



# Figure 4® FLEX-BLK 20

Flexible, Durable

Durable, flexible, high impact-resistant material with long-term environmental stability

Figure 4

## FATIGUE RESISTANT BLACK PLASTIC, WITH LOOK AND FEEL OF PRODUCTION POLYPROPYLENE

Figure 4® FLEX-BLK 20 is a flexible, high impact-resistant material for extremely durable black parts with look and feel of production polypropylene. Great for functional prototypes, enclosures and assemblies, as well as short-run production parts, this fatigue resistant material provides outstanding flexibility and accuracy, enabling many applications.

## 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

- Functional assemblies and prototypes
  - Automotive styling parts
  - Consumer goods and electronic components
  - Containers and enclosures
  - Product design
- Master patterns for RTV/silicone molding
- Concept and marketing models

## BENEFITS

- Reliable and robust functional prototypes
- Excellent mechanical properties and accuracy
- Beautiful black parts with look and feel of molded black polypropylene
- Improved environmental stability of mechanical and performance properties over time

## FEATURES

- High elongation at break and notched impact strength
- Lower tensile modulus
- Engineered for long term environmental stability
- Easy to clean



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**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.

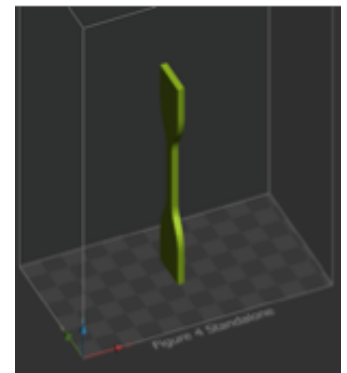
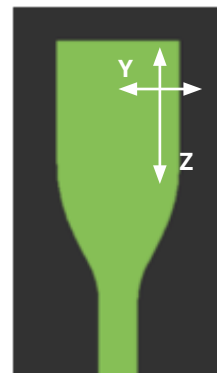
LIQUID MATERIAL						
MEASUREMENT	CONDITION/METHOD	METRIC	ENGLISH			
Viscosity	Brookfield Viscometer @ 25 °C (77 °F)	2250 cps	5440 lb/ft-hr			
Color			Black			
Liquid Density	Kruss K11 Force Tensiometer @ 25 °C (77 °F)	1.11 g/cm <sup>3</sup>	0.040 lb/in <sup>3</sup>			
Default Print Layer Thickness (Standard Mode)		0.05 mm	0.002 in			
Speed - Standard Mode		25 mm/hr	1 in/hr			
Speed - Draft Mode		29 mm/hr	1.1 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	1.18 g/cm <sup>3</sup>	0.043 lb/in <sup>3</sup>	ISO 1183	1.18 g/cm <sup>3</sup>	0.043 lb/in <sup>3</sup>
24 Hour Water Absorption	ASTM D570	0.64%	0.64%	ISO 62	0.64%	0.64%
MECHANICAL				MECHANICAL		
Tensile Strength Ultimate	ASTM D638	36 MPa	5220 psi	ISO 527 -1/2	28 MPa	3112 psi
Tensile Strength at Yield	ASTM D638	24 MPa	3480 psi	ISO 527 -1/2	21 MPa	3112 psi
Tensile Modulus	ASTM D638	1150 MPa	122 ksi	ISO 527 -1/2	877 MPa	127 ksi
Elongation at Break	ASTM D638	76%	76%	ISO 527 -1/2	67 %	67 %
Elongation at Yield	ASTM D638	7.5%	7.5%	ISO 527 -1/2	8.3 %	8.3 %
Flex Strength	ASTM D790	22 MPa	3190 psi	ISO 178	23 MPa	3265 psi
Flex Modulus	ASTM D790	680 MPa	99 ksi	ISO 178	1088 MPa	158 ksi
Izod Notched Impact	ASTM D256	91 J/m	1.7 ft-lb/in	ISO 180-A	10.8 J/m <sup>2</sup>	0.0051 ft-lb/in <sup>2</sup>
Izod Unnotched Impact	ASTM D4812	Does not break		ISO 180-U		
Shore Hardness	ASTM D2240	68D	68D	ISO 7619	68D	68D
THERMAL				THERMAL		
Tg (DMA, E'')	ASTM E1640 (E''at 1C/min)	11 °C	52 °F	ISO 6721-1/11 (E''at 1C/min)	11 °C	52 °F
HDT @ 0.455 MPa/66 PSI	ASTM D648	41 °C	106 °F	ISO 75- 1/2 B	46 °C	115 °F
HDT @ 1.82 MPa/264 PSI	ASTM D648	<25 °C	<77 °F	ISO 75-1/2 A	27 °C	81 °F
CTE below Tg	ASTM E831	69 ppm/°C	38 ppm/°F	ISO 11359-2	69 ppm/°C	38 ppm/°F
CTE above Tg	ASTM E831	188 ppm/°C	104 ppm/°F	ISO 11359-2	188 ppm/°C	104 ppm/°F
UL Flammability	UL94	HB	HB			
ELECTRICAL				ELECTRICAL		
Dielectric Strength (kV/mm) @ 3.0 mm thickness	ASTM D149	14.6				
Dielectric Constant @ 1 MHz	ASTM D150	3.7				
Dissipation Factor @ 1 MHz	ASTM D150	0.035				
Volume Resistivity (ohm-cm)	ASTM D257	1.3x10 <sup>15</sup>				

