

Tough

Our Functional Resin for Engineering Applications



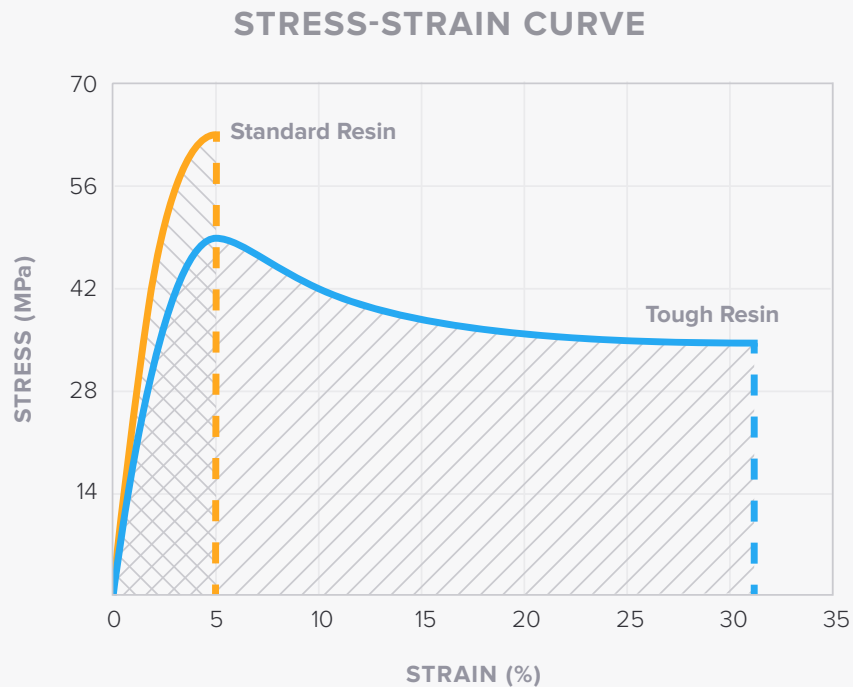
Overview

Tough is durable, adaptive, and impact-resistant. Perfect for engineering challenges, this sturdy, ABS-like material has been developed to withstand high stress or strain. It's ideal for snap-fit joints and other rugged prototypes.

IDEAL FOR:	NOT SUITABLE FOR:
High-impact/high-stress components	Very fine features or thin walls
Snap-fit functions and living hinges	Rigid or stiff prints
Machining	High-temperature applications
Cyclic loading	Constant loading

Material Properties

Formlabs Tough Resin displays a balance of strength and elongation, allowing you to print tough plastic parts on the Form 1+ 3D printer. Parts are less brittle and more impact-resistant, making this resin ideal for various engineering applications. Parts require thorough postcure to achieve final mechanical properties.



STRESS-STRAIN CURVE

In engineering, toughness is defined as the area under a stress-strain curve. The graph above illustrates how Tough Resin compares to our standard resins. As illustrated in the graph, general purpose resins are quite strong, but will snap under too much force. Tough Resin, however, balances strength and ductility (elongation). Under enough stress, parts printed in Tough will absorb energy and begin to deform before they snap or shatter. This characteristic allows these parts to be more durable and impact resistant than traditional 3D printed parts.

Please note: To achieve desired durability, prints made with Tough Resin should be post-cured approximately 2 hours under a 30 W, fluorescent lamp emitting in the UVA range (such as a nail spa).

Tough Resin has a low TGT (glass transition temperature) and low heat deflection temperature. This means that thin parts under constant load may deform over time. Tough Resin is not intended for applications at elevated temperatures.



COMPARISON WITH OTHER MATERIALS

Upon comparison with other ABS-like resins, Formlabs' Tough Resin was found to deliver an outstanding combination of yield strength, elongation, and impact resistance—the key characteristics used to assess material toughness.

	FORMLABS TOUGH	ENVISIONTEC ABS-TUFF ¹	3DS VISIJET SL TOUGH ²	STRATASYS DIGITAL ABS ³
Tensile Strength	52.2 MPa	48.6 MPa	41.0 MPa	55-60 MPa
Elongation	31%	7%	18%	25-40%
Notched Izod	51.1 J/m	No Data	43.8 J/m	65-80 J/m

¹AB Materials - ABflex and ABS-tuff, EnvisionTEC.

²ProJet® 6000 & 7000: Professional 3D Printers, 3D Systems.

³Digital Materials Data Sheet, Stratasys.

Technical Specifications

	METRIC ⁴	IMPERIAL ⁴	METHOD
	Post-Cured ⁵	Post-Cured ⁵	
Tensile Properties			
Tensile Strength at Yield	52.2 MPa	7570 psi	ASTM D 638-10
Young's Modulus	2.24 GPa	325 ksi	ASTM D 638-10
Elongation at Failure	31%	31%	ASTM D 638-10
Flexural Properties			
Flexural Stress at 5% Strain	39.4 MPa	5720 psi	ASTM D 790-10, Procedure A
Flexural Modulus	1.16 GPa	168 ksi	ASTM D 790-10, Procedure A
Impact Properties			
Notched Izod	51.1 J/m	0.96 ft-lbf/in	ASTM D 256-10, Test Method A
Temperature Properties			
Heat Deflection Temp. @ 66 psi	43.2 °C	109.8 °F	ASTM D 648-07, Method B

⁴Material properties can vary with part geometry, print orientation, print settings, and temperature.

⁵Data refers to post-cured properties obtained after exposing green parts for 2 hours in a 30 W UVA curing chamber.

