type IV)
Young's Modulus	994 MPa	144 ksi	ASTM D638-14 (Type IV)
Elongation at Break	33%		ASTM D638-14 (Type IV)
Flexural Properties	**METRIC [1]**	**IMPERIAL [1]**	**METHOD**
Flexural Stress at 5% Strain	21 MPa	92 ksi	ASTM D790-15 (Procedure B)
Flexural Modulus	643 MPa	3070 psi	ASTM D790-15 (Procedure B)
Hardness Properties	**METRIC [1]**	**IMPERIAL [1]**	**METHOD**
Hardness Shore D	75D		ASTM D2240-15 (Type D)
Impact Properties	**METRIC [1]**	**IMPERIAL [1]**	**METHOD**
Notched Izod	98 J/m	1.84 ft-lb/in	ASTM D256-10 (Method A)
Unnotched Izod	1340 J/m	25.1 ft-lb/in	ASTM D4812-11
Thermal Properties	**METRIC [1]**	**IMPERIAL [1]**	**METHOD**
Heat Deflection Temp. @ 1.8 MPa	40 °C	104 °F	ASTM D648-18 (Method B)
Heat Deflection Temp. @ 0.45 MPa	46 °C	115 °F	ASTM D648-18 (Method B)
Coefficient of Thermal Expansion	102.9 um/m/C		ASTM E831-13

Sterilization Compatibility
For details on sterilization compatibilities, visit formlabs.com/medical

Disinfection Compatibility	
Chemical Disinfection	70% Isopropyl Alcohol for 5 minutes

Samples printed with BioMed Durable Resin have been evaluated in accordance with the following biocompatibility endpoints:

ISO Standard	Description [3]	ISO Standard	Description [3]
EN ISO 10993-5:2009	Not cytotoxic	ISO 10993-11: 2017	No evidence of acute systemic toxicity
ISO 10993-10:2010/(R)2014	Not an irritant	ISO 10993-11: 2017/USP, General Chapter <151>, Pyrogen Test	Non-pyrogenic
ISO 10993-10:2010/(R)2014	Not a sensitizer	USP <88> Biological Reactivity Tests, In-vivo	USP Class VI Certified

The product was developed and is in compliance with the following ISO Standards:

ISO Standard	Description
EN ISO 13485:2016	Medical Devices – Quality Management Systems – Requirements for Regulatory Purposes
EN ISO 14971:2012	Medical Devices – Application of Risk Management to Medical Devices

[1] Material properties may vary based on part geometry, print orientation, print settings, temperature, and disinfection or sterilization methods used.

[2] Data were measured on post-cured samples printed on a Form 3B with 100um BioMed Durable Resin settings, washed in a Form Wash for 10 minutes in 99% Isopropyl Alcohol, and post-cured at 60°C, 20 minutes in a Form Cure.

[3] BioMed Durable Resin was tested at NAMSA World Headquarters, OH, USA.

SOLVENT COMPATIBILITY

Percent weight gain over 24 hours for a printed and post-cured 1 x 1 x 1 cm cube immersed in respective solvent:

Solvent	24 hr weight gain, %	Solvent	24 hr weight gain, %
Acetic Acid 5%	0.7	Mineral oil, heavy	0.1
Acetone	12.4	Mineral oil, light	0.1
Bleach ~5% NaOCl	0.5	Salt Water (3.5% NaCl)	0.5
Butyl Acetate	5.0	Skydrol 5	0.6
Diesel Fuel	0.1	Sodium hydroxide solution (0.025% pH = 10)	0.5
Diethyl glycol monomethyl ether	3.0	Strong Acid (HCl Conc)	0.7
Hydraulic Oil	0.2	TPM	1.1
Hydrogen peroxide (3%)	0.6	Water	0.5
Isooctane	0.02	Xylene	4.8
Isopropyl Alcohol	2.0		

formlabs | healthcare

MEDICAL RESIN

BioMed Flex 80A Resin

For Flexible, Biocompatible, Transparent Medical Devices and Models

BioMed Flex 80A Resin is a firm, flexible, medical-grade material for applications requiring durability, biocompatibility, and transparency. This ISO 10993 and USP Class VI certified material is made in an FDA-registered, ISO 13485 facility and can be used in applications for long-term skin (> 30 days), and short-term mucosal membrane contact (< 24hrs).

Flexible Biocompatible Medical Devices

Firm Tissue Models to Assist in Surgeries

V1 **FLBMFL01**

Prepared 20/09/2023

Rev. 01 20/09/2023

Material Properties	METRIC [1]	IMPERIAL [1]	METHOD
	Post-Cured [2]	Post-Cured [2]	
Mechanical Properties	**METRIC [1]**	**IMPERIAL [1]**	**METHOD**
Ultimate Tensile Strength [3]	7.2 MPa	1040 psi	ASTM D412-06 (A)
Stress at 50% Elongation	2.6 MPa	377 psi	ASTM D412-06 (A)
Stress at 100% Elongation	4.5 MPa	653 psi	ASTM D412-06 (A)
Elongation at Break	135 %		ASTM D412-06 (A)
Tear Strength [4]	22 kN/m	125 lb/in	ASTM D624-00
Shore Hardness	77 - 80A		ASTM 2240
Compression Set 23 °C for 22 hours	24.7%		ASTM D395-03 (B)
Compression Set 70 °C for 22 hours	5.3%		ASTM D395-03 (B)
Bayshore Resilience	29%		ASTM D2632
Thermal Properties	**METRIC [1]**	**IMPERIAL [1]**	**METHOD**
Glass transition temperature (Tg)	37 °C	99 °F	DMA

Disinfection Compatibility	
Chemical Disinfection	70% Isopropyl Alcohol for 5 minutes

Samples printed with BioMed Flex 80A Resin have been evaluated in accordance with the following biocompatibility endpoints:

ISO Standard	Description [3]
ISO 10993-5:2009	Met requirements of test
ISO 10993-23:2021	Met requirements of test
ISO 10993-10:2021	Met requirements of test
USP <88> Biological Reactivity Tests, In-vivo	USP Class VI Certified

The product was developed and is in compliance with the following ISO Standards:

ISO Standard	Description
EN ISO 13485:2016	Medical Devices – Quality Management Systems – Requirements for Regulatory Purposes
EN ISO 14971:2012	Medical Devices – Application of Risk Management to Medical Devices

[1] Material properties can vary with part geometry, print orientation, print settings and temperature.

[2] Data was obtained from parts printed using Form 3B, 100 µm, BioMed Flex 80A Resin settings, and using the BioMed Flex 80A MFG guide.

[3] Tensile testing was performed after 3+ hours at 23 °C, using a Die C specimen cut from sheets.