## Figure 4 FLEX-BLK 20

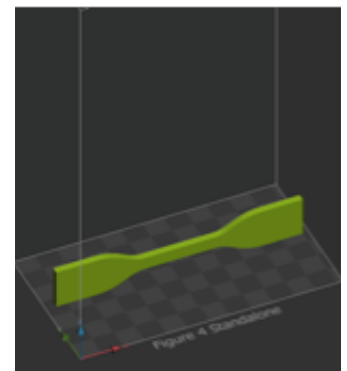
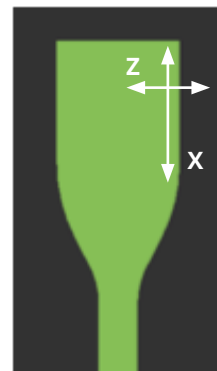
### ISOTROPIC PROPERTIES

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

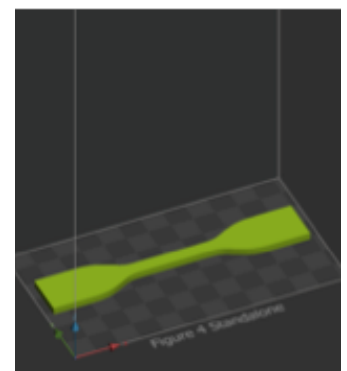
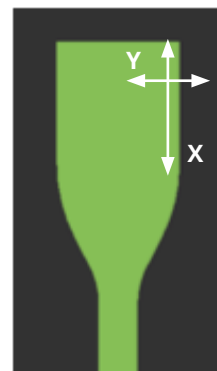
Parts do not need to be oriented to get the highest mechanical properties, further improving the degree of freedom for part orientation for mechanical properties.



