Figure 4® TOUGH-BLK 20

Production Rigid

Figure 4

A strong material with long-term environmental stability for the production of black parts with the look and feel of injection molded ABS

EXCEPTIONAL SURFACE FINISH, DURABILITY AND ENVIRONMENTAL STABILITY FOR HIGH PERFORMANCE PROTOTYPING AND PRODUCTION APPLICATIONS

Figure 4® TOUGH-BLK 20 is a strong black plastic simulating injection molded ABS, with long-term environmental stability for high performance prototyping and production applications where lifecycle stability is critical and mechanical properties fit. It provides high precision, smooth surface finish and exceptional sidewall quality with minimal finishing.

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

APPLICATIONS

- Rapid design iteration
- Strong functional parts for:
  - Automotive styling parts
  - Consumer electronics components
  - Legacy replacement parts
  - Form, fit and function testing
  - Durable assemblies and snap fits
  - Bezels, knobs, brackets, covers, cases
- Master patterns for RTV/silicone molding
- Short-run manufacturing of rigid parts

BENEFITS

- Reliable and robust functional prototypes
- Improved environmental stability of mechanical and performance properties over time
- High precision and exceptional part quality with smooth surfaces and sidewalls
- Beautiful black parts with the look and feel of injection molded ABS

FEATURES

- Long-term indoor and outdoor environmental stability
- Durable and strong
- Excellent humidity/moisture resistance
- Simulating some properties of molded black ABS

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

3D SYSTEMS®

Figure 4 TOUGH-BLK 20

MATERIAL PROPERTIES

The full suite of mechanical properties are given per ASTM and ISO standards where applicable. In addition, properties such as flammability, dielectric properties, and 24 hour water absorption. This allows for better understanding of the material capability to aid in design decisions for the material. All parts are conditioned per ASTM recommended standards for a minimum of 40 hours at 23 °C, 50% RH.

Solid material properties reported were printed along the vertical axis (ZY-orientation). Figure 4 material properties are relatively uniform across print orientations, as detailed in the following section on Isotropic Properties. Because of this, parts do not need to be oriented in a particular direction to exhibit these properties.

LIQUID MATERIAL			
MEASUREMENT	**CONDITION/METHOD**	**METRIC**	**ENGLISH**
Viscosity	Brookfield Viscometer @ 25 °C (77 °F)	2623 cps	6350 lb/ft-hr
Color		Black	
Liquid Density	Kruss K11 Force Tensiometer @ 25 °C (77 °F)	1.04 g/cm³	0.038 lb/in³
Default Print Layer Thickness (Standard Mode)		0.05 mm	0.002 in
Speed - Standard Mode		43 mm/hr	1.8 in/hr
Speed - Draft Mode		53 mm/hr	2.1 in/hr
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**
	PHYSICAL				**PHYSICAL**	
Solid Density	ASTM D792	1.11 g/cm³	0.040 lb/in³	ISO 1183	1.11 g/cm³	0.040 lb/in³
24 Hour Water Absorption	ASTM D570	0.31%	0.31%	ISO 62	0.31%	0.31%
	MECHANICAL				**MECHANICAL**	
Tensile Strength Ultimate	ASTM D638 *	40 MPa	5860 psi	ISO 527 -1/2	40 MPa	5869 psi
Tensile Strength at Yield	ASTM D638	40 MPa	5860 psi	ISO 527 -1/2	40 MPa	5869 psi
Tensile Modulus	ASTM D638	1780 MPa	260 ksi	ISO 527 -1/2	1981 MPa	287 ksi
Elongation at Break	ASTM D638	36%	36%	ISO 527 -1/2	25 %	25 %
Elongation at Yield	ASTM D638	4.6%	4.6%	ISO 527 -1/2	4.4 %	4.4 %
Flex Strength	ASTM D790	61 MPa	8775 psi	ISO 178	64 MPa	9313 psi
Flex Modulus	ASTM D790	1650 MPa	240 ksi	ISO 178	2327 MPa	338 ksi
Izod Notched Impact	ASTM D256	27 J/m	0.5 ft-lb/in	ISO 180-A	2.7 J/m²	0.0013 ft-lb/in²
Izod Unnotched Impact	ASTM D4812	1008 J/m	18.9 ft-lb/in	ISO 180-U		
Shore Hardness	ASTM D2240	79D	79D	ISO 7619	79D	79D
	THERMAL				**THERMAL**	
Tg (DMA, E")	ASTM E1640 (E"at 1C/min)	46 °C	115 °F	ISO 6721-1/11 (E"at 1C/min)	46 °C	115 °F
HDT @ 0.455 MPa/66 PSI	ASTM D648	55 °C	131 °F	ISO 75- 1/2 B	57 °C	134 °F
HDT @ 1.82 MPa/264 PSI	ASTM D648	45 °C	113 °F	ISO 75-1/2 A	46 °C	115 °F
CTE below Tg	ASTM E831	83 ppm/°C	46 ppm/°F	ISO 11359-2	83 ppm/°K	46 ppm/°F
CTE above Tg	ASTM E831	173 ppm/°C	96 ppm/°F	ISO 11359-2	173 ppm/°K	96 ppm/°F
	ELECTRICAL				**ELECTRICAL**	
Dielectric Strength (V/mil) @ 3.0 mm thickness	ASTM D149					
Dielectric Constant @ 1 MHz	ASTM D150					
Dissipation Factor @ 1 MHz	ASTM D150					
Volume Resistivity (ohm-cm)	ASTM D257					

