



# Figure 4<sup>®</sup> High Temp 150C FR Black

High Temperature

UL94 V0 rated flame-retardant black plastic with >150 °C heat deflection temperature

Figure 4

## SAVE ON TOOLING COSTS AND TIME WITH DIRECT PRODUCTION OF FLAME-RESISTANT PLASTIC PARTS

Figure 4<sup>®</sup> High Temp 150C FR Black is a rigid, flame-retardant black material that can be used for production parts requiring UL94 V0 rating as well as FAR 25.853 and 23.853 capability. It provides long-term environmental stability with an injection molded-like surface quality. This material is recommended for consumer, transportation, and aerospace applications that require performance at high temperatures like brackets, covers, and circuit board housings and covers.

## 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

- Printed circuit board covers
- Electrical and under-hood housings requiring UL94 V0 rating
- Rigid covers, hangers, and brackets
- Small FAR 25/23.853 in-cabin parts
- Flame retardant parts for trains and busses

## BENEFITS

- Self-extinguishing, flame-retardant material
- Halogen-free
- High heat deflection temperature for demanding applications
- No secondary thermal cure required
- Excellent surface quality, accuracy and repeatability
- Capable of plating and painting

## FEATURES

- Passes UL94 V0 test standards @ 2 mm and 3 mm thickness
- Passes FAR Part 25.853 @ 12 second vertical burn and HB testing @ 3mm
- Passes FAR Part 23.853 @ 12 second vertical burn and HB testing @3mm
- Passes UL 746C GWIT and GWFI @ 2 mm and 3 mm thickness
- > 150C @ 0.455 MPa HDT
- 2900 MPa flexural modulus
- Long-term indoor and outdoor environmental stability of mechanical properties

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

# Figure 4 High Temp 150C FR Black



## MATERIAL PROPERTIES

The full suite of mechanical properties is given per ASTM and ISO standards where applicable. Properties like flammability, dielectric properties, and 24-hour water absorption are also provided for better understanding of material capabilities to help design decisions using the material. All parts are conditioned per ASTM recommended standards for a minimum of 40 hrs at 23°C, 50% RH.

Solid material properties reported were printed along the vertical axis (ZX-orientation). As detailed in the Isotropic Properties section, Figure 4 material properties are relatively uniform across print orientations. 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)	1700 cPs	4112 lb/ft-h
Color			Black
Liquid Density	Kruss K11 Force Tensiometer @ 25 °C (77 °F)	1.2 g/cm <sup>3</sup>	0.043 lb/in <sup>3</sup>
Default Print Layer Thickness	Internal	50 µm	0.002 in
Speed - Standard Mode	Internal	36 mm/hr	2.4 in/hr
Package Volume		1 kg bottle - Figure 4 Standalone 2.5 kg cartridge - Figure 4 Modular 9 kg container - Figure 4 Production	