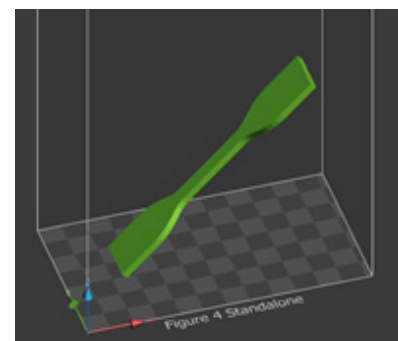
ZY - orientation



XZ - orientation



XY - orientation



Z45-Degree - orientation

SOLID MATERIAL					
METRIC	METHOD	METRIC			
MECHANICAL					
		ZY	XZ	XY	Z45
Tensile Strength Ultimate	ASTM D638	36 MPa	35 MPa	31 MPa	31 MPa
Tensile Strength at Yield	ASTM D639	24 MPa	26 MPa	26 MPa	25 MPa
Tensile Modulus	ASTM D640	1151 MPa	1229 MPa	1102 MPa	1035 MPa
Elongation at Break	ASTM D641	76%	71 %	70 %	68 %
Elongation at Yield	ASTM D642	7.5%	8.1 %	7.5 %	9.1 %
Flex Strength	ASTM D790	22 MPa	34 MPa	21 MPa	21 MPa
Flex Modulus	ASTM D790	680 MPa	1037 MPa	592 MPa	632 MPa
Izod Notched Impact	ASTM D256	91 J/m	105 J/m	108 J/m	109 J/m
Shore Hardness	ASTM D2240	68D	68D	67D	72D

# Figure 4 FLEX-BLK 20

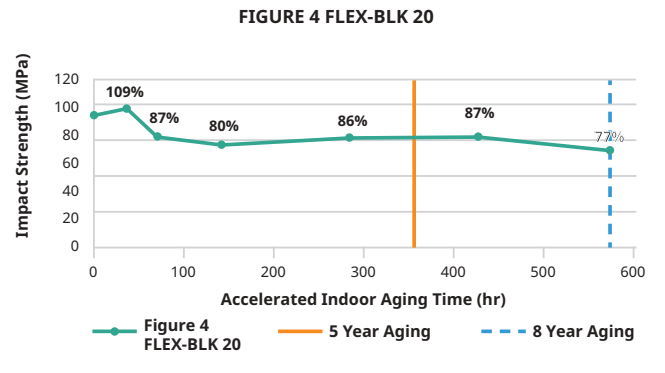
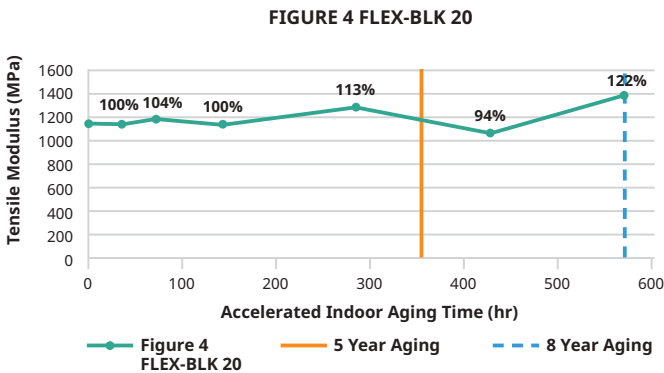
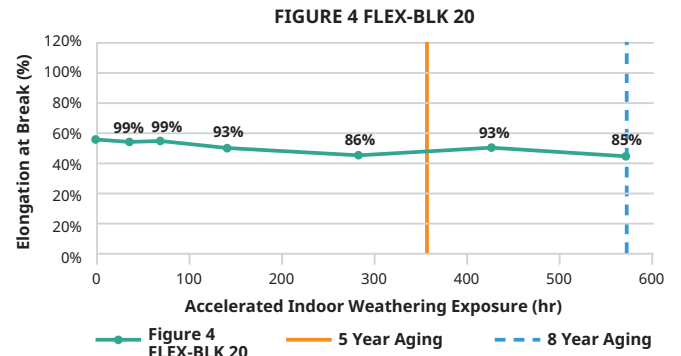
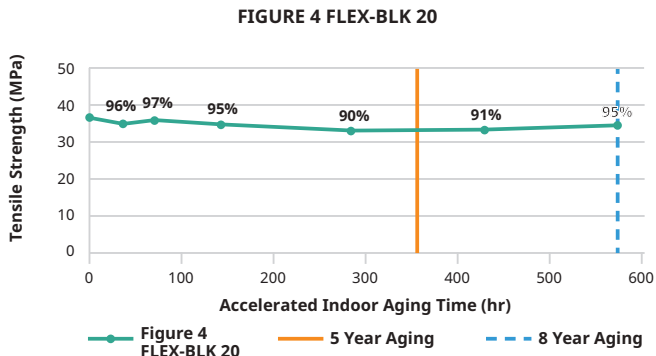


