formlabs

ENGINEERING RESIN

Tough 1000 Resin

Ductile, impact-resistant material with toughness that rivals high-density polyethylene (HDPE)

Parts requiring the strength and stiffness of high-density polyethylene

Impact-resistant jigs and fixtures that survive long-term use on the factory floor

Compliant mechanisms that withstand repeated flexing

Low friction assemblies and non-degrading surfaces (like ball joints)

V1 **FLTO1001**

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Tough 1000 Resin is a ductile, impact-resistant material with comparable strength, stiffness, and toughness to high-density polyethylene (HDPE), designed with exceptional wear and fatigue resistance for long-term toughness and utility.

The 180% elongation at break (EAB) and Gardner impact strength of 128 in-lb surpass HDPE, making it ideal for parts that bend, compress, or deform without cracking. Hinges and functional parts can handle repeated stress and wear with a work of fracture of 3,200 J/m^2 and a Ross flex fatigue of >100,000 cycles (at 23 °C). With a matte, dark grey color, Tough 1000 Resin is engineered for applications that require smooth surfaces and low-friction finishes.

Tough 1000 Resin is a new material formulation that leverages the technology of Form 4 Series printers, with 5x higher fracture toughness, 2x higher EAB, and improved temperature, creep, and aging resistance compared to Durable Resin.

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	23.7 MPa	26.3 MPa	3440 psi	3810 psi	ASTM D638-14
Tensile Modulus	844 MPa	932 MPa	122 ksi	135 ksi	ASTM D638-14
Tensile Strength at Yield	18.6 MPa	21.4 MPa	2700 psi	3100 psi	ASTM D638-14
Elongation at Yield	4.8%	5.0%	4.8%	5.0 %	ASTM D638-14
Elongation at Break	217%	180%	217%	180%	ASTM D638-14
Flexural Properties	METRIC [1]		IMPERIAL [1]		METHOD
Flexural Strength	22.6 MPa	29.0 MPa	3280 psi	4210 psi	ASTM D790-17
Flexural Modulus	595 MPa	761 MPa	86.3 ksi	110 ksi	ASTM D790-17
Toughness Properties	METRIC [1]		IMPERIAL [1]		METHOD
Notched Izod	69 J/m	72 J/m	1.3 ft-lb/in	1.3 ft-lb/in	ASTM D256-10
Unnotched Izod	No Break	No Break	No Break	No Break	ASTM D4812-11
Notched Charpy	7.6 kJ/m^2	9.0 kJ/m^2	3.6 ft-lb/in^2	4.3 ft-lb/in^2	ISO 179-1
Unnotched Charpy	No Break	180 kJ/m^2	No Break	85.6 ft-lb/in^2	ISO 179-1
Gardner Impact Strength at 1/32" (0.79 mm) thickness	13.1 J	13.1 J	116 in-lb	116 in-lb	ASTM D5420-21
Gardner Impact Strength at 1/16" (1.6 mm) thickness	14.0 J	14.5 J	124 in-lb	128 in-lb	ASTM D5420-21
Ross Flex Fatigue	>100,000 cycles	>100,000 cycles	>100,000 cycles	>100,000 cycles	Internal (23 °C, 30 Degree deflection at 1 Hz)
Fracture Properties	METRIC [1]		IMPERIAL [1]		METHOD
Maximum Stress Intensity Factor (Kmax)	Not Tested	1.94 MPa-m$^{1/2}$	Not Tested	1770 psi-in$^{1/2}$	ASTM D5045-14
Work of Fracture (W_f)	Not Tested	3200 J/m^2	Not Tested	219 ft-lb/ft^2	ASTM D5045-14

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

[2] Data was obtained from parts printed on a Form 4 printer with 100um Tough 1000 Resin settings, washed in a Form Wash V2 for 10+10 minutes in >= 99% Isopropyl Alcohol.