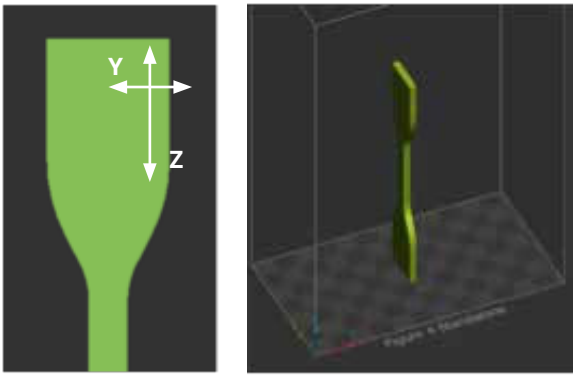
Figure 4 TOUGH-BLK 20

ISOTROPIC PROPERTIES

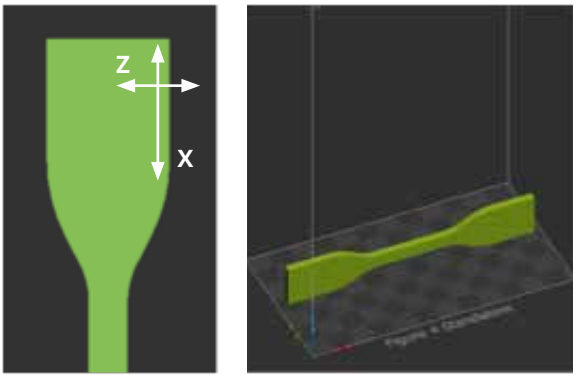
Figure 4 technology prints parts that are isotropic in mechanical properties meaning the parts printed along either the XYZ axis will give similar results.

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.

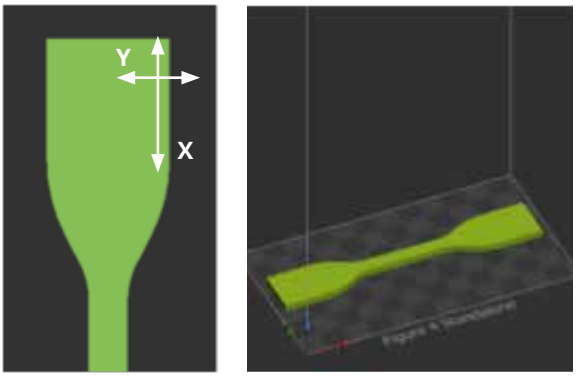
SOLID MATERIAL					
METRIC	METHOD	METRIC			
MECHANICAL					
		ZY	XZ	XY	Z45
Tensile Strength Ultimate	ASTM D638	40 MPa	42 MPa	43 MPa	42 MPa
Tensile Strength at Yield	ASTM D639	40 MPa	42 MPa	43 MPa	42 MPa
Tensile Modulus	ASTM D640	1780 MPa	1625 MPa	1634 MPa	1919 MPa
Elongation at Break	ASTM D641	36%	27 %	31 %	20 %
Elongation at Yield	ASTM D642	4.6%	5 %	5.6 %	4.3 %
Flex Strength	ASTM D790	61 MPa	71 MPa	62.2 MPa	65 MPa
Flex Modulus	ASTM D790	1650 MPa	2029 MPa	1599 MPa	1796 MPa
Izod Notched Impact	ASTM D256	27 J/m	35 J/m	34 J/m	32 J/m
Shore Hardness	ASTM D2240	79D	79D	72D	78D



