



WHITE PAPER

formlabs 

## Clear Resin V5 Technical Data Sheet

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.

# Mechanical Properties

## Tensile Properties

|   | GREEN                 | CURE V1               | CURE V2               | METHOD          |
|---|-----------------------|-----------------------|-----------------------|-----------------|
| <b>TENSILE PROPERTIES (GREEN &amp; POST-CURED WITHOUT HEAT)</b> |                       |                       |                       |                 |
| Ultimate Tensile Strength                                       | 46 MPa<br>(6672 psi)  | 51 MPa<br>(7340 psi)  | 49 MPa<br>(7110 psi)  | ASTM<br>D638-14 |
| Tensile Modulus   | 2200 MPa<br>(319 ksi) | 2575 MPa<br>(373 ksi) | 2167 MPa<br>(314 ksi) | ASTM<br>D638-14 |
| Elongation at Break   | 13%                   | 10%                   | 13.50%                | ASTM<br>D638-14 |
| <b>TENSILE PROPERTIES (HEATED POST-CURE)</b>                    |                       |                       |                       |                 |
| Ultimate Tensile Strength                                       |                       | 60 MPa<br>(8702 psi)  | 58 MPa<br>(8410 psi)  | ASTM<br>D638-14 |
| Tensile Modulus   |                       | 2750 MPa<br>(399 ksi) | 2700 MPa<br>(392 ksi) | ASTM<br>D638-14 |
| Elongation at Break   |                       | 8 %                   | 11 %                  | ASTM<br>D638-14 |

## Flexural Properties

|                   | GREEN                 | 5 MIN POST-CURE<br>CURE V1 | 15 MIN POST-CURE AT 60 °C<br>CURE V1 | METHOD          |
|-------------------|-----------------------|----------------------------|--------------------------------------|-----------------|
| Flexural Strength | 83 MPa<br>(12038 psi) | 92 MPa<br>(13343 psi)      | 105 MPa<br>(15229 psi)               | ASTM<br>D790-15 |
| Flexural Modulus  | 2100 MPa<br>(305 ksi) | 2450 MPa<br>(355 ksi)      | 2700 MPa<br>(392 ksi)                | ASTM<br>D790-15 |

## Impact Properties

|   | GREEN                      | 5 MIN POST-CURE - CURE<br>V1 | 15 MIN POST-CURE AT 60 °C -<br>CURE V1 | METHOD           |
|---|----------------------------|------------------------------|--|------------------|
| Notched Izod  | 32 J/m<br>(0.598 ft-lb/in) | 29 J/m<br>(0.542 ft-lb/in)   | 29 J/m<br>(0.542 ft-lb/in)             | ASTM<br>D256-10  |
| Gardner Impact Strength<br>1.6 mm (1/16 in) thickness | --                         | <0.1 J<br>(<2 in*lb)         | <0.1 J<br>(<2 in*lb)                   | ASTM<br>D5420-21 |

## Fracture Properties

|  | 5 MIN POST-CURE - CURE<br>V1                              | 15 MIN POST-CURE AT 60 °C -<br>CURE V1 | METHOD           |
|--|---|--|------------------|
| Maximum Stress Intensity Factor<br>( $K_{max}$ ) | 0.63 MPa m <sup>0.5</sup><br>(573 psi in <sup>0.5</sup> ) | --                                     | ASTM<br>D5045-14 |
| Work of Fracture ( $W_f$ )                       | 26.7 J/m <sup>2</sup><br>(1.82 ft-lb/ft <sup>2</sup> )    | --                                     | ASTM<br>D5045-14 |