[3] Data was obtained from parts printed on a Form 4 printer with 100µm Tough 1000 Resin settings, washed in a Form Wash V2 for 10+10 minutes in ≥ 99% Isopropyl Alcohol, and post-cured at 70 °C for 12 minutes in a Form Cure V2.

Material Properties	METRIC [1]		IMPERIAL [1]		METHOD
	Green [2]	Post-Cured [3]	Green [2]	Post-Cured [3]	
Thermal Properties	METRIC [1]		IMPERIAL [1]		METHOD
Heat Deflection Temp. @ 1.8 MPa	40.4 °C	44.6 °C	104.7 °F	112.3 °F	ASTM D648-16
Heat Deflection Temp. @ 0.45 MPa	49.7 °C	55.3 °C	121.5 °F	131.5 °F	ASTM D648-16
Thermal Expansion (0-150 °C)	161.6 µm/m/°C	168.2 µm/m/°C	89.8 µin/in/°F	93.4 µin/in/°F	ASTM E 831-19
Flammability	Not Tested	HB	Not Tested	HB	UL 94
Electric Properties	METRIC [1]				METHOD
	Post-Cured [3]				
Dielectric Strength	15.1 kV/mm				ASTM D149-20
Dielectric Constant (50 Hz)	0.014				ASTM D150 (50 Hz)
Dielectric Constant (1 kHz)	0.013				ASTM D150 (1 kHz)
Dissipation Factor (50 Hz)	3.70				ASTM D150 (50 Hz)
Dissipation Factor (1 kHz)	3.59				ASTM D150 (1 kHz)
Volume Resistivity	$4 * 10^{15}$ Ω-cm				ASTM D257-14
Other Properties	METRIC [1]				METHOD
Shore D Hardness	56D		68D		ASTM D2240
Bulk Density	1.07 g/mL				ASTM D792-20
Viscosity at 25 °C	4030 cP				ASTM D792-20
Liquid Density	1.01 g/mL				ASTM D792-20

CHEMICAL COMPATIBILITY

Percent weight gain over 24 hours for a printed and 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	Isooctane (aka gasoline)	39.8
Acetone	30.4	Mineral Oil (Light)	0.0
Isopropyl Alcohol	6.9	Mineral Oil (Heavy)	0.1
Bleach ~5% NaOCl	0.0	Salt Water (3.5% NaCl)	0.2
Butyl Acetate	38.9	Sodium Hydroxide Solution (0.025% pH = 10)	0.2
Diesel Fuel	0.7	Water	0.0
Diethyl Glycol Monomethyl Ether	6.9	Xylene	62.7
Hydraulic Oil	0.1	Strong Acid (HCl conc)	7.3
Skydrol 5	5.0	TPM	7.0
Hydrogen Peroxide (3%)	0.2		

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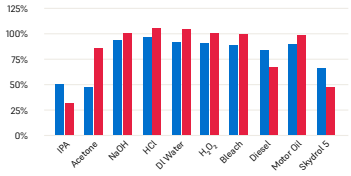
Chemical Compatibility (ASTM D543)

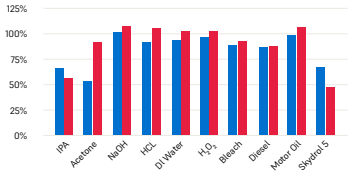
Tested for chemical compatibility according to ASTM D543. The influence of various chemicals was tested by measuring tensile modulus and strength after different exposure times. Exposed samples were stored in containers and fully immersed in the test chemicals for 1 day and 1 week. After removal, exposed samples were washed and conditioned for 24 hours at 22 °C before mechanical testing. Mechanical testing was conducted according to ASTM D638 using Type IV tensile samples at standard lab conditions (22 °C). Results are reported as a % difference from the measured values of non-exposed samples.