[4] Tear testing was performed after 3+ hours at 23 °C, using a Die C tear specimen directly printed

SOLVENT COMPATIBILITY

Percent weight gain over 24 hours for a printed and post-cured 1 x 1 x 1 cm cube immersed in respective solvent:

Solvent	24 hr weight gain, %	Solvent	24 hr weight gain, %
Acetic Acid 5%	1.42	Isooctane (aka gasoline)	9
Acetone	65.3	Mineral oil (light)	0.4
Isopropyl Alcohol	25.9	Mineral oil (Heavy)	0.2
Bleach ~5% NaOCl	0.5	Salt Water (3.5% NaCl)	0.5
Butyl Acetate	97.5	Sodium Hydroxide solution (0.025% PH 10)	0.6
Diesel Fuel	5.1	Water	0.6
Diethyl Glycol Monomethyl Ether	30.9	Xylene	112.5
Hydraulic Oil	2.5	Strong Acid (HCl conc)	37.3
Skydrol 5	28.1	Tripropylene Glycol Methyl Ether (TPM)	31.2
Hydrogen peroxide (3%)	0.7		

formlabs | healthcare

MEDICAL RESIN

BioMed Elastic 50A Resin

For Soft, Biocompatible, Transparent Medical Devices and Models

BioMed Elastic 50A Resin is a soft, elastic, medical grade material for applications requiring comfort, biocompatibility, and transparency. This ISO 10993 and USP Class VI certified material is made in an FDA-registered, ISO 13485 facility and can be used in applications for long-term skin contact (> 30 days), and short-term mucosal membrane contact (< 24hrs).

Elastic Biocompatible Medical Devices

Soft Tissue Models to Assist in Surgeries

V1 **FLBMEL01**

Prepared 20/09/2023

Rev. 02 24/06/2024

Material Properties	METRIC [1]	IMPERIAL [1]	METHOD
	Post-Cured [2]	Post-Cured [2]	
Mechanical Properties	**METRIC [1]**	**IMPERIAL [1]**	**METHOD**
Ultimate Tensile Strength [3]	2.3 MPa	339 psi	ASTM D412-06 (A)
Stress at 50% Elongation	1 MPa	145 psi	ASTM D412-06 (A)
Stress at 100% Elongation	1.3 MPa	189 psi	ASTM D412-06 (A)
Elongation at Break	150%		ASTM D412-06 (A)
Tear Strength [4]	11 kN/m	60.8 lb/in	ASTM D624-00
Shore Hardness	50A		ASTM 2240
Compression Set 23 °C for 22 hours	8%		ASTM D395-03 (B)
Compression Set 70 °C for 22 hours	11%		ASTM D395-03 (B)
Bayshore Resilience	15%		ASTM D2632
Thermal Properties	**METRIC [1]**	**IMPERIAL [1]**	**METHOD**
Glass transition temperature (Tg)	-36 °C	-32.8 °F	DMA

Disinfection Compatibility	
Chemical Disinfection	70% Isopropyl Alcohol for 5 minutes

Samples printed with BioMed Elastic 50A Resin have been evaluated in accordance with the following biocompatibility endpoints:

ISO Standard	Description [3]
ISO 10993-5:2009	Met requirements of test
ISO 10993-23:2021	Met requirements of test
ISO 10993-10:2021	Met requirements of test
USP <88> Biological Reactivity Tests, In-vivo	USP Class VI Certified

The product was developed and is in compliance with the following ISO Standards:

ISO Standard	Description
EN ISO 13485:2016	Medical Devices – Quality Management Systems – Requirements for Regulatory Purposes
EN ISO 14971:2012	Medical Devices – Application of Risk Management to Medical Devices

[1] Material properties can vary with part geometry, print orientation, print settings and temperature.

[2] Data was obtained from parts printed using Form 3B, 100 µm, BioMed Elastic 50A settings, and using the BioMed Elastic 50A MFG guide.

[3] Tensile testing was performed after 3+ hours at 23 °C, using a Die C specimen cut from sheets.

[4] Tear testing was performed after 3+ hours at 23 °C, using a Die C tear specimen directly printed

SOLVENT COMPATIBILITY

Percent weight gain over 24 hours for a printed and post-cured 1 x 1 x 1 cm cube immersed in respective solvent:

Solvent	24 hr weight gain, %	Solvent	24 hr weight gain, %
Acetic Acid 5%	1.5	Isooctane (aka gasoline)	15.6
Acetone	43.4	Mineral oil (light)	0.7
Isopropyl Alcohol	39.2	Mineral oil (Heavy)	0.4
Bleach ~5% NaOCl	0.6	Salt Water (3.5% NaCl)	0.6
Butyl Acetate	133.1	Sodium Hydroxide solution (0.025% PH 10)	0.7
Diesel Fuel	7.9	Water	0.7
Diethyl Glycol Monomethyl Ether	31.4	Xylene	163.9
Hydraulic Oil	3.9	Strong Acid (HCl conc)	45.6
Skydrol 5	41.2	Tripropylene Glycol Methyl Ether (TPM)	43.6
Hydrogen peroxide (3%)	0.9		

formlabs

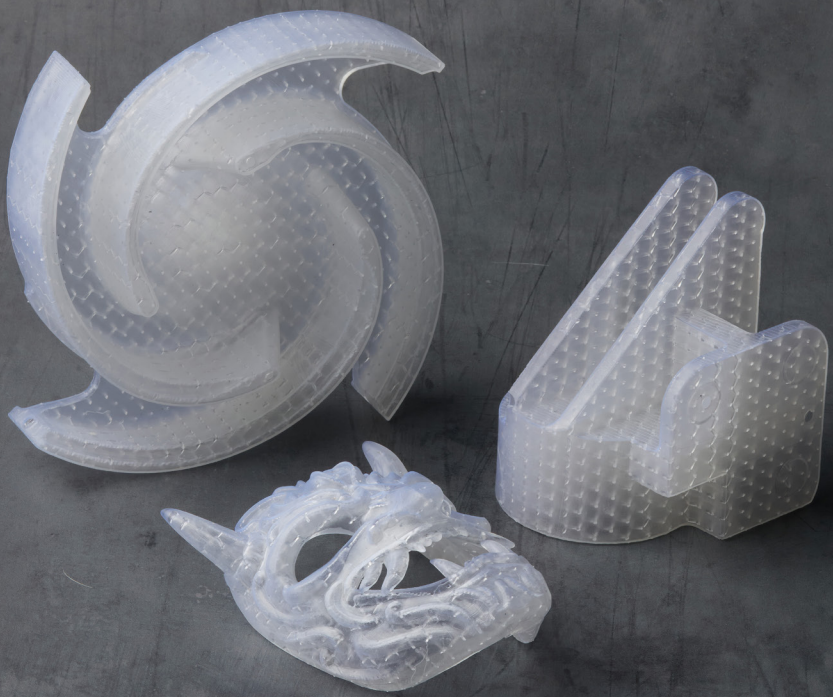
CASTING RESIN

Clear Cast Resin

3D Print Accurate, Low Ash Patterns for Investment Casting Directly in House

Clear Cast Resin is a resin designed for investment casting, to directly print patterns that can be invested and cast. It has an extremely low thermal expansion, low ash, and antimony free with no trace heavy metals.