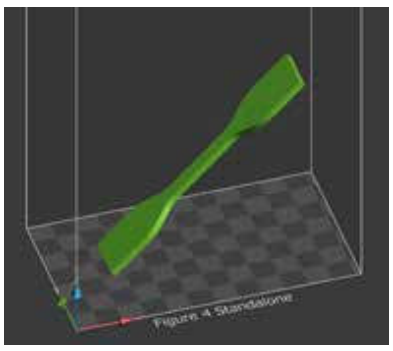
YZ - orientation



XZ - orientation



XY - orientation



Z45-Degree - orientation

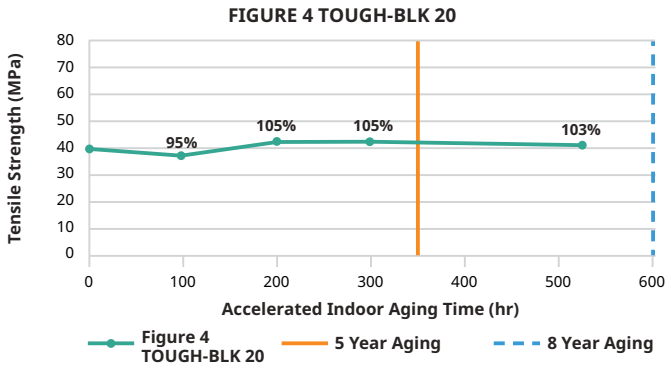
Figure 4 TOUGH-BLK 20

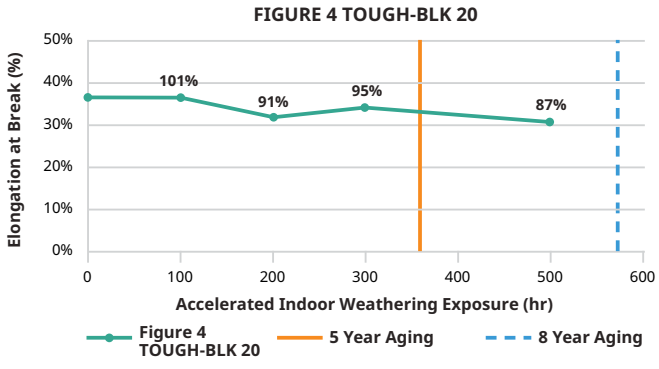
LONG TERM ENVIRONMENTAL STABILITY

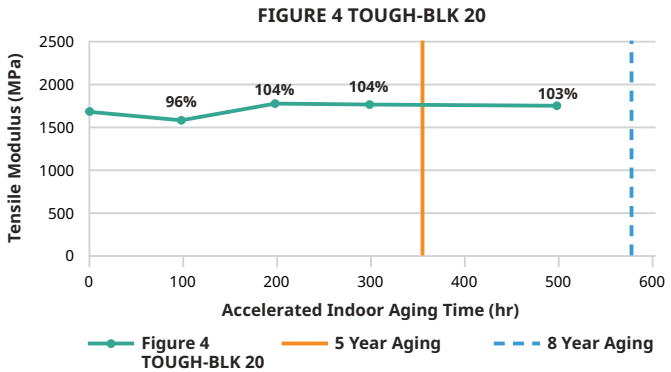
Figure 4 TOUGH-BLK 20 is engineered to give long term environmental UV and humidity stability. This means the material is tested for the ability to retain a high percent of the initial mechanical properties over a given period of time. This provides real design conditions to consider for the application or part. **Actual data value is on Y-axis, and data points are % of initial value.**

