



# Figure 4® Tough 60C White

Production Rigid

White plastic for long-term use parts with a good combination of impact strength, elongation, and tensile strength

Figure 4

## SAVE ON TOOLING COSTS AND TIME WITH DIRECT PRODUCTION PLASTIC PARTS

Figure 4® Tough 60C White is a versatile, biocompatible-capable production-grade white material with good impact strength, elongation, and tensile strength. It provides long-term environmental stability and long-lasting white color with an injection molded-like surface quality.

This material is recommended for high mechanical load-bearing batch production medical parts that remain functional and stable for years.

This resin features a 65 °C heat deflection temperature and 23% elongation at break, and is excellent for brackets, snaps, and clips due to a 7.1% elongation at yield. Fast print speeds and simplified post-processing speeds enable exceptional throughput.

## HANDLING AND POST-PROCESSING GUIDELINES

Proper mixing, cleaning, drying and curing is required for this material. Post-processing information can be found at the end of this document.

Note: all properties are based on using the documented post-processing method. Any deviation from this method could yield a different result.

More details can be found in the Figure 4 User Guide available at <http://infocenter.3dsystems.com>

Figure 4 Standalone:

<http://infocenter.3dsystems.com/figure4standalone/node/1546>

Figure 4 Modular:

<http://infocenter.3dsystems.com/figure4modular/node/1741>

*Note: Not all products and materials are available in all countries — please consult your local sales representative for availability.*

## APPLICATIONS

- Clinical trials and medical devices such as tools, handles, and small plastic parts
- Load-bearing parts such as handles, cranks, knobs, and levers
- Structural parts like brackets, snap-fits, and custom fasteners
- Small parts requiring detail and accuracy in consumer products, wearable devices, and general use
- Functional prototyping and biocompatible end-user parts

## BENEFITS

- Long-term use parts for indoor and outdoor applications
- No secondary thermal cure required
- Clean, long-lasting bright white color
- Excellent surface quality, accuracy & repeatability
- Autoclavable

## FEATURES

- Long-term indoor and outdoor environmental stability of mechanical properties and color; tested out to 8 and 1.5 years (respectively) per ASTM methods
- Biocompatible-capable per ISO10993-5 and ISO10993-10\*
- 65°C HDT at 0.455MPa
- 23% elongation at break
- 7.1% elongation at yield
- 34 J/m notched impact strength
- 1500 MPa tensile modulus
- UL94 HB flammability
- Sterilization through Autoclave

**MATERIAL PROPERTIES**

The full suite of mechanical properties is given per ASTM and ISO standards where applicable. All parts are conditioned per ASTM recommended standards for a minimum of 40 hours at 23 °C, 50% RH. Material properties include physical and mechanical properties, as well as thermal, flammability, and electrical (dielectric strength, dielectric constant, dissipation factor, and volume resistivity).

LIQUID MATERIAL			
MEASUREMENT	CONDITION/METHOD	METRIC	ENGLISH
Viscosity	Brookfield Viscometer @ 25 °C (77 °F)	1800 cPs	4354 lb/ft-h
Color		White	
Liquid Density	Kruss K11 Force Tensiometer @ 25 °C (77 °F)	1.15 g/cm <sup>3</sup>	0.04 lb/in <sup>3</sup>
Default Print Layer Thickness	Internal	50 µm	0.002 in
Speed - Standard Mode	Internal	mm/hr	23
Package Volume		1 kg bottle - Figure 4 Standalone 2.5 kg cartridge - Figure 4 Modular 9 kg container - Figure 4 Production	

