



WHITE PAPER

**formlabs** 

Nylon 12 Powder is a general purpose, versatile, and biocompatible material with high detail and great dimensional accuracy. As the go-to material for SLS 3D printing, it is ideal for both functional prototyping and end-use production of complex assemblies and durable parts with high environmental stability.

## Nylon 12 Powder Technical Data Sheet

# Mechanical Properties

## Tensile Properties

	NYLON 12 <sup>2</sup>	METHOD
<b>Ultimate Tensile Strength</b>	50 MPa (7252 psi)	ASTM D638-14 Type 1
<b>Tensile Modulus</b>	1900 MPa (268 ksi)	ASTM D638-14 Type 1
<b>Elongation at Break (X/Y)</b>	11%	ASTM D638-14 Type 1
<b>Elongation at Break (Z)</b>	6%	ASTM D638-14 Type 1
<b>TENSILE PROPERTIES AT LOW TEMPERATURE</b>		
<b>Ultimate Tensile Strength at -60 °C</b>	67 MPa (9720 psi)	ASTM D638-14 Type 1
<b>Tensile Modulus at -60 °C</b>	2650 MPa (385 ksi)	ASTM D638-14 Type 1
<b>Elongation at Break at -60 °C</b>	3.40%	ASTM D638-14 Type 1

## Flexural Properties

	NYLON 12 <sup>2</sup>	METHOD
<b>Flexural Strength</b>	66 MPa (9.6 ksi)	ASTM D790-15
<b>Flexural Modulus</b>	1600 MPa (232 ksi)	ASTM D790-15

## Impact Properties

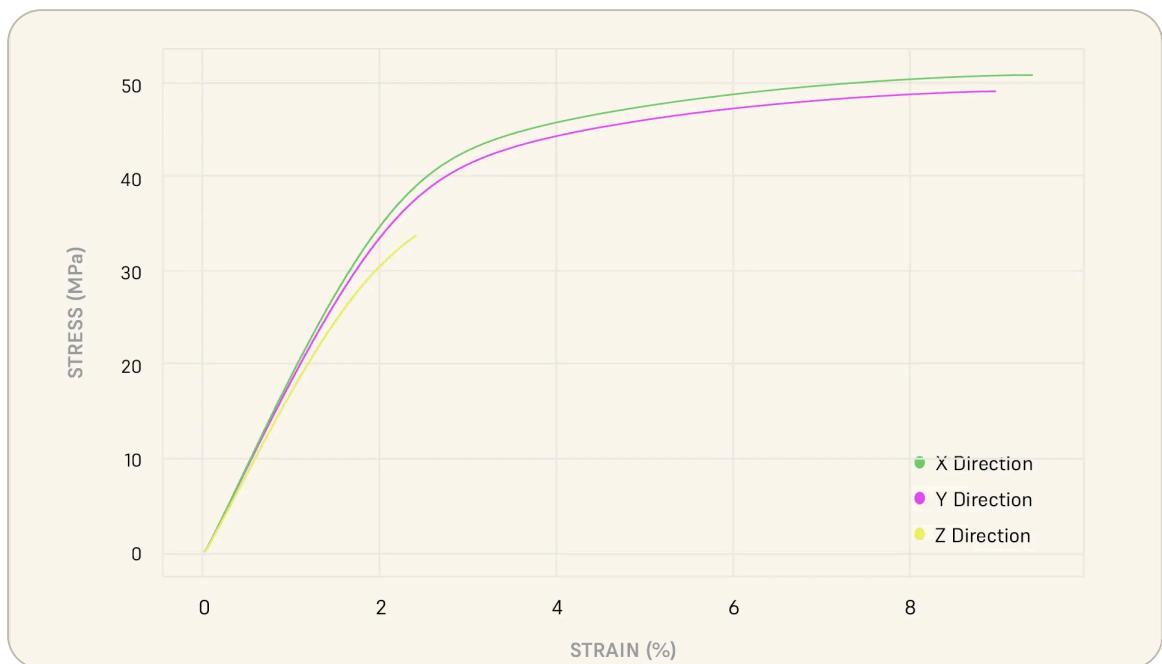
	NYLON 12 <sup>2</sup>	METHOD
<b>Notched Izod</b>	32 J/m (0.60 ft-lb/in)	ASTM D256-10
<b>Gardner at 1.6 mm (1/16") thickness</b>	0.45 J (4 in*lb)	ASTM D5420-21

## General Properties

	NYLON 12 <sup>2</sup>	METHOD
<b>Shore Hardness</b>	75 D	ASTM D2240-15
<b>Density (Printed)</b>	0.99 g/cc (0.0358 lb/in <sup>3</sup> )	ASTM D792
<b>Moisture Content (Powder)</b>	0.25%	ISO 15512 Method D
<b>Water Absorption (Printed Part)</b>	0.66%	ASTM D570

# Representative Tensile Curves

Samples were tested following ASTM D638, Type I in all three axes along the Fuse 1+. Each 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.