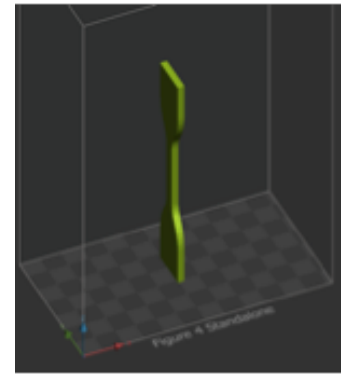
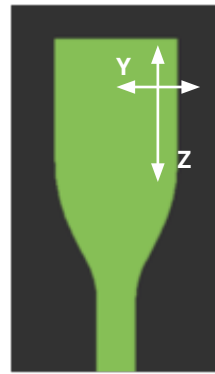
SOLID MATERIAL						
METRIC	ASTM METHOD	METRIC	ENGLISH	ISO METHOD	METRIC	ENGLISH
<b>PHYSICAL</b>				<b>PHYSICAL</b>		
Solid Density	ASTM D792	1.29 g/cm <sup>3</sup>	0.046 lb/in <sup>3</sup>	ISO 1183	1.29 g/cm <sup>3</sup>	0.046 lb/in <sup>3</sup>
24 Hour Water Absorption	ASTM D570	0.26%	0.26%	ISO 62	0.26%	0.26%
<b>MECHANICAL</b>				<b>MECHANICAL</b>		
Tensile Strength Ultimate	ASTM D638	58 MPa	8300 psi	ISO 527 -1/2	43 MPa	6200 psi
Tensile Strength at Yield	ASTM D638	N/A	N/A	ISO 527 -1/2	N/A	N/A
Tensile Modulus	ASTM D638	2600 MPa	380 ksi	ISO 527 -1/2	2200 MPa	315 ksi
Elongation at Break	ASTM D638	4 %	4 %	ISO 527 -1/2	3 %	3 %
Elongation at Yield	ASTM D638	N/A	N/A	ISO 527 -1/2	N/A	N/A
Flex Strength	ASTM D790	100 MPa	14600 psi	ISO 178	90 MPa	13200 psi
Flex Modulus	ASTM D790	2900 MPa	410 ksi	ISO 178	3300 MPa	486 ksi
Izod Notched Impact	ASTM D256	10 J/m	0.2 ft-lb/in	ISO 180-A	1.9 kJ/m <sup>2</sup>	0.9 ft-lb/in <sup>2</sup>
Izod Unnotched Impact	ASTM D4812	50 J/m	1 ft-lb/in	ISO 180-U	5 kJ/m <sup>2</sup>	2.4 ft-lb/in <sup>2</sup>
Shore Hardness	ASTM D2240	85 D	85 D	ISO 7619	85 D	85 D
<b>THERMAL</b>				<b>THERMAL</b>		
Tg (DMA, E'')	ASTM E1640 (E'' at 1C/min)	N/A	N/A	ISO 6721-1/11 (E'' at 1C/min)	N/A	N/A
HDT @ 0.455 MPa/66 PSI	ASTM D648	>150 C	>302 F	ISO 75- 1/2 B	>150 °C	>302 °F
HDT @ 1.82 MPa/264 PSI	ASTM D648	89 C	193 F	ISO 75-1/2 A	104 °C	218 °F
CTE below Tg	ASTM E831	98 ppm/C	55 ppm/F	ISO 11359-2	98 ppm/K	55 ppm/F
CTE above Tg	ASTM E831	158 ppm/C	88 ppm/F	ISO 11359-2	158 ppm/K	88 ppm/F
UL Flammability	UL94	V0 @2mm, 3mm				
Glow Wire Ignition Temperature (GWIT)	UL 746C	750C @ 2mm, 3mm				
Glow Wire Flammability Index (GWFI)	UL 746C	960C @ 2mm, 3mm				
FAR 25.853(a) Vertical Burn @ 12 seconds Horizontal Burn @ 2.5/mm Horizontal Burn @ 4.0/mm	Appendix F Part I(b) (4) Appendix F Part I(b) (5) Appendix F Part I(b) (5)	Pass @3mm Pass Pass				
Vertical Burn @ 12 seconds Horizontal Burn @ 2.5/mm Horizontal Burn @ 4.0/mm	FAR 23.853 Appendix F AC23-21 Appendix F AC23-21	Pass @3mm Pass Pass				
<b>SMOKE</b>				<b>SMOKE</b>		
Smoke Generation - Flaming	BSS 7238 Rev-C	332				
Smoke Generation - Non - Flaming	BSS 7238 Rev-C	93				
<b>TOXICITY</b>				<b>TOXICITY</b>		
Gas Toxicity - Flaming	BSS 7239	Pass				
Gas Toxicity - Non - Flaming	BSS 7239	Pass				
<b>ELECTRICAL</b>				<b>ELECTRICAL</b>		
Dielectric Strength (kV/mm) @ 3.0 mm thickness	ASTM D149	15.2				
Dielectric Constant @ 1 MHz	ASTM D150	3.19				
Dissipation Factor @ 1 MHz	ASTM D150	0.029				
Volume Resistivity (ohm-cm)	ASTM D257	3.36x10 <sup>15</sup>				

# Figure 4 High Temp 150C FR Black

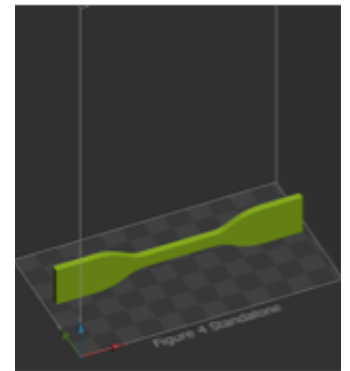
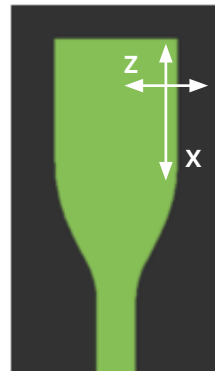
## ISOTROPIC PROPERTIES

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.