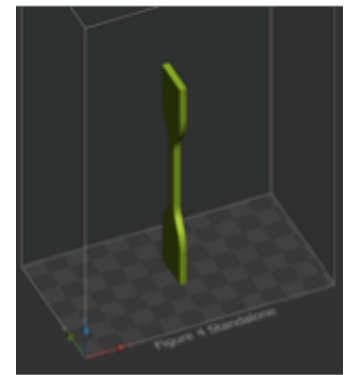
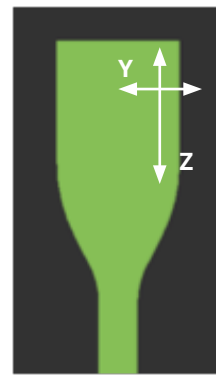
SOLID MATERIAL						
METRIC	ASTM METHOD	METRIC	ENGLISH	ISO METHOD	METRIC	ENGLISH
<b>PHYSICAL</b>				<b>PHYSICAL</b>		
Solid Density	ASTM D792	1.23 g/cm <sup>3</sup>	0.044 lb/in <sup>3</sup>	ISO 1183	1.23 g/cm <sup>3</sup>	0.044 lb/in <sup>3</sup>
24 Hour Water Absorption	ASTM D570	0.61 %	0.61 %	ISO 62	0.61 %	0.61 %
<b>MECHANICAL</b>				<b>MECHANICAL</b>		
Tensile Strength Ultimate	ASTM D638	35 MPa	5100 psi	ISO 527 -1/2	34 MPa	5000 psi
Tensile Strength at Yield	ASTM D638	35 MPa	5100 psi	ISO 527 -1/2	33.5 MPa	4900 psi
Tensile Modulus	ASTM D638	1500 MPa	220 ksi	ISO 527 -1/2	1400 MPa	208 ksi
Elongation at Break	ASTM D638	23 %	23 %	ISO 527 -1/2	23 %	23 %
Elongation at Yield	ASTM D638	7.1 %	7.1 %	ISO 527 -1/2	9.4 %	9.4 %
Flex Strength	ASTM D790	52 MPa	7500 psi	ISO 178	40 MPa	5600 psi
Flex Modulus	ASTM D790	1500 MPa	220 ksi	ISO 178	1100 MPa	160 ksi
Izod Notched Impact	ASTM D256	34 J/m	0.6 ft-lb/in	ISO 180-A	3.1 kJ/m <sup>2</sup>	1.5 ft-lb/in <sup>2</sup>
Izod Unnotched Impact	ASTM D4812	90 J/m	2 ft-lb/in	ISO 180-U	9.2 kJ/m <sup>2</sup>	4.4 ft-lb/in <sup>2</sup>
Shore Hardness	ASTM D2240	79 D	79 D	ISO 7619	79 D	79 D
<b>THERMAL</b>				<b>THERMAL</b>		
Tg (DMA, E")	ASTM E1640 (E"at 1C/min)	50 °C	123 °F	ISO 6721-1/11 (E"at 1C/min)	50 °C	123 °F
HDT @ 0.455 MPa/66 PSI	ASTM D648	65 °C	149 °F	ISO 75- 1/2 B	64 °C	147 °F
HDT @ 1.82 MPa/264 PSI	ASTM D648	48 °C	119 °F	ISO 75-1/2 A	46 °C	114 °F
CTE below Tg	ASTM E831	95 ppm/°C	53 ppm/°F	ISO 11359-2	95 ppm/K	53 ppm/°F
CTE above Tg	ASTM E831	171 ppm/°C	95 ppm/°F	ISO 11359-2	171 ppm/K	95 ppm/°F
UL Flammability	UL94	HB	HB			
<b>ELECTRICAL</b>				<b>ELECTRICAL</b>		
Dielectric Strength (kV/mm) @ 3.0 mm thickness	ASTM D149	13				
Dielectric Constant @ 1 MHz	ASTM D150	3.79				
Dissipation Factor @ 1 MHz	ASTM D150	0.033				
Volume Resistivity (ohm-cm)	ASTM D257	2.45x10 <sup>15</sup>				