Patterns for investment casting



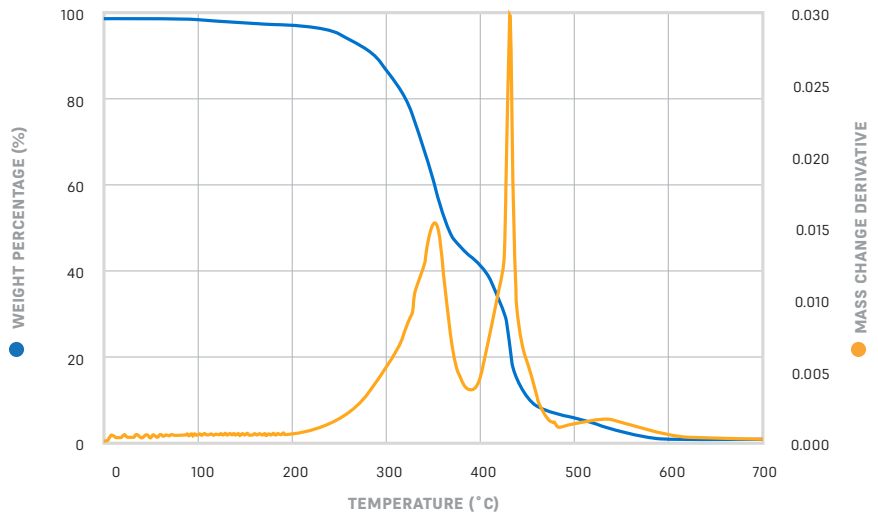
V1 **FLCCCL01**

Prepared 12/08/2024

Rev. 01 12/08/2024

Material Properties	METRIC [1]		IMPERIAL		METHOD
	Green	Post-Cured	Green	Post-Cured	
Mechanical Properties	METRIC [1]		IMPERIAL		METHOD
Ultimate Tensile Strength	38 MPa	65 MPa	5510 psi	9380 psi	ASTM D638-14
Tensile Modulus	1.6 GPa	2.8 GPa	234 ksi	402 ksi	ASTM D638-14
Elongation at Break	12%	6%	12%	6%	ASTM D638-14
Flexural Modulus	1.3 GPa	2.2 GPa	181 psi	320 psi	ASTM D790-15
Notched Izod	16 J/m	25 J/m	0.3 ft-lb/in	0.46 ft-lb/in	ASTM D256-10
Thermal Properties	METRIC [1]		IMPERIAL		METHOD
Thermal Expansion, -30-140°C	-	94.8 µm/m/°C	-	52.6 µin/in/°F	ASTM E831-19
Heat Deflection Temp. @ 1.8 MPa	43 °C	58 °C	109 °F	137 °F	ASTM D648-16
Heat Deflection Temp. @ 0.45 MPa	50 °C	73 °C	121 °F	163 °F	ASTM D648-16
Burnout Characteristics	METRIC [1]		IMPERIAL		METHOD
Ash Content	-	<0.020%	-	<0.020%	ASTM D2584-18
Antimony[2]	-	<10 ppm	-	<10 ppm	ASTM E1479-16
Detected Transition Metals (>10 ppm)	-	Al, Cu	-	Al, Cu	ASTM E1479-16
High Concentration Transition Metals (>50 ppm)	-	none	-	none	ASTM E1479-16

Clear Cast Resin TGA Trace



formlabs

CASTING RESIN

Castable Wax Resin

Casting Resin optimized for fine features

A 20% wax-filled photopolymer for reliable casting with near zero ash content and clean burnout, Castable Wax Resin accurately captures intricate features and offers the smooth surfaces stereolithography 3D printing is known for.

V1 **FLCWPU01**

Prepared 07/05/2018

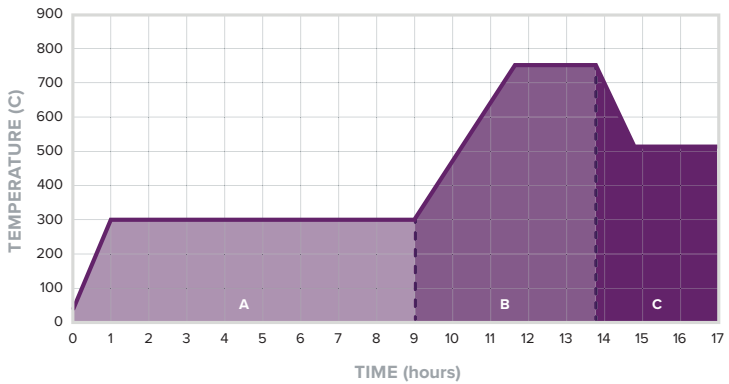
Rev. 01 07/05/2018

Material Properties	METRIC [1]	IMPERIAL [1]	METHOD
	Green [2]	Green [2]	
Tensile Properties	**METRIC [1]**	**IMPERIAL [1]**	**METHOD**
Ultimate Tensile Strength	12 MPa	1680 psi	ASTM D638-10
Tensile Modulus	220 MPa	32 ksi	ASTM D638-10
Elongation at Break	13%		ASTM D638-10
Burnout Properties	**METRIC [1]**	**IMPERIAL [1]**	**METHOD**
Temp @ 5% Mass Loss	249 °C	480 °C	ASTM E1131
Ash Content (TGA)	0.0 - 0.1%		ASTM E1131

STANDARD BURNOUT SCHEDULE

The Standard Burnout Schedule is designed to provide the maximum possible investment strength and complete burnout of the finest details using Certus Prestige Optima or similar investment materials. Use this schedule as a starting point and make adjustments as needed.

	PHASE	TIME	SCHEDULE °C	SCHEDULE °F
A	Insert Flasks	0 min	21 °C	70 °F
	Ramp	60 min	4.7 °C / min	8.4 °F / min
	Hold	480 min	300 °C	572 °F
B	Ramp	100 min	4.5 °C / min	8.1 °F / min
	Hold	180 min	750 °C	1382 °F
C	Ramp	60 min	- 4.0 °C / min	- 7.1 °F / min
	Casting Window	Up to 2 hours	512 °C (or desired casting temp)	954 °F (or desired casting temp)



Post-Curing Info:

No post-cure required.

[1] Material properties can vary with part geometry, print orientation, print settings, and temperature.

[2] Data was obtained from parts printed using Form 2, Castable 50 µm Fine Detail settings and washed without post-cure.

formlabs

FORM X

Alumina 4N Resin

Technical Ceramic with Extreme Performance

A 99.99% purity technical ceramic with exceptional performance in extreme environments: thermally resistant, hard, abrasion resistant, mechanically strong, and chemically inert.