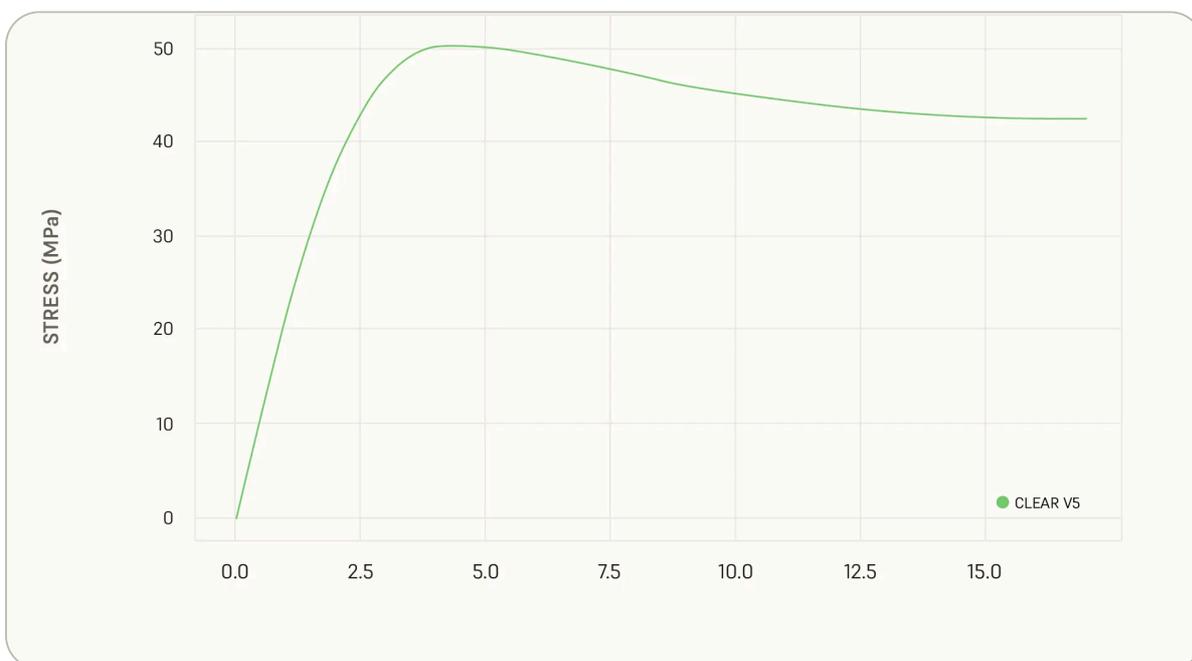
## General Properties

|                | 5 MIN POST-CURE<br>- CURE V1                           | 15 MIN POST-CURE AT 60<br>°C - CURE V1                 | METHOD        |
|----------------|--|--|---------------|
| Shore Hardness | 78 D   | 80 D   | ASTM D2240-15 |
| Density        | 1.21 g/cm <sup>3</sup><br>(0.0437 lb/in <sup>3</sup> ) | 1.21 g/cm <sup>3</sup><br>(0.0437 lb/in <sup>3</sup> ) | ASTM D792     |

## Representative Tensile Curve

Samples were tested following ASTM D638, Type I. The curve is a single sample chosen as representative and may not be representative of the average values of stress and strain. Samples were conditioned in a laboratory environment at 23°C, 50% relative humidity for 48 hours prior to testing.

### Formlabs Clear Resin V5 Representative Tensile Curve



Single Sample ASTM D638 Type 1 Bar Conditioned 23°C 50% RH

**Footnotes:**

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  $\mu\text{m}$  Clear Resin V5 settings, washed in a Form Wash for 5 minutes in  $\geq 99\%$  Isopropyl Alcohol, and post-cured as indicated in the column header.

## Thermal & Electric Properties

### Thermal Properties

|   | GREEN | 5 MIN POST-CURE - CURE V1  | 15 MIN POST-CURE AT 60 °C - CURE V1 | METHOD          |
|---|-------|--|-------------------------------------|-----------------|
| Glass Transition Temp (T <sub>g</sub> )       | --    | 96 °C<br>(205 °F)  | 96 °C<br>(205 °F)                   | ASTM<br>D4065   |
| Heat Capacity at 25 °C                        | --    | 1.8 J/g*K<br>(0.430 BTU/lb-°F)   | --                                  | ASTM<br>E1269   |
| Coefficient of Thermal Expansion (-30-140 °C) | --    | 114.1 $\mu\text{m}/\text{m}/\text{°C}$<br>(63.4 $\mu\text{in}/\text{in}-\text{°F}$ ) | --                                  |                 |
| Heat Deflection Temp. @ 1.8 MPa               | 47 °C | 49 °C<br>(120 °F)  | 59 °C<br>(138 °F)                   | ASTM<br>D648-16 |
| Heat Deflection Temp. @ 0.45 MPa              | 52 °C | 56 °C<br>(133 °F)  | 74 °C<br>(165 °F)                   | ASTM<br>D648-16 |