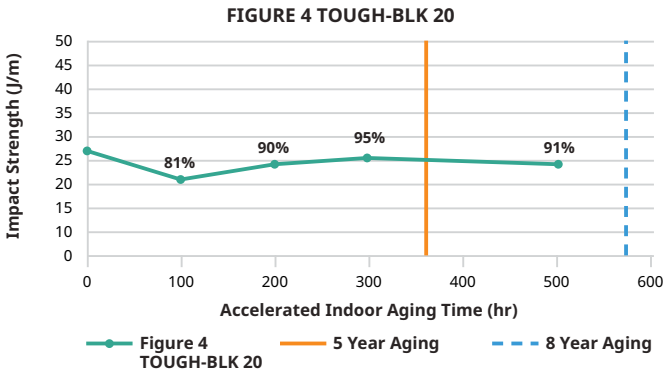
INDOOR STABILITY

INDOOR STABILITY: Tested per ASTM D4329 standard method.



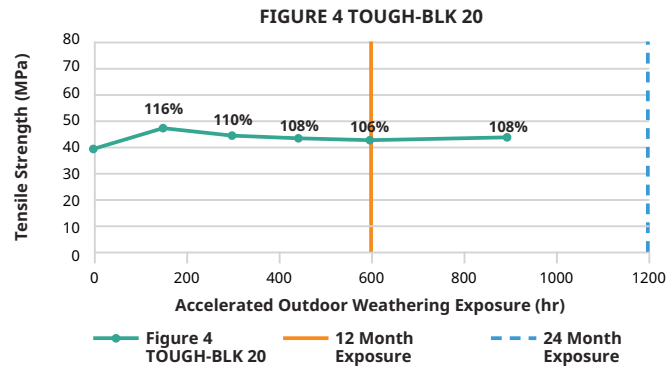


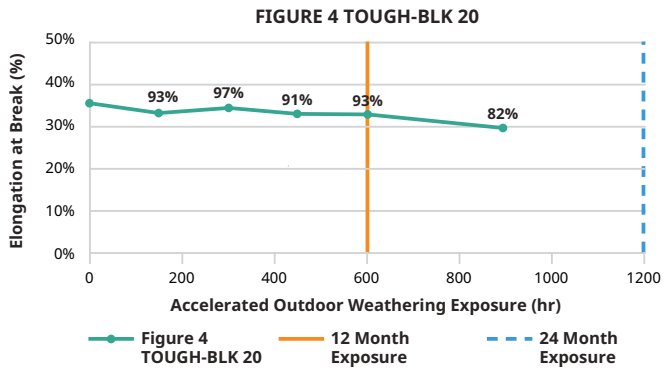


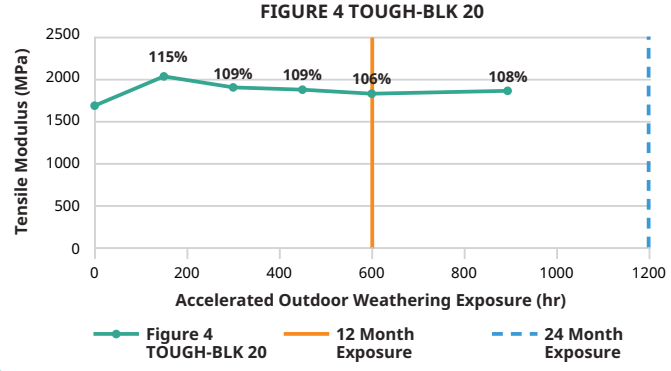


OUTDOOR STABILITY

OUTDOOR STABILITY: Tested per ASTM G154 standard method.