Solvent	IPA	Acetone	NaOH (0.025% pH=10)	HCl (10%)	DI Water	H_2O_2 (3%)	Bleach (~5% NaOCl)	Diesel	Motor Oil	Skydrol 5
Relative Modulus										
1 day	52%	47%	94%	97%	91%	91%	88%	83%	91%	65%
1 week	34%	87%	101%	105%	105%	100%	100%	68%	99%	46%
Relative Strength										
1 day	66%	53%	102%	92%	94%	95%	89%	86%	98%	68%
1 week	56%	92%	108%	106%	102%	102%	93%	88%	107%	47%
Relative Elongation										
1 day	109%	99%	87%	94%	94%	96%	87%	95%	103%	91%
1 week	140%	138%	117%	111%	118%	117%	80%	141%	133%	97%
Relative Mass										
1 day	111%	144%	100%	100%	100%	100%	100%	103%	100%	107%
1 week	130%	142%	100%	100%	100%	101%	100%	108%	100%	116%

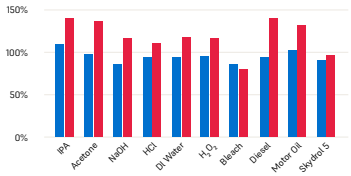
Tensile Modulus after Immersion Time



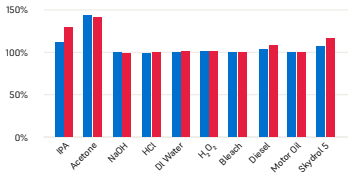
Ultimate Tensile Strength after Immersion Time