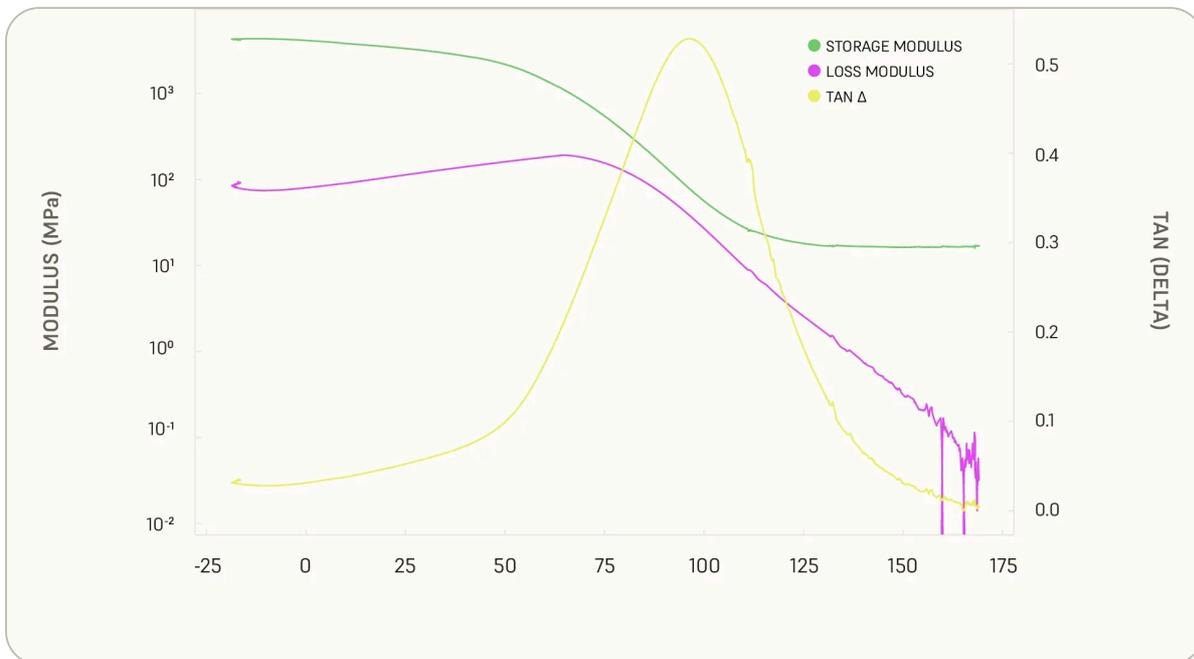
## Electrical Properties

|                            | GREEN | 5 MIN POST-CURE - CURE V1                           | 15 MIN POST-CURE AT 60 °C - CURE V1                 | METHOD        |
|----------------------------|-------|---|---|---------------|
| Surface Resistivity        | --    | >1x10 <sup>12</sup> Ω/sq                            | >1x10 <sup>12</sup> Ω/sq                            | ASTM D257     |
| Comparative Tracking Index | --    | 600 V   | --  | ASTM D3638    |
| Thermal Conductivity       | --    | 0.540 W/m*K<br>(3.75 BTU-in/hr-ft <sup>2</sup> -°F) | 0.540 W/m*K<br>(3.75 BTU-in/hr-ft <sup>2</sup> -°F) | ASTM E1530-25 |
| Dielectric Strength        | --    | 16.3 kV/mm<br>(415 V/mil)                           | --  | ASTM D149-20  |
| Dielectric Constant (k')   | --    | 4.28 @ 1 MHz  | --  | ASTM D150-22  |
| Dielectric Dissipation (D) | --    | 0.036 @ 1 MHz                                       | --  | ASTM D150-22  |