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

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# Thermal and Electrical Properties

## Thermal Properties

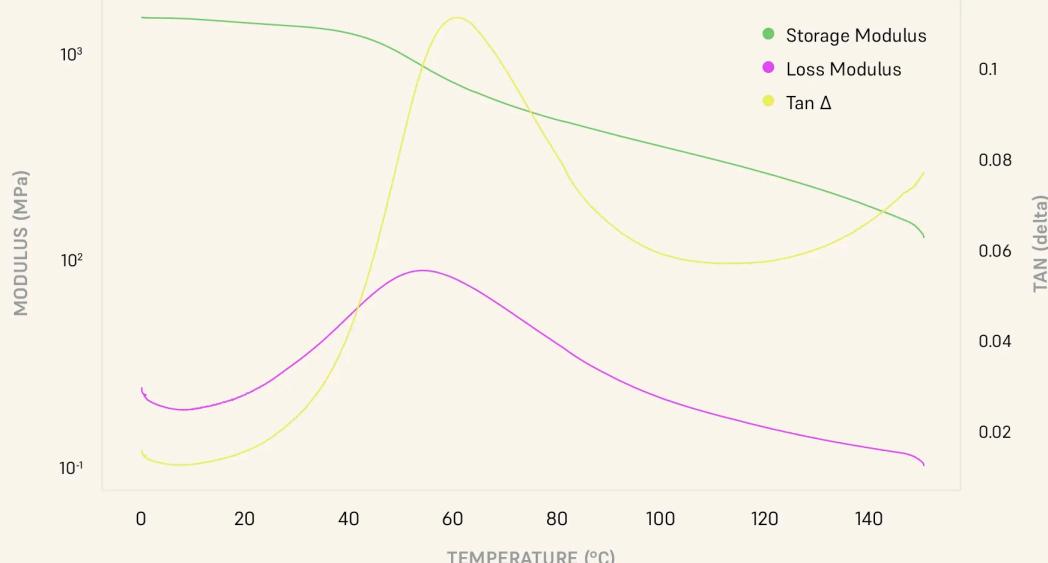
	NYLON 12 <sup>2</sup>	METHOD
<b>Heat Deflection Temp. @ 1.8 MPa</b>	87 °C (189 °F)	ASTM D648-16
<b>Heat Deflection Temp. @ 0.45 MPa</b>	171 °C (340 °F)	ASTM D648-16
<b>Vicat Softening Temperature</b>	175 °C (347 °F)	ASTM D1525
<b>Thermal Conductivity</b>	0.428 W/m*K (2.97 BTU-in/hr-ft <sup>2</sup> -°F)	ASTM D7984-16
<b>Thermal Effusivity</b>	787.4 W*s <sup>0.5</sup> / K*m <sup>2</sup> (2.3 BTU /ft <sup>2</sup> · hr <sup>0.5</sup> · °F)	ASTM D7984-16
<b>Glass Transition Temperature (T<sub>g</sub>)</b>	60 °C (140 °F)	ASTM D4065-20
<b>Coefficient of Thermal Expansion (-30-140 °C)</b>	150.1 µm/m-°C (83.4 µin/in-°F)	ASTM E831-19
<b>Flammability - 3.00mm (0.118 in) thick</b>	HB	UL 94 Section 7

## Electrical Properties

	NYLON 12 <sup>2</sup>	METHOD
<b>Surface Resistivity</b>	1 x 10 <sup>11</sup> Ω/sq	ASTM D257
	2.86 @ 6.78 MHz	ASTM D150-22
<b>Dielectric Constant (k')</b>	2.80 @ 13.56 MHz	ASTM D150-22
	2.74 @ 27.12 MHz	ASTM D150-22
	0.034 @ 6.78 MHz	ASTM D150-22
<b>Dielectric Dissipation (D)</b>	0.028 @ 13.56 MHz	ASTM D150-22
	0.008 @ 27.12 MHz	ASTM D150-22
<b>Dielectric Strength</b>	8.82 kV/mm (224 V/mil)	ASTM D149-20, Method A
<b>Comparative Tracking Index</b>	600 V	ASTM D3638
<b>CTI 600 Compliance</b>	Pass	IEC 60112:2020