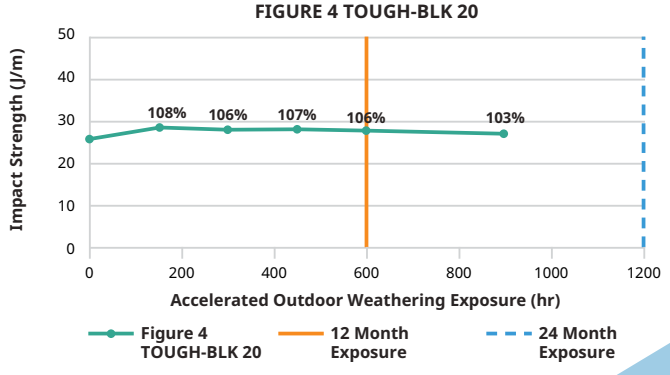


Figure 4 TOUGH-BLK 20

AUTOMOTIVE FLUID COMPATIBILITY

The compatibility of a material with hydrocarbons and cleaning chemicals is critical to part application. Figure 4 TOUGH-BLK 20 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
Automative 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-BLK 20

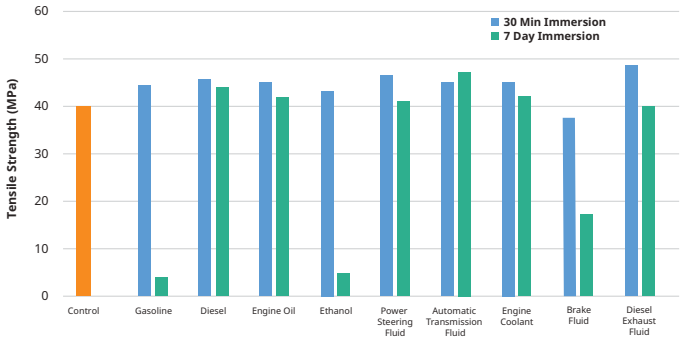
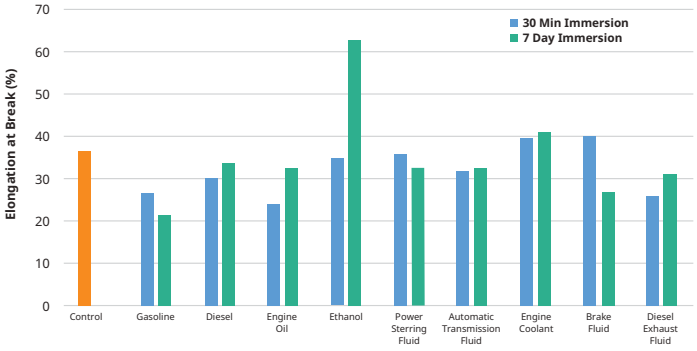


FIGURE 4 TOUGH-BLK 20



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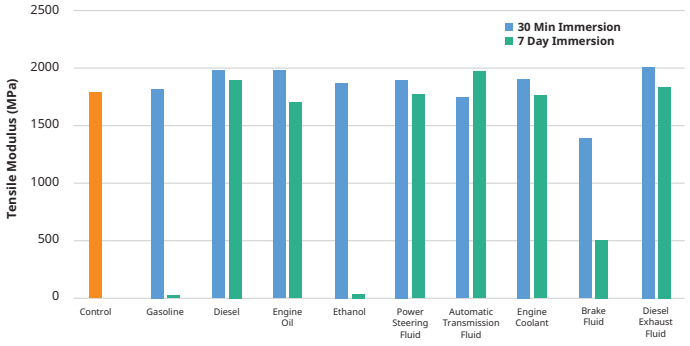


FIGURE 4 TOUGH-BLK 20

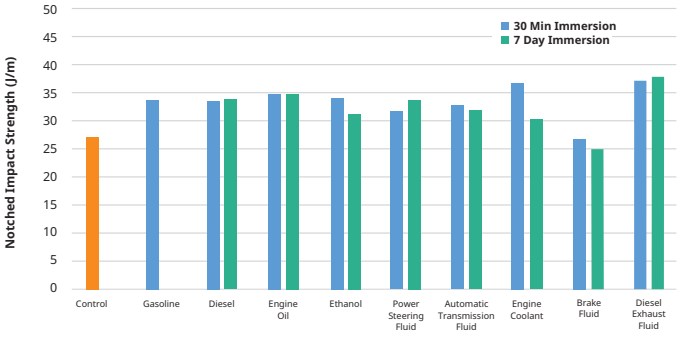


Figure 4 TOUGH-BLK 20

CHEMICAL COMPATIBILITY

The compatibility of a material with cleaning chemicals is critical to part application. Figure 4 TOUGH-BLK 20 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.