# Dynamic Mechanical Analysis (DMA)

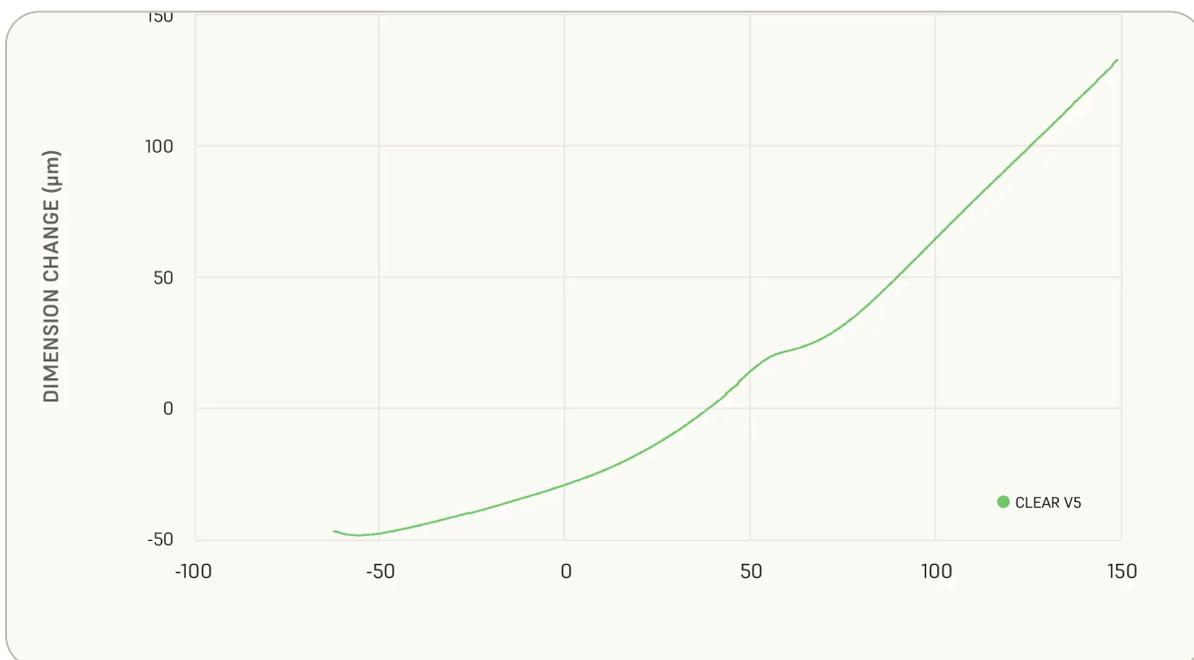
## Clear Resin V5 Loss Modulus, Storage Modulus and tan $\delta$

A DMA curve from -20 °C to 170 °C at 3 °C/min is shown.



## Thermal Expansion by TMA

Sample was tested by ASTM E831-19 in a TMA. Ramp rate was 5 °C/min with a Ultra-High Purity Nitrogen purge of 50 cc/min.



# Chemical Compatibility

## Solvent Weight Gain

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 (%) |
|--|-----------------------|
| Acetic Acid 5%                             | 0.9                   |
| Acetone                                    | 5.1                   |
| Bleach ~5% NaOCl                           | 0.7                   |
| Butyl Acetate                              | 0.3                   |
| Diesel Fuel                                | 0.1                   |
| Diethyl glycol monomethyl ether            | 1.1                   |
| Hydraulic Oil                              | 0.1                   |
| Hydrogen peroxide (3%)                     | 0.9                   |
| Isooctane                                  | <0.1                  |
| Isopropyl Alcohol                          | 0.3                   |
| Mineral oil, heavy                         | 0.2                   |
| Mineral oil, light                         | 0.2                   |
| Salt Water (3.5% NaCl)                     | 0.8                   |
| Skydrol 5                                  | 0.7                   |
| Sodium hydroxide solution (0.025% pH = 10) | 0.8                   |
| Strong Acid (HCl Conc)                     | 0.5                   |
| TPM  | 0.5                   |
| Water                                      | 0.9                   |
| Xylene                                     | <0.1                  |

## Mechanical Properties after Immersion (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 4 tensile samples at standard lab conditions (22°C). Results are reported as a % difference from the measured values of non-exposed samples.