# Figure 4 Tough 60C White

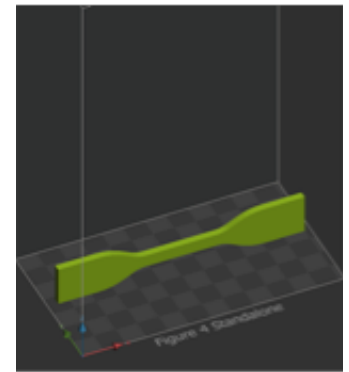
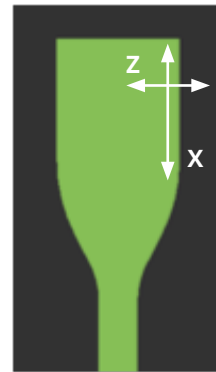
## ISOTROPIC PROPERTIES

Figure 4 technology prints parts that are generally isotropic in mechanical properties meaning the parts printed along either the XYZ axis will give similar results.

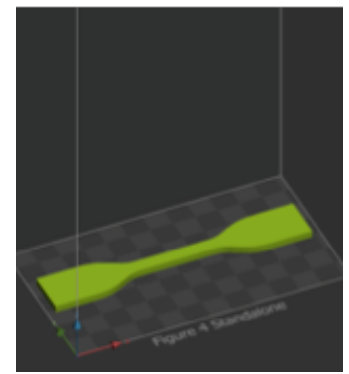
Parts do not need to be oriented to get the highest mechanical properties, further improving the degree of freedom for part orientation for mechanical properties.



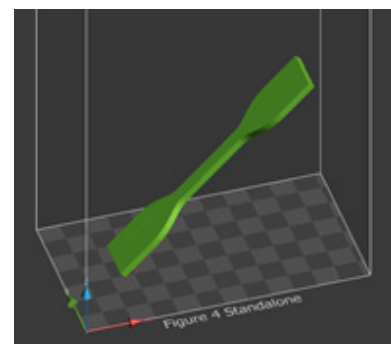
ZY - orientation



XZ - orientation



XY - orientation



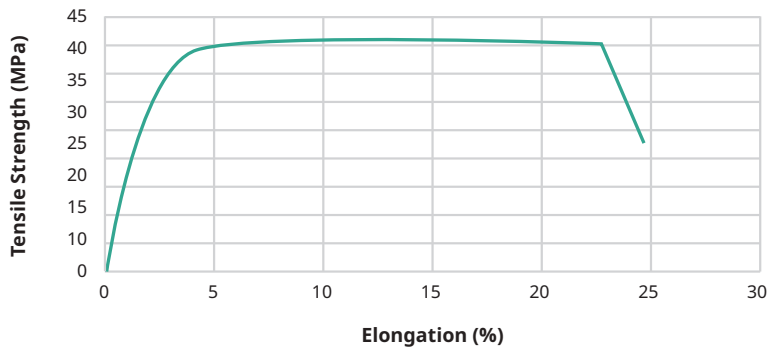
Z45-Degree - orientation

SOLID MATERIAL					
METRIC	METHOD	METRIC			
MECHANICAL					
		ZY	XZ	XY	Z45
Tensile Strength Ultimate	ASTM D638 Type IV	35 MPa	38 MPa	38 MPa	35 MPa
Tensile Strength at Yield	ASTM D638 Type IV	35 MPa	38 MPa	38 MPa	35 MPa
Tensile Modulus	ASTM D638 Type IV	1500 MPa	1500 MPa	1500 MPa	1500 MPa
Elongation at Break	ASTM D638 Type IV	23 %	30 %	34 %	20 %
Elongation at Yield	ASTM D638 Type IV	7.1 %	7.2 %	8.2 %	10.1 %
Flex Strength	ASTM D790	52 MPa	44 MPa	46 MPa	44 MPa
Flex Modulus	ASTM D790	1500 MPa	1200 MPa	1300 MPa	1200 MPa
Izod Notched Impact	ASTM D256	34 J/m	41 J/m	41 J/m	26 J/m
Shore Hardness	ASTM D2240	79 D	N/A	N/A	N/A

## STRESS-STRAIN CURVE

The graph represents the Stress-Strain curve for Figure 4 Tough 60C White per ASTM D638 testing.