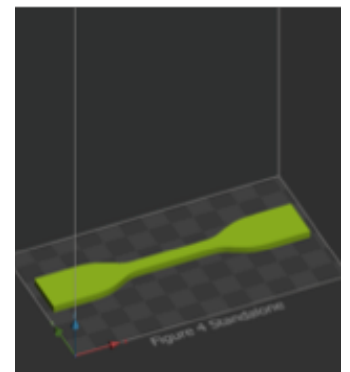
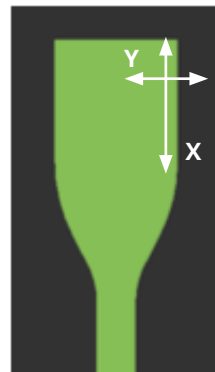
Parts do not need to be oriented to get the highest mechanical properties, further improving the degree of freedom for part orientation for mechanical properties.



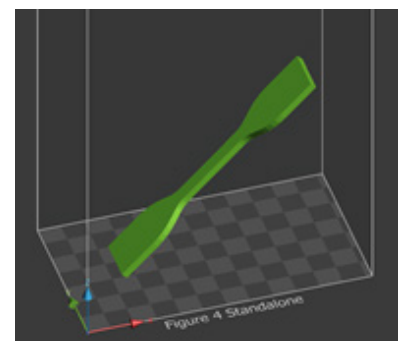
ZY - orientation



XZ - orientation



XY - orientation

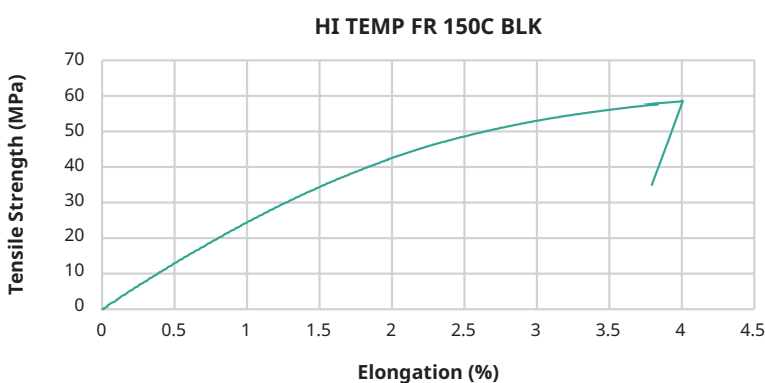


Z45-Degree - orientation

SOLID MATERIAL					
METRIC	METHOD	METRIC			
MECHANICAL					
		ZY	XZ	XY	Z45
Tensile Strength Ultimate	ASTM D638	58 MPa	37 MPa	42 MPa	47 MPa
Tensile Strength at Yield	ASTM D639	N/A	N/A	N/A	N/A
Tensile Modulus	ASTM D640	2600 MPa	2500 MPa	2400 MPa	2300 MPa
Elongation at Break	ASTM D641	4 %	2 %	2%	3 %
Elongation at Yield	ASTM D642	N/A	N/A	N/A	N/A
Flex Strength	ASTM D790	100 MPa	76 MPa	64 MPa	84 MPa
Flex Modulus	ASTM D790	2900 MPa	3300 MPa	2000 MPa	2200 MPa
Izod Notched Impact	ASTM D256	10 J/m	10 J/m	11 J/m	10 J/m
Shore Hardness	ASTM D2240	85 D	N/A	N/A	N/A

## STRESS-STRAIN CURVE

The graph represents the Stress-Strain curve for Figure 4 High Temp 150C FR Black per ASTM D638 testing.