High voltage components

Mixing blades and pipes

Insulating housings or tubes

Foundry tools for metal casting

V1 **FLAL4N01**

Prepared 31/09/2023

Rev. 01 31/09/2023

Resin Properties	METRIC	IMPERIAL	METHOD
Purity (%)	99.99%		-
Particle Size	d90 < 1 micron		-
Green State Properties			
Flexural Strength [3]	3.6 MPa	520 psi	ASTM D790
Flexural Modulus [3]	24.5 MPa	3.5 ksi	ASTM D790
Shore D Hardness [3]	70D		ASTM D2240
Color	Off-White		
Sintered State Properties	**METRIC**	**IMPERIAL**	**METHOD**
Physical and Mechanical Properties			
4 Point Flex Strength (XY) [3, 5]	400 MPa	58 ksi	ASTM C1259
4 Point Flex Strength (Z) [3, 5]	320 MPa	46 ksi	ASTM C1259
Weibull Modulus (XY) [3, 5]	9	-	ASTM C1259
Theoretical Density [4, 5]	3.987 g/cm^3	0.144 lbs/in3	-
Relative Density [3, 5]	98.60%	-	ASTM C373
Compressive Strength [4, 5]	2200 MPa	330 ksi	ASTM C773
Color	White		-
Vickers Hardness [4, 5]	1500	-	-
Young's Modulus [4, 5]	390 GPa	58,000 ksi	ASTM C1259
Fracture Toughness [4, 5]	3-5 MPa √m	-	ASTM C1421
Surface Roughness (R_a) [3, 5]	0.5-3 μm	20-120 microinches Ra	
Electrical Properties	**METRIC**	**IMPERIAL**	**METHOD**
Electrical Resistivity [4, 5]	> 1 x 10^{14} Ω· cm	-	ASTM D257
Dielectric Loss tan delta (tan δ), 1 MHz [4, 5]	9x10^{-5}	-	-
Permittivity [4, 5]	9.8	-	-
Thermal properties	**METRIC**	**IMPERIAL**	**METHOD**
Coefficient of Thermal Expansion [4, 5]	5 ppm/K	2.78 ppm / °F	ASTM E228
Maximum Working Temperature [3, 5]	1500 °C	2750 °F	-
Thermal Conductivity [4, 5]	32 W/m· K	-	-

To learn more about how to use Alumina 4N Resin, visit our support site.

[1] Material properties may vary based on part geometry, print orientation, print settings, and firing schedule used.

[2] All sintered parts were fired using a 2 oven conservative firing schedule (schedule #1)

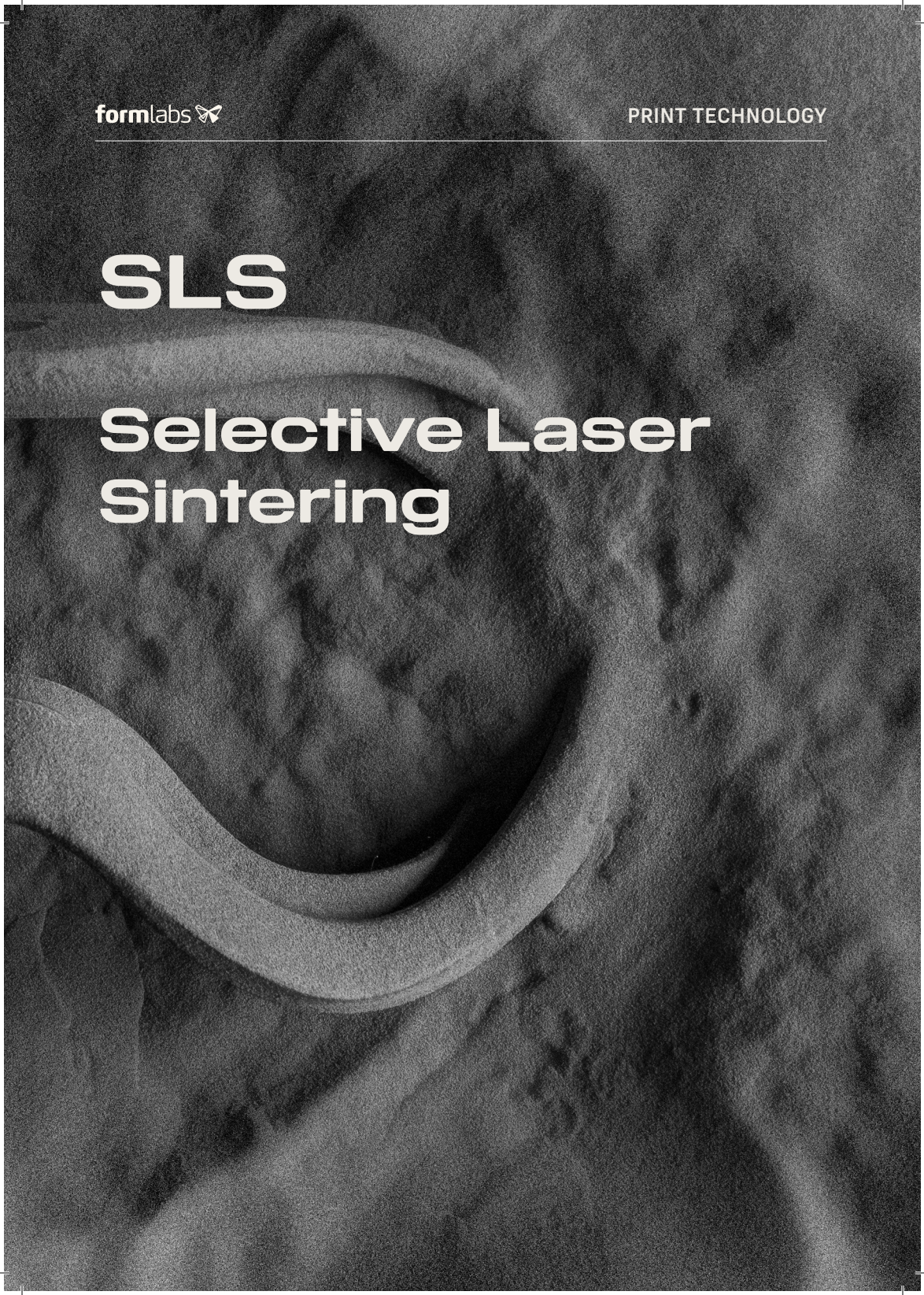
[3] Internally measured data

4 Literature value

[5] Currently testing at an independent testing lab

SLS

Selective Laser Sintering



SLS Material Printability Chart

formlabs

	Nylon 12 Recommended	Nylon 11	Nylon 12 GF	Nylon 11 CF	TPU 90A	Nylon 12 White	Nylon 12 Tough
Air / Inert Recommendation	Air	Nitrogen**	Air	Nitrogen	Air	Nitrogen**	Air
Refresh Rate	30%	30%	50%	30%	20%	30%	20%
Printer Compatibility	Fuse 1, Fuse 1+	Fuse 1+	Fuse 1, Fuse 1+	Fuse 1+	Fuse 1, Fuse 1+	Fuse 1+	Fuse 1+
Dimensional Accuracy	Best	Good	Best	Good	Fair	Good	Best
Surface Finish	Best	Good	Best	Good	Fair	Good	Good
Print Speed	Best	Fair	Fair	Fair	Good	Fair	Good
Fine Feature Resolution	Best	Fair	Fair	Fair	Good	Good	Best
High Aspect Ratio Parts	Best	Fair	Good	Good	Fair	Best	Best
Large Cross Section Parts	Good	Fair	Good	Good	Fair	Good	Best
Material Properties							
Tensile Strength	Best	Best	Good	Best	Not Recommended	Best	Good
Impact Resistance	Good	Best	Good	Best	–	Good	Best
Elongation	Fair	Good	Not Recommended	Fair	Best	Fair	Good
Temp Resistance	Fair	Not Recommended	Good	Best	Not Recommended	Fair	Not Recommended
Low Moisture Absorption	Fair	Best	Good	–	Fair	Not Recommended	Good
Lightweight / Density	Good	Good	Fair	Good	Good	Good	Good
See It In Use							
	Kling & Freitag	MAG Orthotics	JasperEngines	TUM	Artus3D	Coming Soon	Coming Soon

**Nylon 11 is recommended to print in Nitrogen environment. Printing in air is possible but will compromise material properties and lead to powder degradation at a faster rate.

