



# Tough

## Tough Resin for Rugged Prototyping

\$175 / L

Tough Resin balances strength and compliance, making it the ideal choice for prototyping strong, functional parts and assemblies that will undergo brief periods of stress or strain.

Sturdy prototypes

Interference and press fits

Assemblies



# Material Properties Data

|                                  | METRIC <sup>1</sup> |                         | IMPERIAL <sup>1</sup> |                         | METHOD        |
|----------------------------------|---------------------|-------------------------|-----------------------|-------------------------|---------------|
|                                  | Green <sup>2</sup>  | Post-Cured <sup>3</sup> | Green <sup>2</sup>    | Post-Cured <sup>3</sup> |               |
| <b>Mechanical Properties</b>     |                     |                         |                       |                         |               |
| Ultimate Tensile Strength        | 34.7 MPa            | 55.7 MPa                | 5040 psi              | 8080 psi                | ASTM D 638-14 |
| Tensile Modulus                  | 1.7 GPa             | 2.7 GPa                 | 239 ksi               | 387 ksi                 | ASTM D 638-14 |
| Elongation at Break              | 42 %                | 24 %                    | 42 %                  | 24 %                    | ASTM D 638-14 |
| Flexural Strength at 5% Strain   | 20.8 MPa            | 60.6 MPa                | 3020 psi              | 8790 psi                | ASTM D 790-15 |
| Flexural Modulus                 | 0.6 GPa             | 1.6 GPa                 | 90.3 ksi              | 241 ksi                 | ASTM D 790-15 |
| Notched IZOD                     | 32.6 J/m            | 38 J/m                  | 0.61 ft-lbf/in        | 0.71 ft-lbf/in          | ASTM D256-10  |
| <b>Thermal Properties</b>        |                     |                         |                       |                         |               |
| Heat Deflection Temp. @ 1.8 MPa  | 32.8 °C             | 45.9 °C                 | 91.1 °F               | 114.6 °F                | ASTM D 648-16 |
| Heat Deflection Temp. @ 0.45 MPa | 40.4 °C             | 48.5 °C                 | 104.7 °F              | 119.3 °F                | ASTM D 648-16 |
| Thermal Expansion (23 – 50 °C)   | 159.7 µm/m/°C       | 119.4 µm/m/°C           | 88.7 µin/in/°F        | 66.3 µin/in/°F          | ASTM E 831-13 |

<sup>1</sup>Material properties can vary with part geometry, print orientation, print settings, and temperature.

<sup>2</sup>Data was obtained from green parts, printed using Form 2, 100 µm, Tough settings, without additional treatments.

<sup>3</sup>Data was obtained from parts printed using Form 2, 100 µm, Tough settings and post-cured with 2.5 mW/cm<sup>2</sup> of 405 nm LED light for 120 minutes at 60°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:

| Solvent                         | 24 hr weight gain (%) | Solvent                             | 24 hr weight gain (%) |
|---------------------------------|-----------------------|-------------------------------------|-----------------------|
| Acetic Acid, 5 %                | 2.8                   | Hydrogen Peroxide (3 %)             | 2.1                   |
| Acetone                         | sample cracked        | Isooctane                           | < 1                   |
| Isopropyl Alcohol               | 2.1                   | Mineral Oil, light                  | < 1                   |
| Bleach, ~5 % NaOCl              | 1.7                   | Mineral Oil, heavy                  | < 1                   |
| Butyl Acetate                   | 1.6                   | Salt Water (3.5 % NaCl)             | 1.5                   |
| Diesel                          | < 1                   | Sodium hydroxide (0.025 %, pH = 10) | 1.5                   |
| Diethyl glycol monomethyl ether | 6.6                   | Water                               | 1.6                   |
| Hydraulic Oil                   | < 1                   | Xylene                              | < 1                   |
| Skydrol 5                       | 1.2                   | Strong Acid (HCl Conc)              | distorted             |