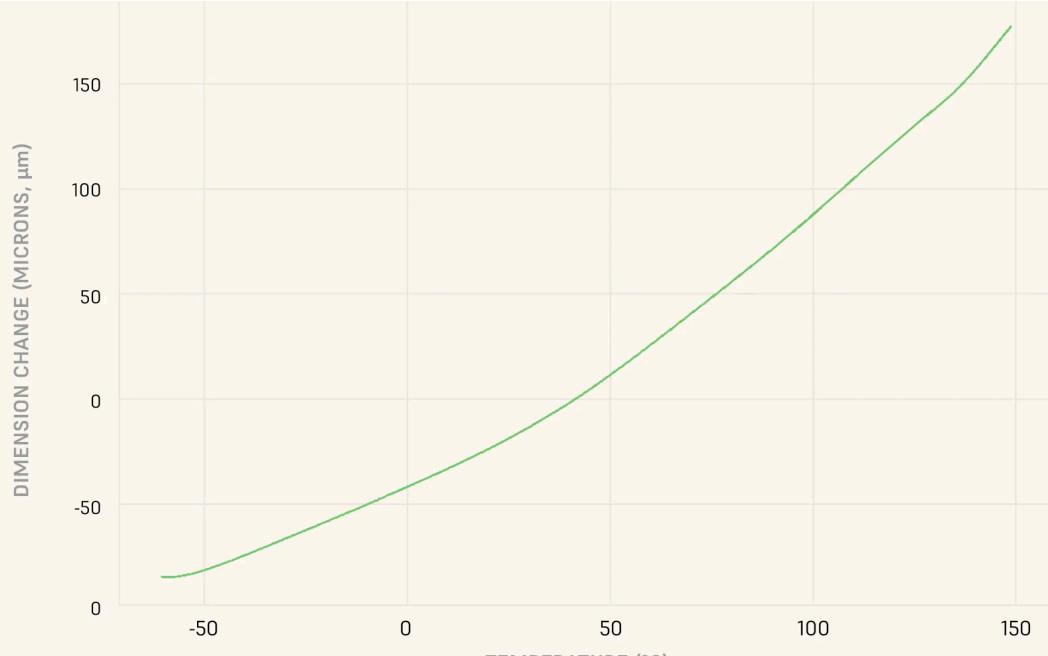
# Dynamic Mechanical Analysis (DMA)

A DMA curve from 0 °C to 150 °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.



# UV Aging

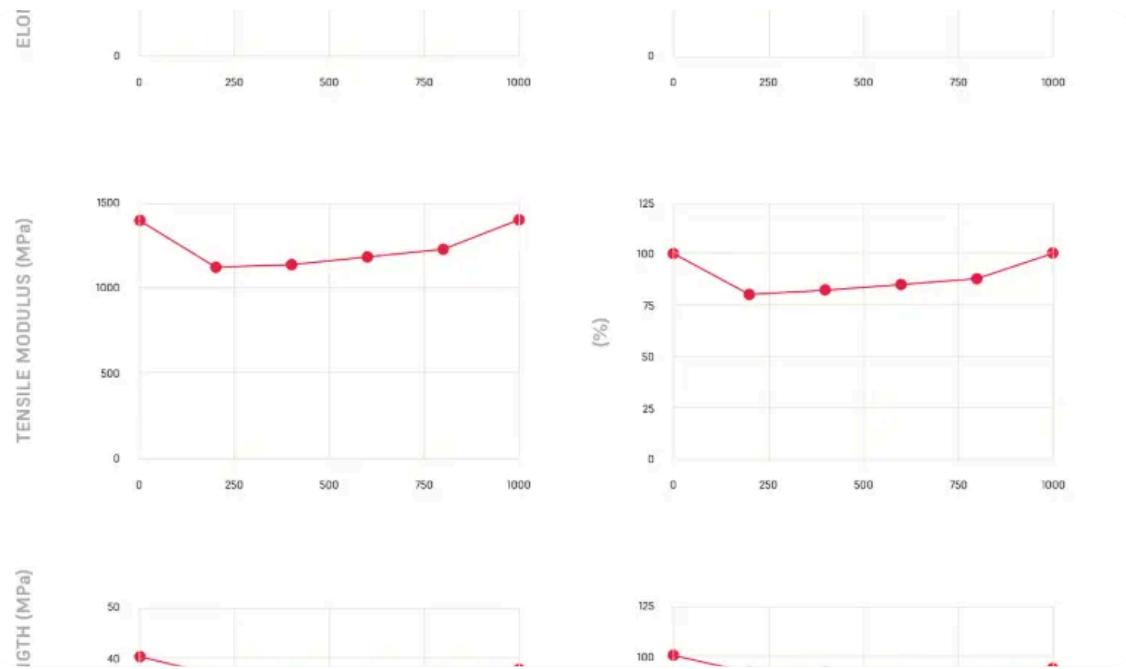
## Outdoor Aging ASTM D4329

Tested in accelerated outdoor weathering conditions according to ASTM D4329 (Cycle A). Test samples were exposed to defined conditions of heat, water condensation and UV light. Exposed samples were conditioned for 24 hours at 22 °C before mechanical testing. Control samples were stored at a constant 22 °C. Mechanical testing was conducted according to ASTM D638 at standard lab conditions (22 °C). "0 hrs" represents non-aged samples stored at 22 °C and tested 24 hours after post-processing.