## LONG TERM ENVIRONMENTAL STABILITY

Figure 4 FLEX-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.**

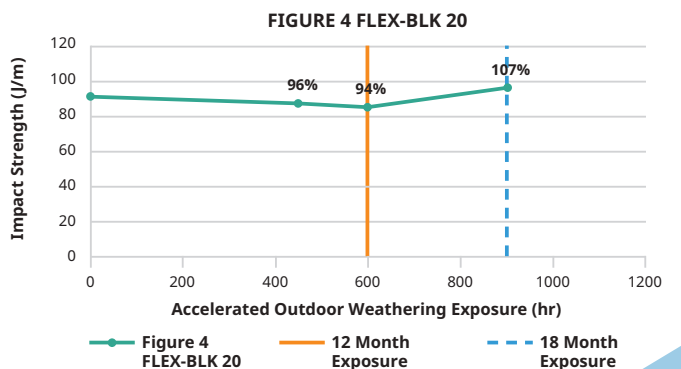
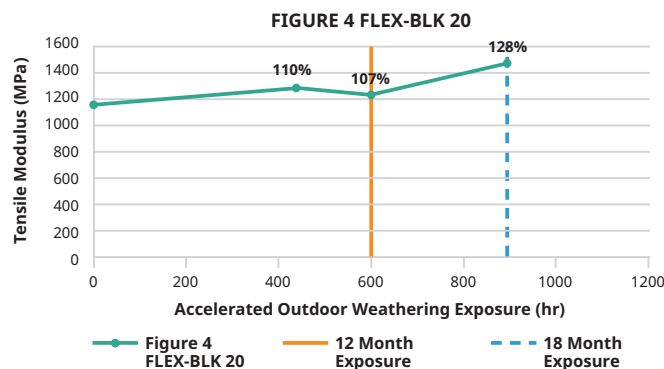
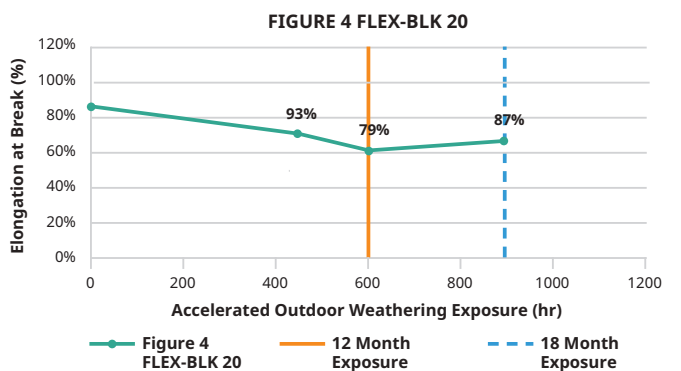
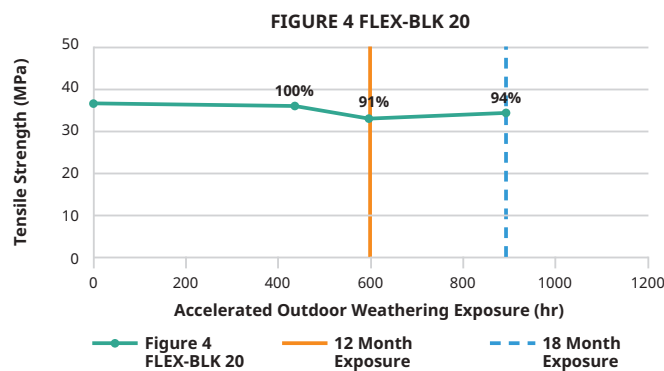
### INDOOR STABILITY: Tested per ASTM D4329 standard method.