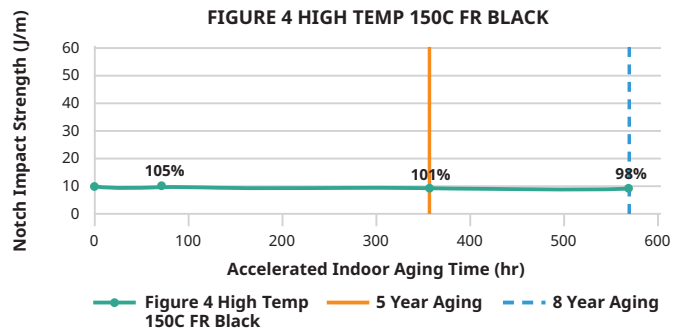
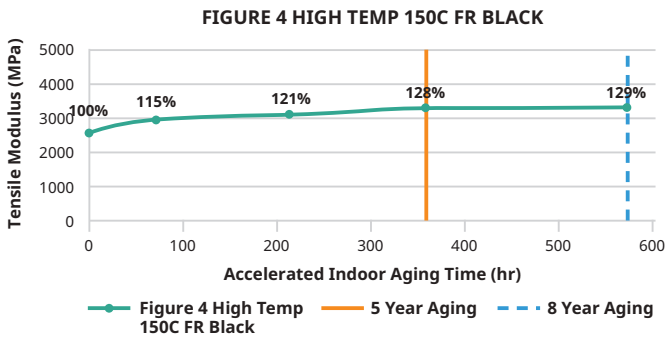
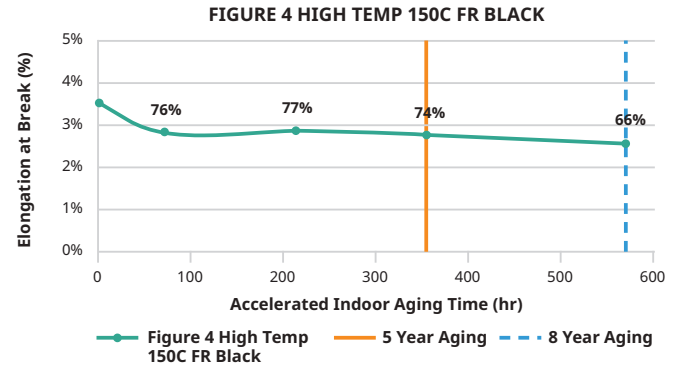
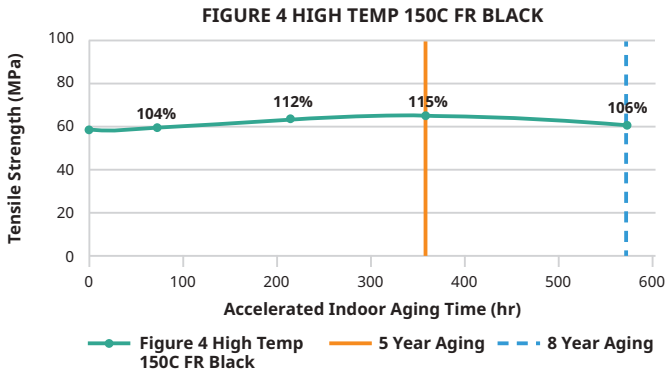
# Figure 4 High Temp 150C FR Black

## LONG TERM ENVIRONMENTAL STABILITY

Figure 4 High Temp 150C FR 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.**

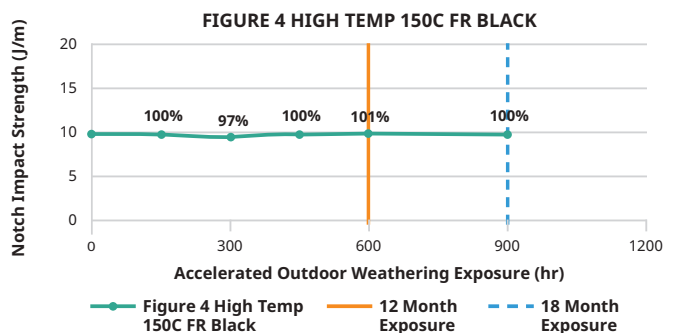
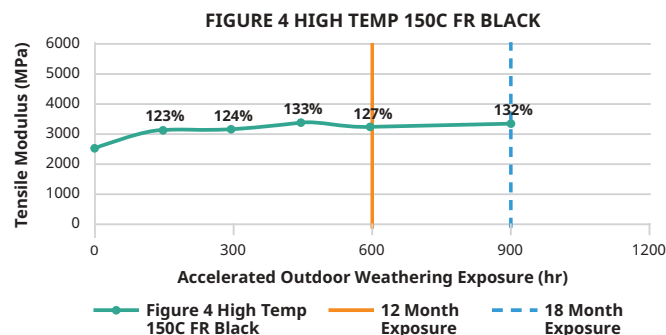
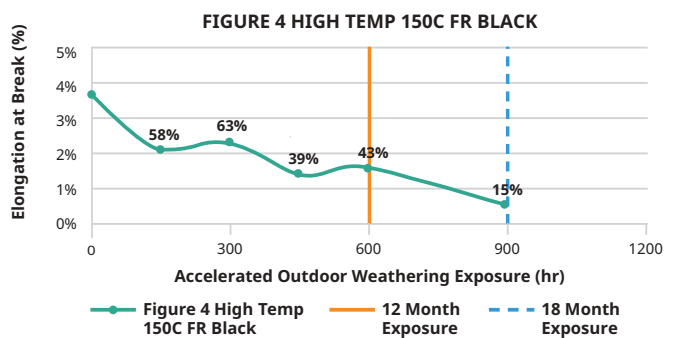
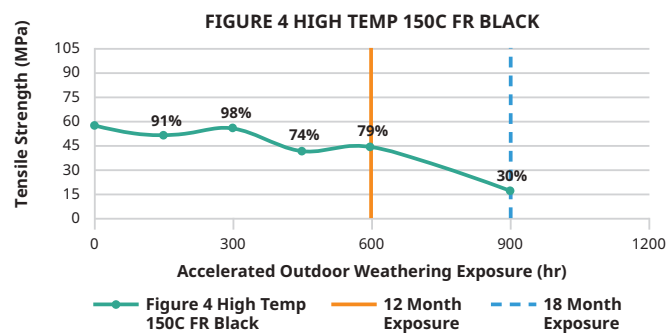
**INDOOR STABILITY:** Tested per ASTM D4329 standard method.