**Results are from samples tested in Grey V5. These results are expected to follow the same trends and be approximately the same, however some results may vary.**

### 1 Day Immersion

| SOLVENT   | RELATIVE MODULUS | RELATIVE STRENGTH | RELATIVE ELONGATION | RELATIVE MASS |
|-----------|------------------|-------------------|---------------------|---------------|
| IPA       | 104.54%          | 98.58%            | 132.33%             | 100.48%       |
| Acetone   | 21.02%           | 20.08%            | 152.24%             | 109.38%       |
| NaOH      | 97.89%           | 92.69%            | 80.42%              | 101.08%       |
| HCl       | 97.02%           | 93.37%            | 104.23%             | 100.94%       |
| DI Water  | 88.63%           | 89.21%            | 105.36%             | 101.38%       |
| H2O2      | 86.20%           | 87.54%            | 103.71%             | 101.57%       |
| Bleach    | 91.55%           | 91.87%            | 101.29%             | 101.14%       |
| Diesel    | 98.79%           | 99.48%            | 125.45%             | 100.11%       |
| Motor Oil | 94.86%           | 100.27%           | 104.11%             | 100.63%       |
| Skydrol 5 | 92.77%           | 100.85%           | 119.69%             | 100.90%       |

## 1 Week Immersion

| SOLVENT   | RELATIVE MODULUS     | RELATIVE STRENGTH    | RELATIVE ELONGATION  | RELATIVE MASS        |
|-----------|----------------------|----------------------|----------------------|----------------------|
| IPA       | 88.43%               | 86.98%               | 115.87%              | 101.71%              |
| Acetone   | Sample Disintegrated | Sample Disintegrated | Sample Disintegrated | Sample Disintegrated |
| NaOH      | 77.38%               | 80.26%               | 67.19%               | 102.46%              |
| HCl       | 84.07%               | 83.14%               | 76.80%               | 102.09%              |
| DI Water  | 65.29%               | 67.62%               | 83.53%               | 103.23%              |
| H2O2      | 62.66%               | 62.75%               | 91.67%               | 103.63%              |
| Bleach    | 77.78%               | 77.60%               | 58.92%               | 102.67%              |
| Diesel    | 100.45%              | 101.34%              | 101.63%              | 100.09%              |
| Motor Oil | 102.62%              | 103.32%              | 84.20%               | 100.14%              |
| Skydrol 5 | 104.59%              | 105.93%              | 87.22%               | 100.79%              |

## Bar Charts of Properties after Immersion



## Optical Properties

|                       | 5 MIN POST-CURE<br>CURE - CURE V1 | 15 MIN POST-CURE<br>AT 60 °C - CURE V1 | METHOD         |
|-----------------------|-----------------------------------|--|----------------|
| Refractive Index      | 1.62                              | 1.62                                   | ASTM D542-22   |
| Gloss Level (60°, XY) | 89 GU                             | --                                     | ASTM D523      |
| Gloss Level (60°, Z)  | 24 GU                             | --                                     | ASTM D523      |
| Transmission @ 2 mm   | 85 %                              | 85 %                                   | ASTM D1003-21  |
| a* @ 2 mm             | -4.02                             | -4.31                                  | ASTM E 1348-15 |
| b* @ 2 mm             | 7.52                              | 5.58                                   | ASTM E 1348-15 |
| Transmission @ 10 mm  | 59 %                              | 59 %                                   | ASTM D1003-21  |

|            | 5 MIN POST-CURE - CURE V1 | 15 MIN POST-CURE AT 60 °C - CURE V1 | METHOD         |
|------------|---------------------------|-------------------------------------|----------------|
| a* @ 10 mm | -4.25                     | -3.98                               | ASTM E 1348-15 |