INDOOR STABILITY



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

OUTDOOR STABILITY



# Figure 4 FLEX-BLK 20

## AUTOMOTIVE FLUID COMPATIBILITY

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

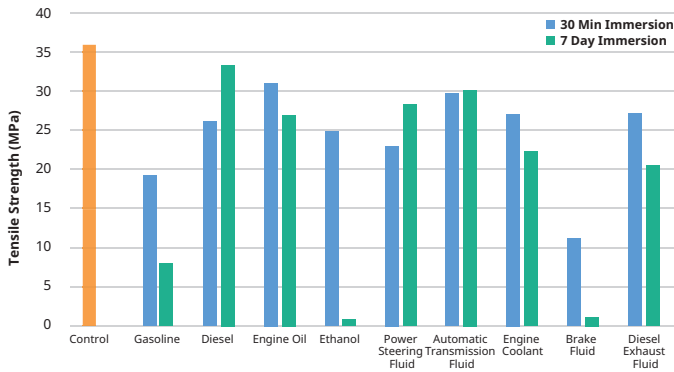


FIGURE 4 FLEX-BLK 20

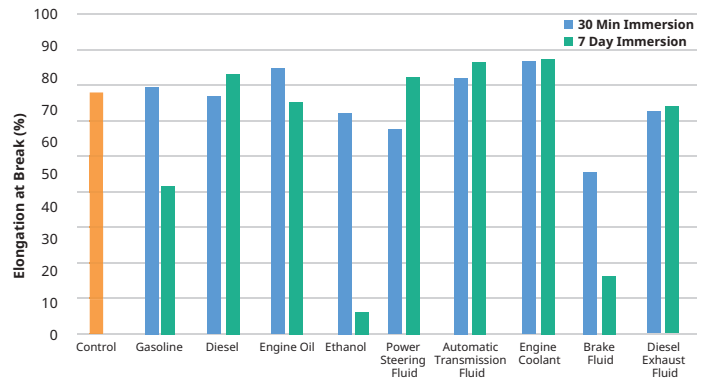


FIGURE 4 FLEX-BLK 20

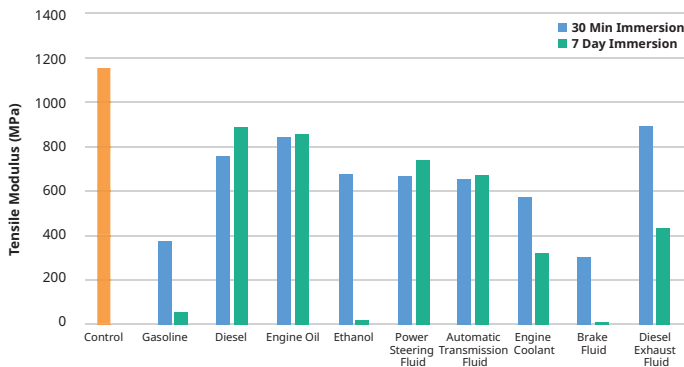
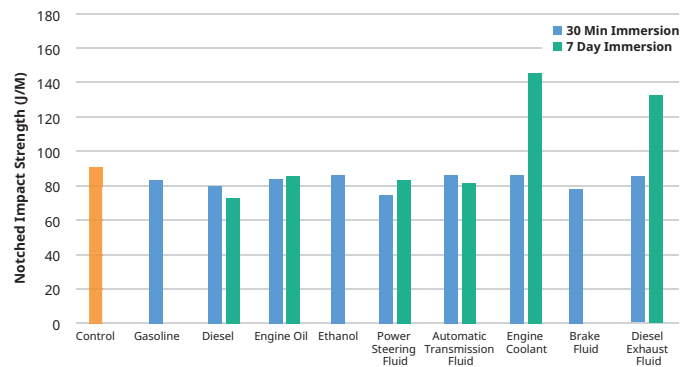