Elongation at Break After Immersion Time



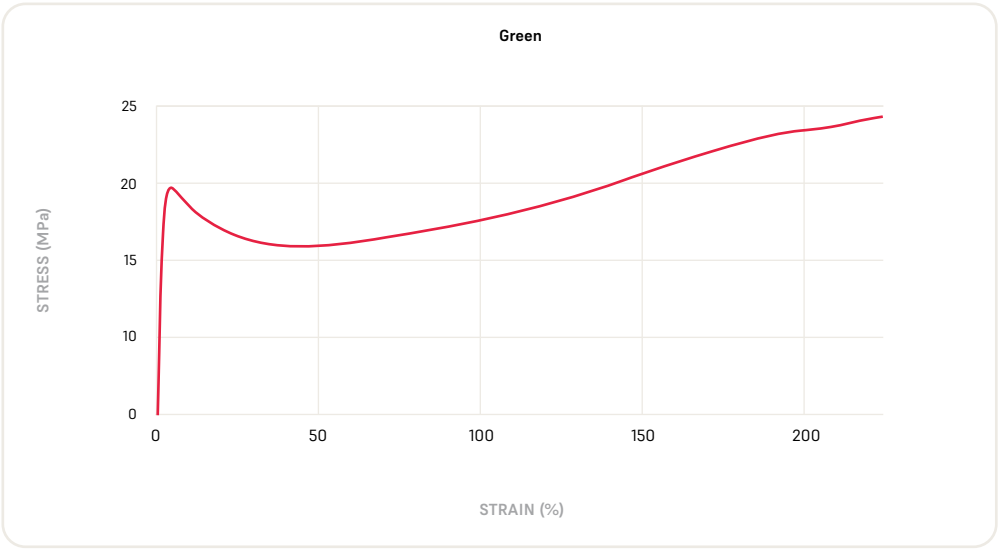
Mass Absorption after Immersion Time

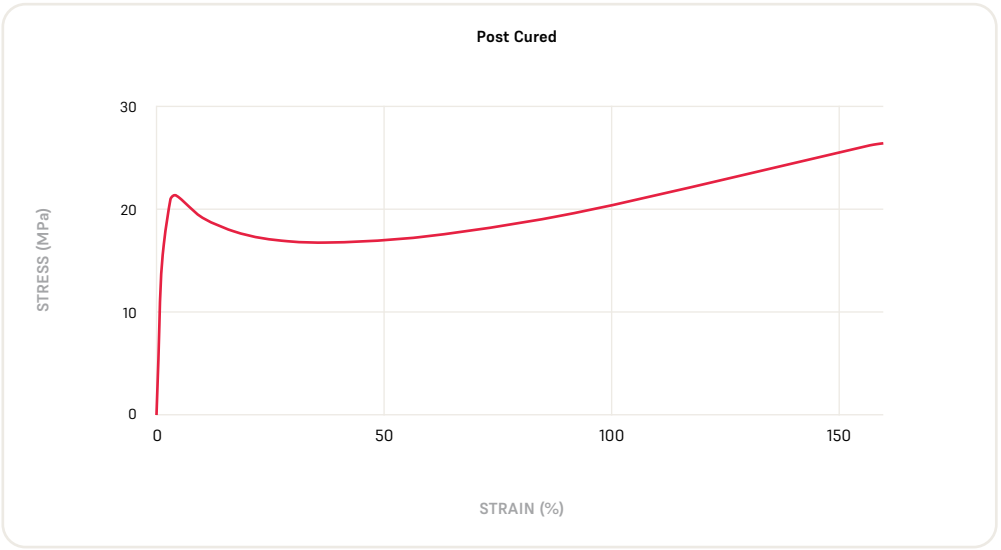


● 1 DAY ● 1 WEEK

Representative Tensile Curve (ASTM D638-14)

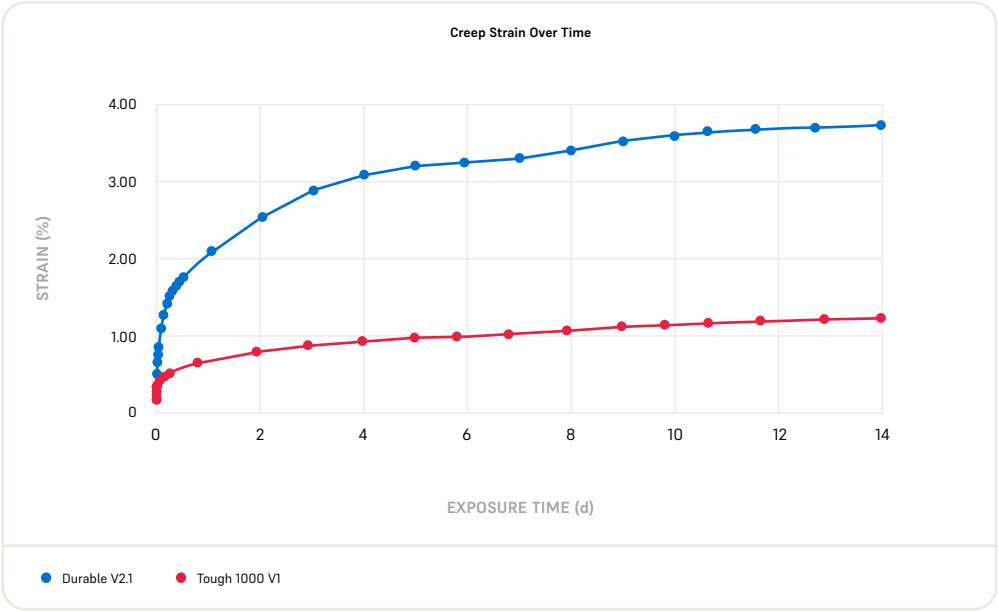
Type I, 50 mm/min





Flexural Creep ISO 6602

Formlabs evaluated the creep resistance of Tough 1000 Resin using ISO 6602. This test measures a materials rate of deformation at a constant temperature under a fixed load. Speciments were tested at 22 °C under a 2.0 MPa load. Deflection was measured over the course of 14 days.



Dynamic Mechanical Analysis (DMA)

A DMA curve of Tough 1000 Resin from 0 °C to 140 °C at 3 °C/min is shown. A glass transition is observed at 106.6 °C, and an inflection of the storage modulus is observed at 68.4 °C.