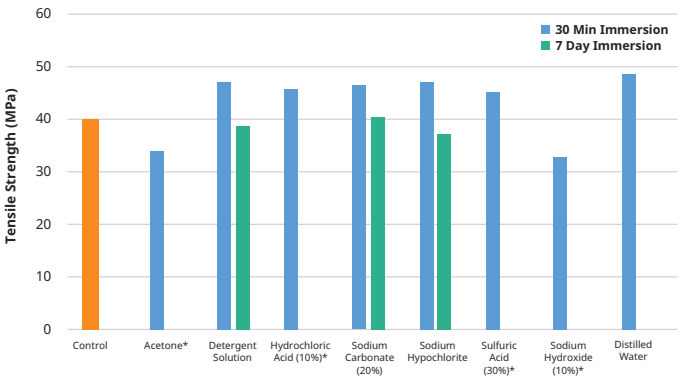
- Immerse for 7-days, then take mechanical property data for comparison.
- Immerse for 30-minutes, remove, and take mechanical property data for comparison in 7-days

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%)
Distilled Water

FIGURE 4 TOUGH-BLK 20



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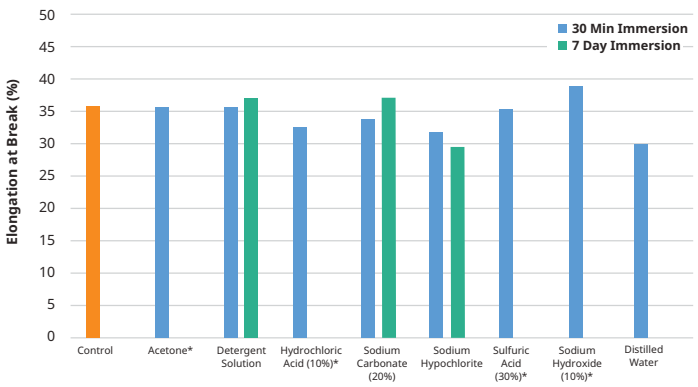

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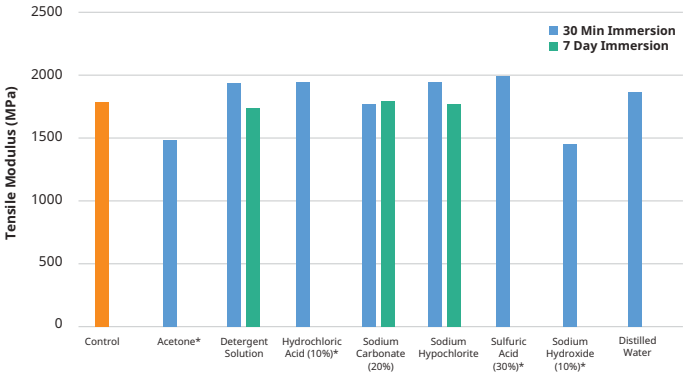

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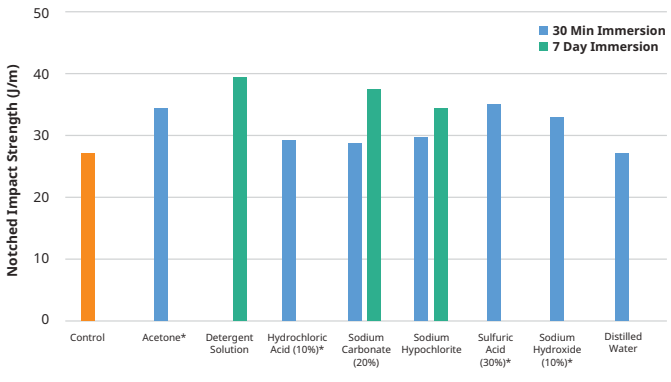

Figure 4 TOUGH-BLK 20

POST-PROCESSING INSTRUCTIONS

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

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 5 minutes while agitating part
- Rinse in 'clean' IPA for 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

- Ambient air dry > 1 hour before post cure

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