**Nylon 12 White Powder is recommended to print in Nitrogen to maintain the most consistent white appearance. Printing in air has been correlated with yellowing of powder over time.

Powder yellowing has little to no impact on the ability and efficacy of dyeing printed parts.

formlabs

SLS POWDER

Nylon 12 Powder

SLS Powder For Strong, Functional Prototypes and End-Use Parts

With high tensile strength, ductility, and environmental stability, Nylon 12 Powder is suitable for creating complex assemblies and durable parts with minimal water absorption.

Nylon 12 Powder is specifically developed for use on the Fuse Series printers.

V1 **FLP12G01**

Prepared 08/19/2020

Rev. 01 08/19/2020

Mechanical Properties	METRIC	IMPERIAL	METHOD
Ultimate Tensile Strength	50 MPa	7252 psi	ASTM D638 Type 1
Tensile Modulus	1850 MPa	268 ksi	ASTM D638 Type 1
Elongation at Break (X/Y)	11%	11%	ASTM D638 Type 1
Elongation at Break (Z)	6%	6%	ASTM D638 Type 1
Flexural Properties	**METRIC**	**IMPERIAL**	**METHOD**
Flexural Strength	66 MPa	9572 psi	ASTM D 790-15
Flexural Modulus	1600 MPa	232 ksi	ASTM D 790-15
Impact Properties	**METRIC**	**IMPERIAL**	**METHOD**
Notched Izod	32 J/m	0.60 ft-lb/in	ASTM D256-10
Thermal Properties	**METRIC**	**IMPERIAL**	**METHOD**
Heat Deflection Temp. @ 1.8 MPa	87 °C	189 °F	ASTM D648
Heat Deflection Temp. @ 0.45 MPa	171 °C	340 °F	ASTM D648
Vicat Softening Temperature	175 °C	347 °F	ASTM D1525
Other Properties	**METRIC**	**IMPERIAL**	**METHOD**
Moisture Content (powder)	0.25%	0.25%	ISO 15512 Method D
Water Absorption (printed part)	0.66%	0.66%	ASTM D570

Samples printed with Nylon 12 Powder have been evaluated in accordance with ISO 10993-1:2018, and has passed the requirements for the following biocompatibility risks:

ISO Standard	Description [3,4]
ISO 10993-5:2009	Not cytotoxic
ISO 10993-10:2010/(R)2014	Not an irritant
ISO 10993-10:2010/(R)2014	Not a sensitizer
ISO 10993-11:2017 (Material Mediated Pyrogenicity)	Non-Pyrogenic
ISO 10993-11:2017 (Acute Systemic Toxicity)	No Evidence of Systemic Toxicity

Flammability Properties

Testing Standard	Rating
UL 94 Section 7	HB *

* Thickness of the sample tested = 3.00mm

Solvent Compatibility
Percent weight gain over 24 hours for a printed 1 x 1 x 1 cm cube immersed in respective solvent:

Solvent	24 hr weight gain, %	Solvent	24 hr weight gain, %
Acetic Acid 5%	0.1	Mineral oil (Heavy)	0.7
Acetone	0.1	Mineral oil (Light)	0.5
Bleach ~5% NaOCl	0.2	Salt Water (3.5% NaCl)	0.2
Butyl Acetate	0.2	Skydrol 5	0.6
Diesel Fuel	0.4	Sodium Hydroxide solution (0.025% PH 10)	0.2
Diethyl glycol Monomethyl Ether	0.5	Strong Acid (HCl conc)	0.8
Hydraulic Oil	0.6	Tripropylene glycol monomethyl ether	0.3
Hydrogen peroxide (3%)	0.2	Water	0.1
Isooctane (aka gasoline)	<0.1	Xylene	0.1
Isopropyl Alcohol	0.2		

[1] Material properties may vary with part geometry, print orientation and temperature.

[2] Parts were printed using Fuse 1 with Nylon 12 Powder. Parts were conditioned at 50% relative humidity and 23 °C for 7 days before testing.

[3] Material properties may vary based on part design and manufacturing practices. It is the manufacturer's responsibility to validate the suitability of the printed parts for the intended use.

[4] Nylon 12 was tested at NAMSA World Headquarters, OH, USA.

formlabs

SLS POWDER

Nylon 12 Tough

A highly ductile and dimensionally accurate nylon powder.

Nylon 12 Tough Powder offers the best-in-class refresh rate among Nylon powders, high ductility, and great dimensional accuracy across the build chamber. Print more durable parts for prototyping and small batch production that have reduced warpage without sacrificing strength.

For best results, Nylon 12 Tough Powder is required to undergo a powder aging process prior to first built. Nylon 12 Tough Powder is specifically developed for use on the Fuse 1+ 30W printer.

Material properties testing was completed with parts printed using aged powder on a bed temperature tuned printer. Scan the QR Codes to learn more about Powder Aging and Bed Temperature Tuning.

Powder Aging

Temperature Tuning

V1 **FLP12T01**

Prepared 08/10/2024

Rev. 01 08/10/2024

Mechanical Properties	METRIC	IMPERIAL	METHOD
Ultimate Tensile Strength	42 MPa	6200 psi	ASTM D638-14 Type 1
Tensile Modulus	1450 MPa	215 ksi	ASTM D638-14 Type 1
Elongation at Break (X/Y)	25%	25%	ASTM D638-14 Type 1
Elongation at Break (Z)	15%	15%	ASTM D638-14 Type 1
Flexural Strength	42 MPa	6200 psi	ASTM D790-17
Flexural Modulus	1100 MPa	165 ksi	ASTM D790-17
Notched Izod	60 J/m	1.1 ft-lb/in	ASTM D256-10

Thermal Properties	METRIC	IMPERIAL	METHOD
Heat Deflection Temp. @ 1.8 MPa	46 °C	116 °F	ASTM D648-16
Heat Deflection Temp. @ 0.45 MPa	161 °C	321 °F	ASTM D648-16
Vicat Softening Temperature	170 °C	337 °F	ASTM D1525

Other Properties	METRIC	IMPERIAL	METHOD
Water Absorption (printed part)	0.30%	0.30%	ASTM D570

Biocompatibility Testing In Progress
Samples are currently undergoing testing for biocompatibility. When the testing has concluded, results will be updated on this sheet. In the meantime, Formlabs recommends that customers complete their own biocompatibility evaluation specific to their intended end use.