FIGURE 4 TOUGH 60C WHITE



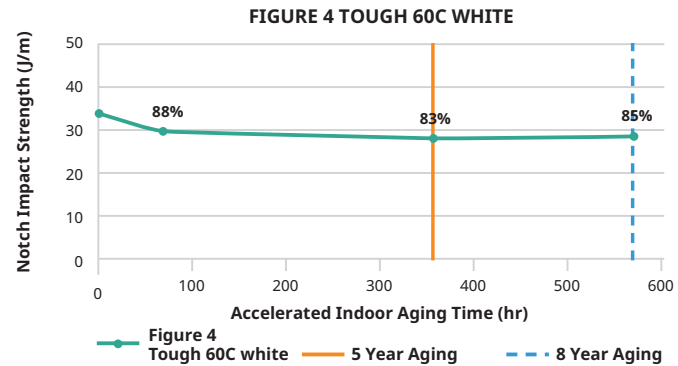
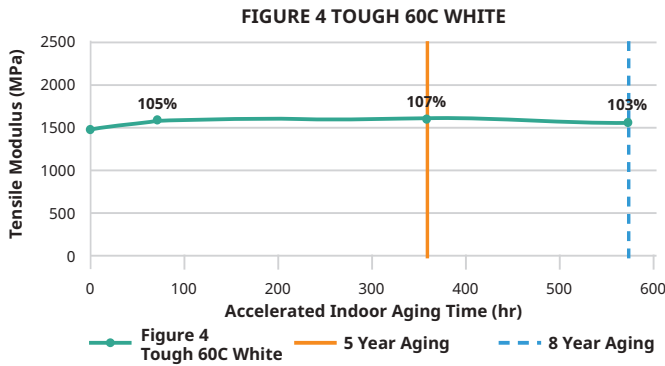
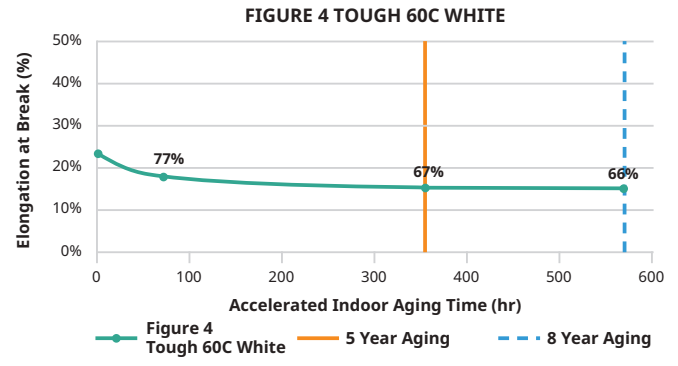
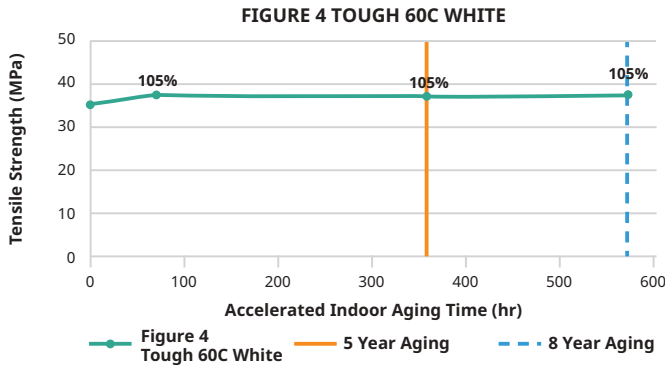
# Figure 4 Tough 60C White

## LONG TERM ENVIRONMENTAL STABILITY

Figure 4 Tough 65C Black is engineered to give long term environmental UV and humidity stability. This means the material is tested for the ability to retain a high percent of the initial mechanical properties over a given period of time. This provides real design conditions to consider for the application or part. **Actual data value is on Y-axis, and data points are % of initial value.**