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:

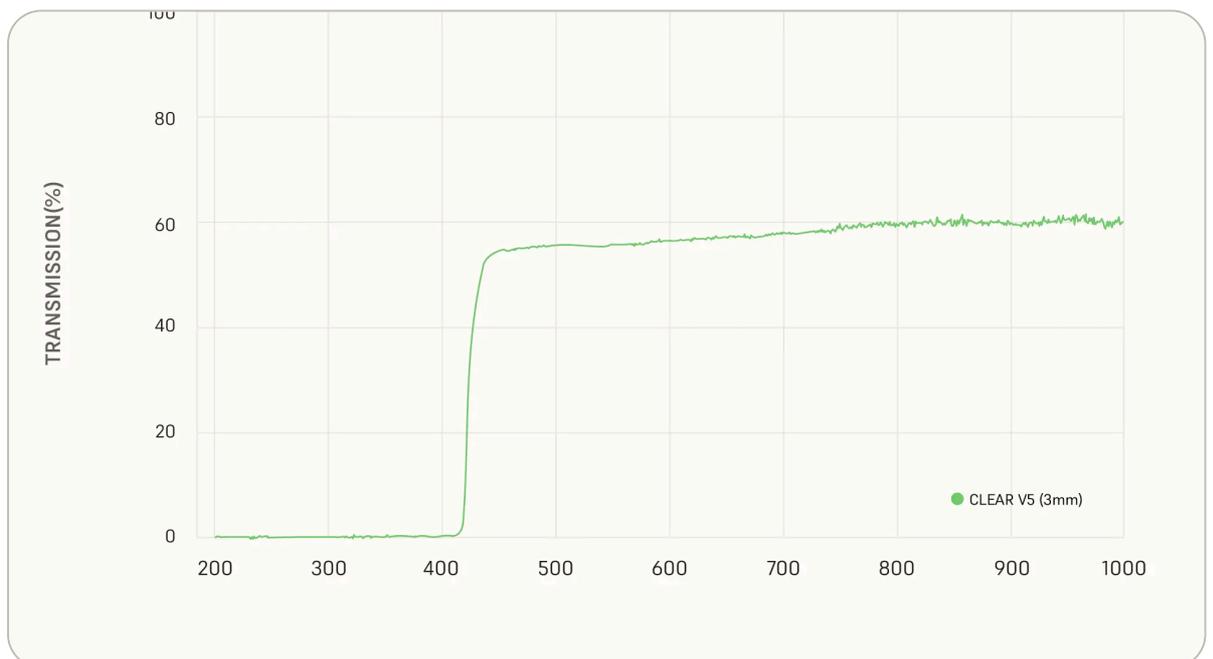
a\* axis: Ranges from green to red, with negative values indicating green and positive values indicating red.

b\* axis: Ranges from blue to yellow, with negative values indicating blue and positive values indicating yellow.

## Light Transmission Curve

Light transmission was tested on a Varian Cary 50 Spectrophotometer from 200 to 1000 nm. Noise at high wavelengths is expected and may not be indicative of real fluctuations. The chosen sample was 3 mm thick, washed for 10 minutes in IPA and then cured for 1 minute in the Form Cure (2nd Generation). The surface was vertical and unpolished.

### Light Transmission for Clear V5



## Outgassing

The Outgas Test was performed in a vacuum environment of less than  $5 \times 10^{-5}$  torr according to ASTM E595, for a duration of 24 hours, at 125°C on three specimens per sample. Data was obtained using Grey Resin V5, and is expected to fall in the same approximate range. Some results may vary. Consult Grey Resin V5 TDS for information on printing and post-processing of samples.

| Outgassing | Post Cured for 5 min at Ambient Temperature |
|------------|---|
| TML        | 1.70%                                       |
| CVCM       | < 0.01%                                     |
| WVR        | 0.33%                                       |