Samples printed with Nylon 12 Tough have been evaluated in accordance with ISO 10993-1:2018, and has passed the requirements for the following biocompatibility risks:

ISO Standard Description	Result [3,4]
ISO 10993-11:2017	No systemic toxicity
ISO 10993-5:2009	Not cytotoxic
ISO 10993-23:2021	Not an irritant
ISO 10993-10:2021	Not a sensitizer
ISO 10993-11:2017	Nonpyrogenic

Solvent Compatibility
Percent weight gain over 24 hours for a printed 1 x 1 x 1 cm cube immersed in respective solvent:

Solvent	24 hr weight gain, %	Solvent	24 hr weight gain, %
Acetic Acid 5%	0.2	Mineral oil, heavy	1.0
Acetone	0.2	Mineral oil, light	0.8
Bleach ~5% NaOCl	0.1	Salt Water (3.5% NaCl)	0.2
Butyl Acetate	0.1	Skydrol 5	0.8
Diesel Fuel	0.6	Sodium hydroxide solution (0.025% pH = 10)	0.1
Diethyl glycol monomethyl ether	0.5	Strong Acid (HCl Conc)	5.6
Hydraulic Oil	0.9	TPM	0.8
Hydrogen peroxide (3%)	0.1	Water	0.1
Isooctane	0.1	Xylene	0.2
Isopropyl Alcohol	0.3		

[1] Material properties may vary with part geometry, print orientation and temperature.

[2] Parts were printed using Fuse 1+ 30W with Nylon 12 Tough Powder. Parts were conditioned at 23 °C, 50% R.H. for 40 hours.

[3] Material properties may vary based on part design and manufacturing practices. It is the manufacturer's responsibility to validate the suitability of the printed parts for the intended use.

[4] Nylon 12 Tough was tested at NAMSA World Headquarters, OH, USA.

formlabs

SLS POWDER

Nylon 12 White

Produce high contrast and detailed white SLS parts.

Nylon 12 White Powder combines all of the great qualities of the general purpose and biocompatible Nylon 12 Powder with the customizability of white parts. Create functional prototypes and end-use customer-facing parts that can be easily dyed to match brand aesthetics as well as medical devices and models with high contrast and detail.

For best results, print Nylon 12 White Powder with inert atmospheric control on a bed temperature tuned printer. Nylon 12 White Powder is specifically developed for use on the Fuse 1+ 30W printer.

Material properties testing was completed with parts printed on a bed temperature tuned printer. Scan the QR Code to learn more about the Bed Temperature Tuning process.

Temperature Tuning

V1 **FLP12W01**

Prepared 08/10/2024

Rev. 01 08/10/2024

Mechanical Properties	METRIC	IMPERIAL	METHOD
Ultimate Tensile Strength	47 MPa	6900 psi	ASTM D638-14 Type 1
Tensile Modulus	1950 MPa	285 ksi	ASTM D638-14 Type 1
Elongation at Break (X/Y)	8%	8%	ASTM D638-14 Type 1
Elongation at Break (Z)	6%	6%	ASTM D638-14 Type 1
Flexural Strength	56 MPa	8100 psi	ASTM D790-17
Flexural Modulus	1500 MPa	217 ksi	ASTM D790-17
Notched Izod	28 J/m	0.5 ft-lb/in	ASTM D256-10

Thermal Properties	METRIC	IMPERIAL	METHOD
Heat Deflection Temp. @ 1.8 MPa	87 °C	189 °F	ASTM D648-16
Heat Deflection Temp. @ 0.45 MPa	177 °C	350 °F	ASTM D648-16
Vicat Softening Temperature	177 °C	350 °F	ASTM D1525

Other Properties	METRIC	IMPERIAL	METHOD
Water Absorption (printed part)	1.40%	1.40%	ASTM D570

Biocompatibility Testing In Progress
Samples are currently undergoing testing for biocompatibility. When the testing has concluded, results will be updated on this sheet. In the meantime, Formlabs recommends that customers complete their own biocompatibility evaluation specific to their intended end use.

Samples printed with Nylon 12 White have been evaluated in accordance with ISO 10993-1:2018, and has passed the requirements for the following biocompatibility risks:

ISO Standard Description	Result [3,4]
ISO 10993-11:2017	No systemic toxicity
ISO 10993-5:2009	Not cytotoxic
ISO 10993-23:2021	Not an irritant
ISO 10993-10:2021	Not a sensitizer
ISO 10993-11:2017	Nonpyrogenic

Solvent Compatibility
Percent weight gain over 24 hours for a printed 1 x 1 x 1 cm cube immersed in respective solvent:

Solvent	24 hr weight gain, %	Solvent	24 hr weight gain, %
Acetic Acid 5%	0.2	Mineral oil, heavy	2.2
Acetone	0.2	Mineral oil, light	2.0
Bleach ~5% NaOCl	0.2	Salt Water (3.5% NaCl)	0.1
Butyl Acetate	0.2	Skydrol 5	1.9
Diesel Fuel	1.3	Sodium hydroxide solution (0.025% pH = 10)	0.1
Diethyl glycol monomethyl ether	1.0	Strong Acid (HCl Conc)	4.8
Hydraulic Oil	1.7	TPM	1.1
Hydrogen peroxide (3%)	0.1	Water	0.1
Isooctane	0.3	Xylene	0.2
Isopropyl Alcohol	0.2		

[1] Material properties may vary with part geometry, print orientation and temperature.

[2] Parts were printed using Fuse 1+ 30W with Nylon 12 White Powder. Parts were conditioned at 23 °C, 50% R.H. for 40 hours.

[3] Material properties may vary based on part design and manufacturing practices. It is the manufacturer's responsibility to validate the suitability of the printed parts for the intended use.

[4] Nylon 12 White was tested at NAMSA World Headquarters, OH, USA.

formlabs

SLS POWDERS

Nylon 12 GF Powder

For stiff, stable, functional parts.

A high-performance SLS material for in-house production of parts that require high rigidity, dimensional accuracy, and thermal stability.

Specifically developed for use on the Fuse Series Printers.

Fixtures Undergoing Long-Term Sustained Loading

Stiff Structural Components

End-Use Industrial Parts

Functional Prototypes for composite products

Thermally StressedHousings

V1 **FLP12B01**

Prepared 02/01/2022

Rev. 01 02/01/2022

Material Properties	METRIC [1,2]	IMPERIAL [1,2]	METHOD
Mechanical Properties	**METRIC [1,2]**	**IMPERIAL [1,2]**	**METHOD**
Ultimate Tensile Strength	38 MPa	5510 psi	ASTM D638-14 Type 1
Tensile Modulus	2800 MPa	406 ksi	ASTM D638-14 Type 1
Elongation at Break (X/Y)	4%		ASTM D638-14 Type 1
Elongation at Break (Z)	3%		ASTM D638-14 Type 1
Flexural Properties	**METRIC [1,2]**	**IMPERIAL [1,2]**	**METHOD**
Flexural Strength	56 MPa	8122 psi	ASTM D790-15
Flexural Modulus	2400 MPa	348 ksi	ASTM D790-15
Impact Properties	**METRIC [1,2]**	**IMPERIAL [1,2]**	**METHOD**
Notched Izod	36 J/m	0.67 ft-lb/in	ASTM D256-10
Thermal Properties	**METRIC [1,2]**	**IMPERIAL [1,2]**	**METHOD**
Heat Deflection Temp. @ 1.8 MPa	113 °C	235 °F	ASTM D648-16
Heat Deflection Temp. @ 0.45 MPa	170 °C	338 °F	ASTM D648-16
Vicat Softening Temperature	175 °C	347 °F	ASTM D1525
Other Properties	**METRIC [1,2]**	**IMPERIAL [1,2]**	**METHOD**
Moisture Content (powder)	0.23%		ISO 15512 Method D
Water Absorption (printed part)	0.24%		ASTM D570