FIGURE 4 FLEX-BLK 20



## CHEMICAL COMPATIBILITY

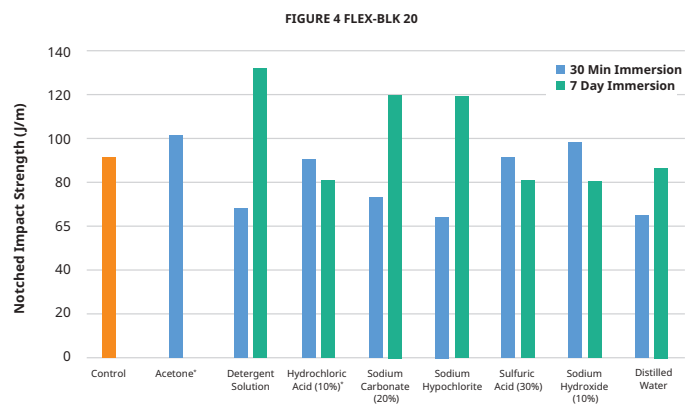
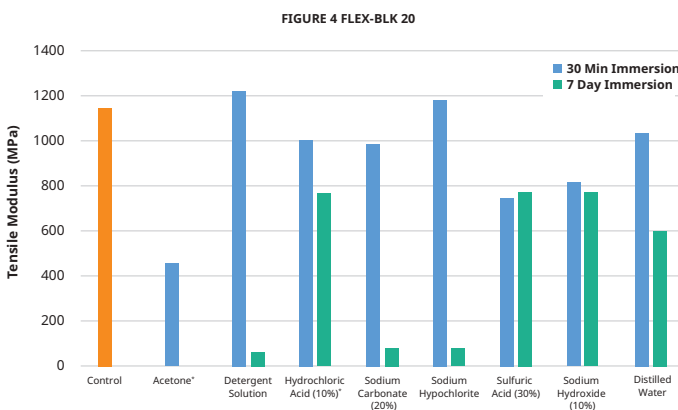
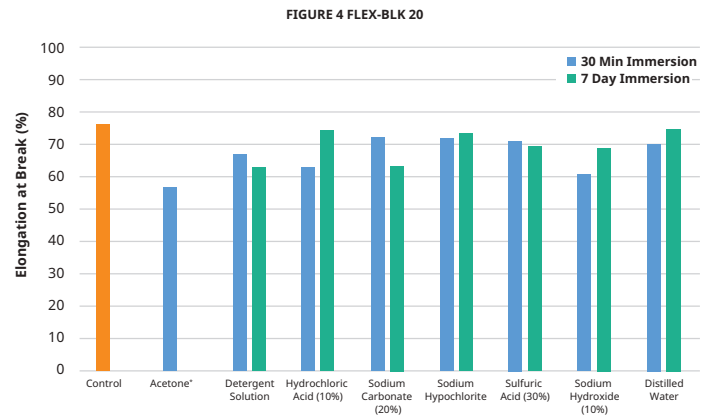
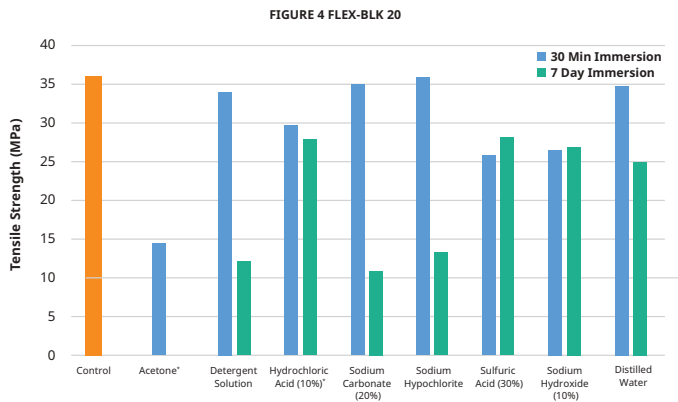
The compatibility of a material with cleaning chemicals is critical to part application. Figure 4 FLEX-BLK 20 parts were tested for sealed and surface contact compatibility per ASTM D543 test conditions. The fluids below were tested in two different ways per the specs.

- 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%)
6.3.15 Distilled Water



### 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 2.5 minutes while agitating part
- Rinse in 'clean' IPA for 2.5 minutes while agitating part
  - DO NOT EXCEED more than 5 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>

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