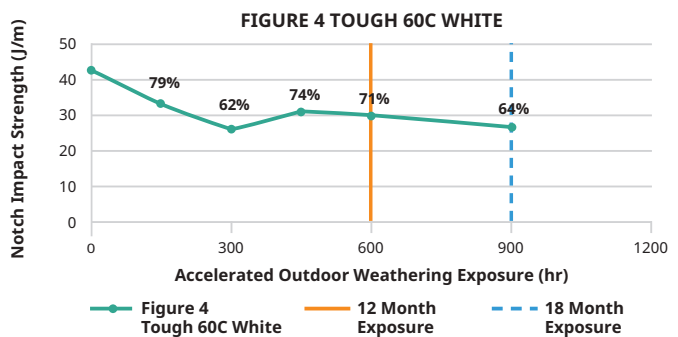
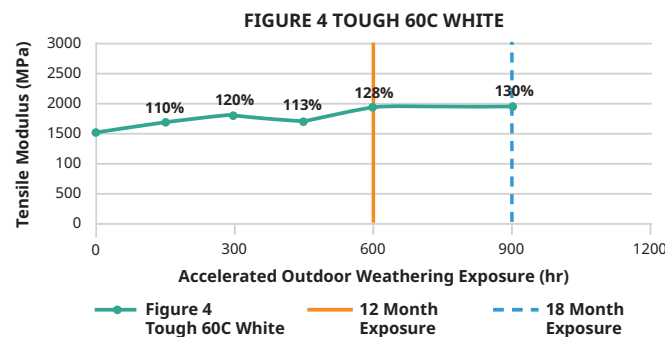
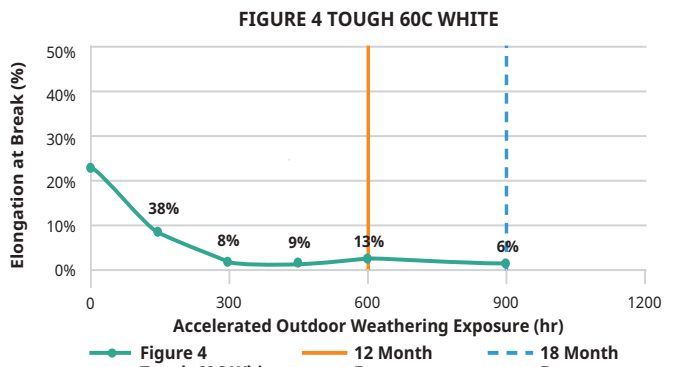
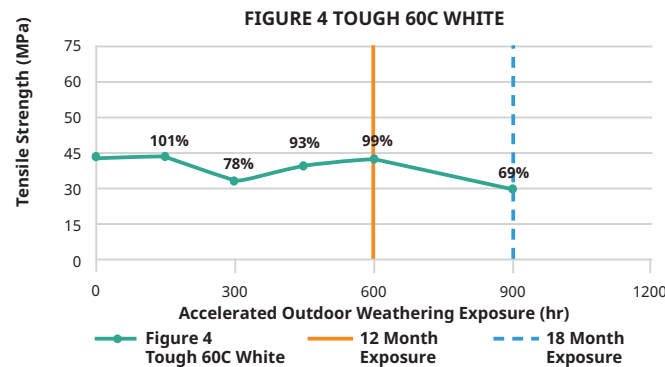
**INDOOR STABILITY:** Tested per ASTM D4329 standard method.