Samples printed with Nylon 12 GF Powder have been evaluated in accordance with ISO 10993-1:2018, and has passed the requirements for the following biocompatibility risks:

ISO Standard	Description [3,4]
ISO 10993-5:2009	Not cytotoxic
ISO 10993-10:2010/(R)2014	Not an irritant
ISO 10993-10:2010/(R)2014	Not a sensitizer

Flammability Properties	
Testing Standard	**Rating**
UL 94 Section 7	HB *

* Thickness of the sample tested = 3.00mm

SOLVENT COMPATIBILITY

Percent weight gain over 24 hours for a printed and post-cured 1 x 1 x 1 cm cube immersed in respective solvent:

Solvent	24 hr weight gain, %	Solvent	24 hr weight gain, %
Acetic Acid 5%	0.2	Mineral oil (Heavy)	1.0
Acetone	0.2	Mineral oil (Light)	1.3
Bleach ~5% NaOCl	0.2	Salt Water (3.5% NaCl)	0.2
Butyl Acetate	0.2	Skydrol 5	0.8
Diesel Fuel	0.6	Sodium Hydroxide solution (0.025% PH 10)	0.2
Diethyl glycol Monomethyl Ether	0.5	Strong Acid (HCl conc)	0.8
Hydraulic Oil	1.0	Tripropylene glycol monomethyl ether	0.8
Hydrogen peroxide (3%)	0.2	Water	0.1
Isooctane (aka gasoline)	0.0	Xylene	0.2
Isopropyl Alcohol	0.2		

[1] Material properties may vary with part geometry, print orientation and temperature.

[2] Parts were printed using Fuse 1, with Nylon 12 GF powder. Parts were conditioned at 50% relative humidity and 23 °C for 7 days before testing.

[3] Material properties may vary based on part design and manufacturing practices. It is the manufacturer's responsibility to validate the suitability of the printed parts for the intended use.

[4] Nylon 12 GF was tested at NAMSA World Headquarters, OH, USA.

formlabs

SLS POWDERS

Nylon 11 Powder

Nylon 11 Powder for High Performance, High Impact

For ductile, robust parts, Nylon 11 Powder is a high performance, bio-based nylon material for functional prototyping and small batch production. Nylon 11 Powder is suitable for printing parts that need to bend or resist impact.

Nylon 11 Powder is specifically developed for use on the Fuse Series printers.

V1 **FLP11B01**

Prepared 06/05/2021

Rev. 02 06/05/2021

Material Properties	METRIC [1,2]	IMPERIAL [1,2]	METHOD
Tensile Properties	**METRIC [1,2]**	**IMPERIAL [1,2]**	**METHOD**
Ultimate Tensile Strength	49 MPa	7107 psi	ASTM D638-14 Type 1
Tensile Modulus	1.6 GPa	232 ksi	ASTM D638-14 Type 1
Elongation at Break (X/Y)	40%		ASTM D638-14 Type 1
Flexural Properties	**METRIC [1,2]**	**IMPERIAL [1,2]**	**METHOD**
Flexural Strength	55 MPa	7977 psi	ASTM D790-15
Flexural Modulus	1.4 GPa	203 ksi	ASTM D790-15
Impact Properties	**METRIC [1,2]**	**IMPERIAL [1,2]**	**METHOD**
Notched Izod	71 J/m	1.3 ft-lb/in	ASTM D256-10
Thermal Properties	**METRIC [1,2]**	**IMPERIAL [1,2]**	**METHOD**
Heat Deflection Temp. @ 1.8 MPa	46 °C	115 °F	ASTM D648-16
Heat Deflection Temp. @ 0.45 MPa	182 °C	360 °F	ASTM D648-16
Vicat Softening Temperature	189 °C	372°F	ASTM D1525
Other Properties	**METRIC [1,2]**	**IMPERIAL [1,2]**	**METHOD**
Moisture Content (powder)	0.37%		ISO 15512 Method D
Water Absorption (printed part)	0.07%		ASTM D570

Samples printed with Nylon 11 Powder have been evaluated in accordance with ISO 10993-1, and has passed the requirements for the following biocompatibility risks:

ISO Standard	Description [3,4]
ISO 10993-5:2009	Not cytotoxic
ISO 10993-10:2010/(R)2014	Not an irritant
ISO 10993-10:2010/(R)2014	Not a sensitizer

Flammability Properties	
Testing Standard	**Rating**
UL 94 Section 7	HB *

* Thickness of the sample tested = 3.00mm

SOLVENT COMPATIBILITY

Percent weight gain over 24 hours for a printed and post-cured 1 x 1 x 1 cm cube immersed in respective solvent:

Solvent	24 hr weight gain, %	Solvent	24 hr weight gain, %
Acetic Acid 5%	0.1	Mineral oil (Light)	0.4
Acetone	0.1	Mineral oil (Heavy)	0.4
Bleach ~5% NaOCl	0.1	Salt Water (3.5% NaCl)	0.1
Butyl Acetate	0.1	Skydrol 5	0.2
Diesel Fuel	0.2	Sodium Hydroxide solution (0.025% pH 10)	0.1
Diethyl glycol Monomethyl Ether	0.4	Strong Acid (HCl conc)	1.0
Hydraulic Oil	0.5	Tripropylene glycol monomethyl ether	0.3
Hydrogen peroxide (3%)	< 0.1	Water	0.1
Isooctane (aka gasoline)	< 0.1	Xylene	0.1
Isopropyl Alcohol	0.1		

[1] Material properties may vary with part geometry, print orientation and temperature.

[2] Parts were printed using Fuse 1 with Nylon 11 Powder. Parts were conditioned at 50% relative humidity and 23 °C for 7 days before testing.

[3] Material properties may vary based on part design and manufacturing practices. It is the manufacturer's responsibility to validate the suitability of the printed parts for the intended use.

[4] Nylon 11 Powder was tested at NAMSA World Headquarters, OH, USA.

formlabs

SLS POWDERS

Nylon 11 CF Powder

Carbon Fiber Reinforced, for Strong and Lightweight parts

Get the best of nylon and carbon fiber with this highly stable, high-performance material, perfect for end-use applications that require both high stiffness and superior strength and can take an impact.

Nylon 11 CF Powder is specifically developed for use on the Fuse 1+ 30W.