Please note, accelerated weathering testing cannot fully represent all aging conditions. Formlabs recommends conducting additional testing relevant for your specific application needs.

HOURS EXPOSED	0 HOURS	200 HOURS	400 HOURS	600 HOURS	800 HOURS	1000 HOURS
<b>Elongation at Break (%)</b>						
at Break (%)	9.8	9.5	10.3	8.9	9.7	8.1
<b>% of Initial EAB</b>						
	100%	97%	105%	91%	99%	83%
<b>Tensile Modulus (MPa)</b>						
	1832	1794	1633	1854	1863	1764
<b>% of Initial Tensile Modulus</b>						
	100%	98%	89%	101%	102%	96%
<b>Ultimate Tensile Strength (MPa)</b>						
	50.76	49.32	49.17	49.06	50.64	48.91
<b>% of Initial Tensile Strength</b>						
	100%	97%	97%	97%	100%	96%





## Biocompatibility

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

ISO STANDARD DESCRIPTION	RESULT <sup>3,4</sup>
EN ISO 10993-5:2009	Not Cytotoxic
ISO 10993-10:2010/(R)2014	Non Irritant
ISO 10993-10:2010/(R)2014	Not a sensitizer
ISO 10993-11:2017	No Evidence of Systemic Toxicity
ISO 10993-11:2017	Non-Pyrogenic

## Chemical Compatibility

### Solvent Weight Gain

SOLVENT	24 HR WEIGHT GAIN, %
Acetic Acid 5%	0.1

SOLVENT	24 HR WEIGHT GAIN, %
Acetone	0.1
Bleach ~5% NaOCl	0.2
Butyl Acetate	0.2
Diesel Fuel	0.4
Diethyl glycol monomethyl ether	0.5
Hydraulic Oil	0.6
Hydrogen peroxide (3%)	0.2
Isooctane	<0.1
Isopropyl Alcohol	0.2
Mineral oil, heavy	0.7
Mineral oil, light	0.5
Salt Water (3.5% NaCl)	0.2
Skydrol 5	0.6
Sodium hydroxide solution (0.025% pH = 10)	0.2
Strong Acid (HCl Conc)	0.8
TPM	0.3
Water	0.1
Xylene	0.1

## 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 4

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

## 1 Day Immersion

SOLVENT	RELATIVE MODULUS	RELATIVE STRENGTH	RELATIVE ELONGATION	RELATIVE MASS
IPA	100.44%	101.19%	117.35%	100.29%
Acetone	92.89%	97.95%	105.83%	100.19%
NaOH	102.99%	102.77%	120.19%	100.36%
HCl	96.53%	99.59%	100.52%	100.44%
DI Water	93.57%	100.43%	105.05%	100.43%
H <sub>2</sub> O <sub>2</sub>	97.11%	102.92%	109.89%	100.34%
Bleach	92.25%	100.45%	104.39%	100.31%
Diesel	95.54%	98.61%	102.64%	100.44%
Motor Oil	101.92%	101.32%	108.10%	100.88%
Skydrol 5	97.57%	100.86%	107.26%	101.03%

## 1 Week Immersion

SOLVENT	RELATIVE MODULUS	RELATIVE STRENGTH	RELATIVE ELONGATION	RELATIVE MASS
IPA	94.97%	100.84%	110.49%	100.63%
Acetone	93.71%	99.13%	132.37%	100.43%
NaOH	95.66%	100.70%	122.75%	100.71%
HCl	91.56%	101.66%	111.25%	100.48%

SOLVENT	RELATIVE MODULUS	RELATIVE STRENGTH	RELATIVE ELONGATION	RELATIVE MASS
DI Water	85.37%	97.86%	112.44%	100.49%
H2O2	86.70%	98.58%	119.42%	100.76%
Bleach	92.31%	99.83%	113.74%	100.90%
Diesel	100.12%	101.68%	119.33%	100.51%
Motor Oil	95.30%	98.70%	95.41%	100.76%
Skydrol 5	102.48%	104.60%	113.59%	100.68%

## 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  $125^{\circ}\text{C}$  on three specimens per sample

OUTGASSING	NYLON 12	METHOD
TML	0.38%	ASTM E595
CVCM	<0.01%	ASTM E595
WVR	0.14%%	ASTM E595

## Footnotes

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  $23^{\circ}\text{C}$  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

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the printed parts for the intended use.

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