INDOOR STABILITY



**OUTDOOR STABILITY:** Tested per ASTM G154 standard method.

OUTDOOR STABILITY



# Figure 4 Tough 60C White

## AUTOMOTIVE FLUID COMPATIBILITY

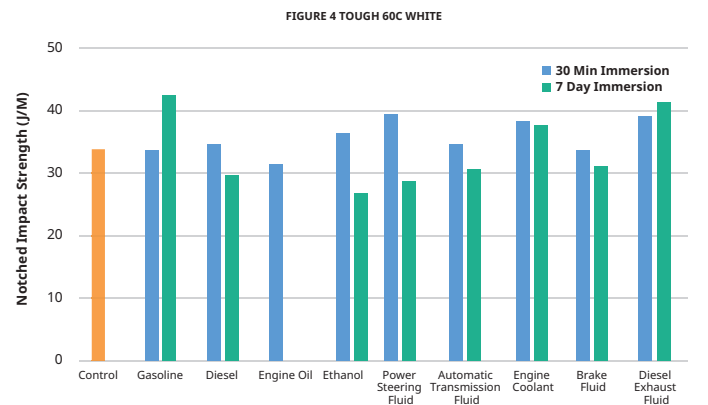
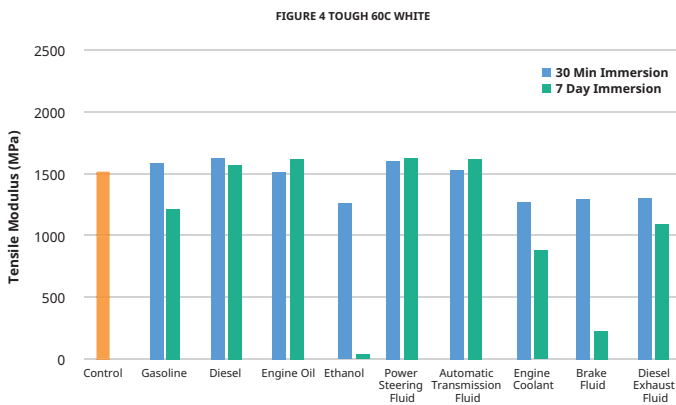
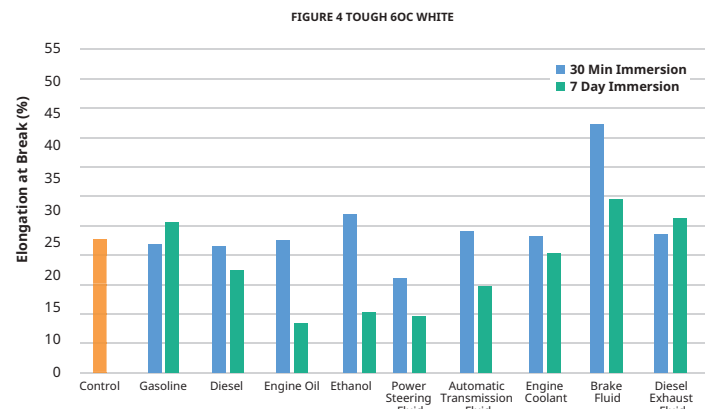
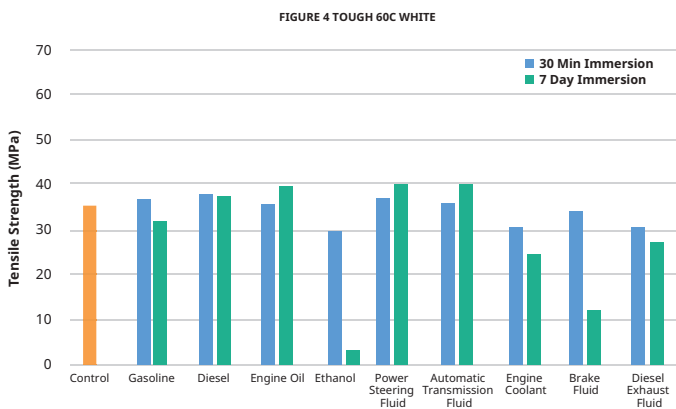
The compatibility of a material with hydrocarbons and cleaning chemicals is critical to part application. Figure 4 Tough 65C Black parts were tested for sealed and surface contact compatibility per USCAR2 test conditions. The fluids below were tested in two different ways per the specs.

- Immerse for 7-days, then take mechanical property data for comparison.
- Immerse for 30-minutes, remove, and take mechanical property data for comparison in 7-days

Data reflects the measured value of properties over that period of time.