Functional composite prototypes

Replacement and spare alternatives to metal parts

Tooling, Jigs, Fixtures

High-impact equipment

V1 **FLP11C01**

Prepared 06/22/2022

Rev. 02 08/08/2023

Material Properties	METRIC [1,2]			IMPERIAL [1,2]			METHOD
	X	Y	Z	X	Y	Z	
Tensile Properties	METRIC [1,2]			IMPERIAL [1,2]			METHOD
Ultimate Tensile Strength	69 MPa	52 MPa	38 MPa	10 ksi	7.6 ksi	5.5 ksi	ASTM D638-14 Type 1
Tensile Modulus	5.3 GPa	2.8 GPa	1.6 GPa	770 ksi	410 ksi	240 ksi	ASTM D638-14 Type 1
Elongation at Break	9%	15%	5%	9%	15%	5%	ASTM D638-14 Type 1
Mechanical Properties	METRIC [1,2]			IMPERIAL [1,2]			METHOD
Flexural Strength	110 MPa			16 ksi			ASTM D790-15
Flexural Modulus	4.2 GPa			610 ksi			ASTM D790-15
Notched Izod	74 J/m			1.4 ft-lb/in			ASTM D256-10
Thermal Properties	METRIC [1,2]			IMPERIAL [1,2]			METHOD
Heat Deflection Temp. @ 1.8 MPa	178 °C			352 °F			ASTM D648-16
Heat Deflection Temp. @ 0.45 MPa	188 °C			370 °F			ASTM D648-16
Vicat Softening Temperature	188 °C			370 °F			ASTM D1525

Samples printed with Nylon 11 CF Powder have been evaluated in accordance with ISO 10993-1:2020 and is biologically safe for long term (>30 day) surface (intact skin) contacting devices. It has passed the requirements for the following biocompatibility risks:

ISO Standard	Description [3,4]
ISO 10993-5: 2009	Not cytotoxic
ISO 10993-23:2021	Not an irritant
ISO 10993-10:2021	Not a sensitizer

SOLVENT COMPATIBILITY

Percent weight gain over 24 hours for a printed and post-cured 1 x 1 x 1 cm cube immersed in respective solvent:

Solvent	24 hr weight gain, %	Solvent	24 hr weight gain, %
Acetic Acid 5%	0.2	Mineral oil, heavy	1.0
Acetone	0.2	Mineral oil, light	1.3
Bleach ~5% NaOCl	0.2	Salt Water (3.5% NaCl)	0.2
Butyl Acetate	0.2	Skydrol 5	0.8
Diesel Fuel	0.6	Sodium hydroxide solution (0.025% pH = 10)	0.2
Diethyl glycol monomethyl ether	0.5	Strong Acid (HCl Conc)	0.8
Hydraulic Oil	1.0	TPM	0.8
Hydrogen peroxide (3%)	0.2	Water	0.1
Isooctane	0.0	Xylene	0.2
Isopropyl Alcohol	0.2		

[1] Material properties may vary with part geometry, print orientation and temperature.

[2] Parts were printed using Fuse 1+ 30W, with Nylon 11 CF Powder. Parts were conditioned at 50% relative humidity and 23 °C for 7 days before testing.

[3] Material properties may vary based on part design and manufacturing practices. It is the manufacturer's responsibility to validate the suitability of the printed parts for the intended use.

[4] Nylon 11 CF Powder was tested at NAMSA World Headquarters, OH, USA.

formlabs

SLS POWDERS

TPU 90A Powder

A Tough SLS Elastomer for Resilient, Skin-Safe Products

Create flexible TPU parts with unmatched design freedom and ease. Balancing high elongation at break and superior tear strength, TPU 90A Powder enables you to produce flexible, skin-safe prototypes and end-use parts that withstand the demands of everyday use – all at a low cost per part thanks to a 20% refresh rate.

TPU 90A Powder is specifically developed for use on Fuse Series printers.

- **Wearables and soft-touch elements**
- **Gaskets, seals, masks, belts, plugs, and tubes**
- **Padding, dampers, cushions, and grippers**
- **Soles, splints, orthotics, and prosthetics**
- **Protective sports equipment**

V1 **FLTP9G01**

Prepared 14/03/2023

Rev. 01 14/03/2023

Material Properties			
Mechanical Properties	METRIC [1,2]	IMPERIAL [1,2]	METHOD
Ultimate Tensile Strength (X/Y)	8.7 MPa	1260 psi	ASTM D412-16, Method A
Ultimate Tensile Strength (Z)	7.2MPa	1050 psi	ASTM D412-16, Method A
Elongation at Break (X/Y)	310%		ASTM D412-16, Method A
Elongation at Break (Z)	110%		ASTM D412-16, Method A
Stress @ 50% Elongation (X/Y)	6.1 MPa	889 psi	ASTM D412-16, Method A
Stress @ 50% Elongation (Z)	5.9 MPa	860 psi	ASTM D412-16, Method A
Stress @ 100% Elongation (X/Y)	7.2 MPa	1050 psi	ASTM D412-16, Method A
Stress @ 100% Elongation (Z)	7.0 MPa	1020 psi	ASTM D412-16, Method A
Tear Resistance (X/Y)	66 kN/m	378 lb/in	ASTM D624-00 (2020)
Tear Resisitance (Z)	39 kN/m	247 lb/in	ASTM D624-00 (2020)
Compression Set (23°C)	20.5%		ASTM D395-18, Method B
Compression Set (70°C)	59.9%		ASTM D395-18, Method B
Shore Hardness	90A		ASTM D2240-15 (2021)
Taber Abrasion	122 mm^3	7 x 10^{-3} in^3	ISO 4649 (40rpm, 10N load)
Thermal Properties	METRIC [1,2]	IMPERIAL [1,2]	METHOD
Vicat Softening Temperature	94.3 °C	201.7 °F	ASTM D1525
Other Properties	METRIC [1,2]	IMPERIAL [1,2]	METHOD
Moisture Content (powder)	0.19%		ISO 15512 Method D
Water Absorption (Printed Part)	0.89%		ASTM D570
Bulk Density (Sintered)	1.14 g/cm^3	71.2 lb/ft^3	In-house method

Samples printed with TPU 90A powder have been evaluated in accordance with ISO 10993-1:2018, and has passed the requirements for the following biocompatibility risks:

ISO Standard	Result [3,4]
ISO 10993-5: 2009	Non-cytotoxic
ISO 10993-23:2021	Non-irritant
ISO 10993-10:2021	Non-sensitizer

[1] Material properties may vary with part geometry, print orientation and temperature.

[2] Results on Fuse 1 and Fuse 1+ 30W are equivalent within the bounds of experimental uncertainty

[3] Material properties may vary based on part design and manufacturing practices. It is the manufacturer's responsibility to validate the suitability of the printed parts for the intended use.

[4] TPU 90A was tested at NAMSA World Headquarters, OH, USA.

SOLVENT COMPATIBILITY

Percent weight gain over 24 hours for a printed 1 x 1 x 1 cm cube immersed in respective solvent:

Solvent	24 hr weight gain, %	Solvent	24 hr weight gain, %
Acetic Acid 5%	1.3	Isooctane (aka gasoline)	0.7
Acetone	28.6	Mineral oil (light)	2.3
Isopropyl Alcohol	4.8	Mineral oil (Heavy)	2.1
Bleach ~5% NaOCl	0.8	Salt Water (3.5% NaCl)	0.9
Butyl Acetate	16.5	Sodium Hydroxide solution (0.025% PH 10)	0.9
Diesel Fuel	2.0	Water	0.9
Diethyl glycol Monomethyl Ether	14.4	Xylene	20.8
Hydraulic Oil	2.8	Strong Acid (HCl conc)	- 5.2
Skydrol 5	6.5	TPM	9.9
Hydrogen peroxide (3%)	1.0		

formlabs