AUTOMOTIVE FLUIDS		
FLUID	SPECIFICATION	TEST TEMP °C
Gasoline	ISO 1817, liquid C	23 ± 5
Diesel Fuel	905 ISO 1817, Oil No. 3 + 10% p-xylene*	23 ± 5
Engine Oil	ISO 1817, Oil No. 2	50 ± 3
Ethanol	85% Ethanol + 15% ISO 1817 liquid C*	23 ± 5
Power Steering Fluid	ISO 1917, Oil No. 3	50 ± 3
Automotive Transmission Fluid	Dexron VI (North American specific material)	50 ± 3
Engine Coolant	50% ethylene glycol + 50% distilled water*	50 ± 3
Brake Fluid	SAE RM66xx (Use latest available fluid for xx)	50 ± 3
Diesel Exhaust Fluid (DEF)	API certified per ISO 22241	23 ± 5

\*Solutions are determined as percent by volume



# Figure 4 Tough 60C White

## CHEMICAL COMPATIBILITY

The compatibility of a material with cleaning chemicals is critical to part application. Figure 4 Tough 65C Black parts were tested for sealed and surface contact compatibility per ASTM D543 test conditions. The fluids below were tested in two different ways per the specs.

- Immerse for 7-days, then take mechanical property data for comparison.
- Immerse for 30-minutes, remove, and take mechanical property data for comparison in 7-days

Data reflects the measured value of properties over that period of time.

\*Denotes materials did not go thru 7-day soak conditioning.

CHEMICAL COMPATIBILITY
6.3.3 Acetone
6.3.12 Detergent Solution, Heavy Duty
6.3.23 Hydrochloric Acid (10%)
6.3.38 Sodium Carbonate Solution (20%)
6.3.44 Sodium Hypochlorite Solution
6.3.46 Sulfuric Acid (30%)
6.3.42 Sodium Hydroxide Soln (10%)
6.3.15 Distilled Water

FIGURE 4 TOUGH 60C WHITE

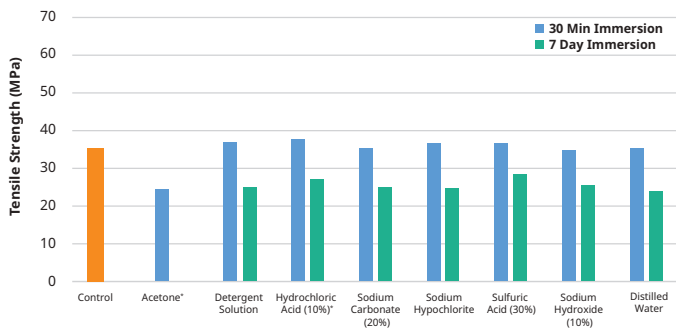


FIGURE 4 TOUGH 60C WHITE

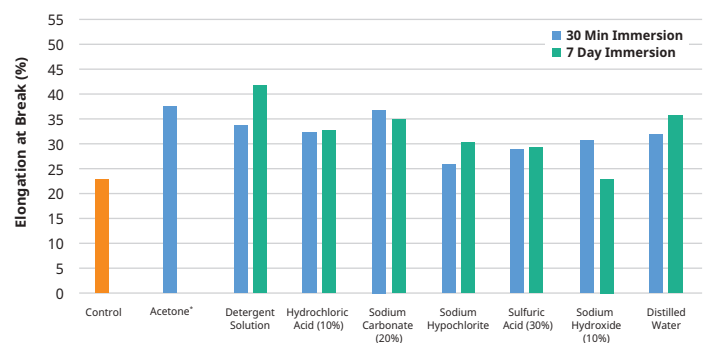


FIGURE 4 TOUGH 60C WHITE

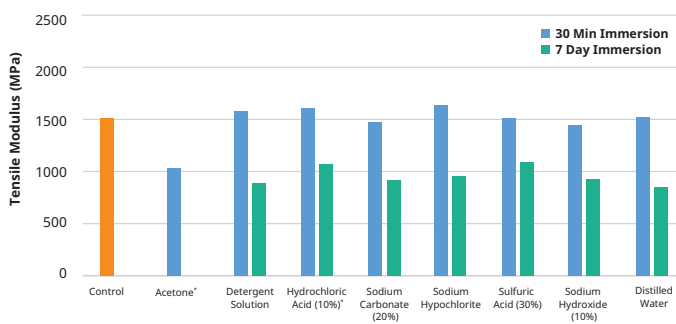
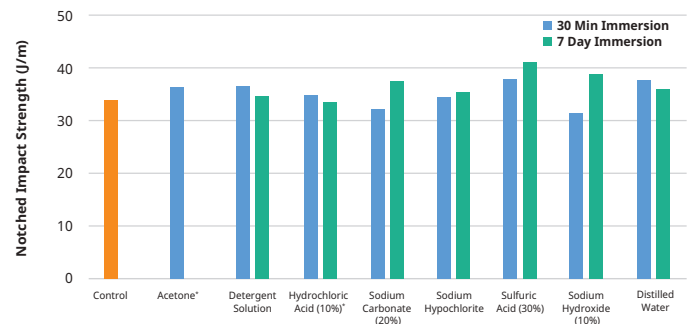


FIGURE 4 TOUGH 60C WHITE



### BIOCOMPATIBILITY STATEMENT

Figure 4<sup>®</sup> Tough 60C White test coupons printed and processed according to the post processing instructions below were provided to an external biological testing laboratory for evaluation in accordance with *ISO 10993-5* and *ISO 10993-10, Biological evaluation of medical devices - Part 5: Tests for in vitro cytotoxicity*. The test results indicate that Figure 4<sup>®</sup> Tough 60C White has passed the requirements for biocompatibility according to the above test.

It is the responsibility of each customer to determine that its use of Figure 4<sup>®</sup> Tough 60C White material is safe, lawful and technically suitable to the customer's intended applications. Customers should conduct their own testing to ensure that this is the case. Because of possible changes in the law and in regulations, as well as possible changes in these materials, 3D Systems cannot guarantee that the status of these materials will remain unchanged or that it will qualify as biocompatible in any particular use. Therefore, 3D Systems recommends that customers continuing to use these materials verify their status on a periodic basis.

## Figure 4 Tough 60C White

### POST-PROCESSING INSTRUCTIONS REQUIRED TO PASS ISO 10993-5

#### MIXING INSTRUCTIONS

This material has a pigment that settles very slowly over time before printing. For best results mix material in the bottle:

##### 1 kg bottle for Figure 4 Standalone

- Roll bottle for 1 hour on 3D Systems LC-3D Mixer for first use
- Roll for 10 minutes before subsequent uses

##### 2.5 kg cartridge for Figure 4 Modular

- Vigorously shake the bottle for 2 minutes before installing cartridge
- For Modular system, roll bottle 20 minutes at the beginning of each day of use

Use the Resin Mixer to stir material in the tray for 30 seconds between print jobs.

#### MANUAL CLEANING INSTRUCTIONS

- Manual cleaning with 2 containers of IPA (wash and rinse)
- Clean in 'wash' IPA for 2.5 minutes while agitating part
- Rinse in 'clean' TPM for 2.5 minutes while agitating part
  - DO NOT EXCEED more than 10 minutes total exposure to IPA to preserve mechanical properties
- Manual agitation and/or a soft brush can be used to aid cleaning
- Refresh IPA when cleaning becomes ineffective

#### DRYING INSTRUCTIONS

- Oven dry at 35 °C for 25 minutes

#### UV CURE TIME

- 3D Systems LC-3DPrint Box UV Post-Curing Unit or Figure 4 UV Cure Unit 350: 90 minutes

More details can be found in the Figure 4 User Guide available at <http://infocenter.3dsystems.com>

Figure 4 Standalone: <http://infocenter.3dsystems.com/figure4standalone/node/1546>

Figure 4 Modular: <http://infocenter.3dsystems.com/figure4modular/node/1741>