INDOOR STABILITY



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

OUTDOOR STABILITY



# Figure 4 High Temp 150C FR Black

## AUTOMOTIVE FLUID COMPATIBILITY

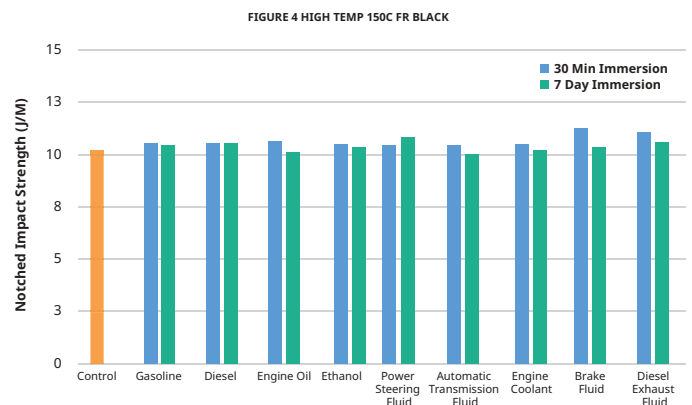
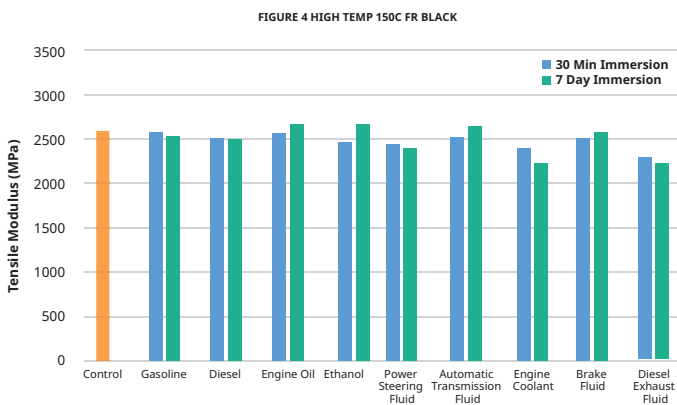
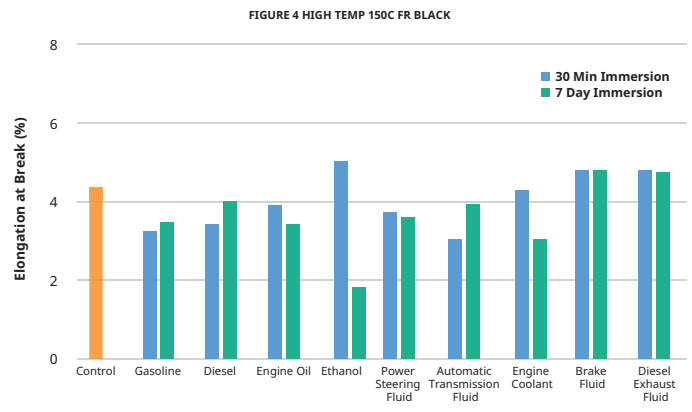
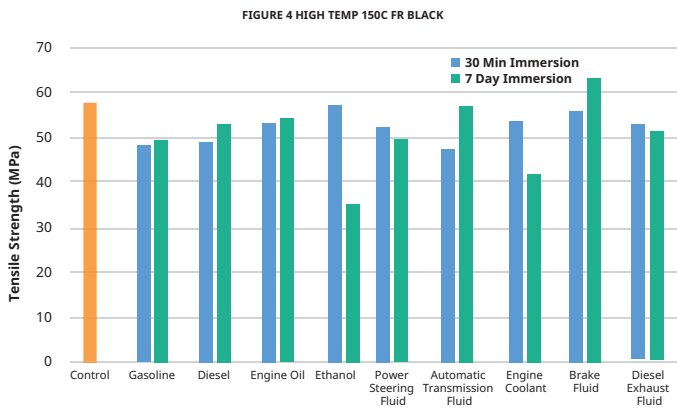
The compatibility of a material with hydrocarbons and cleaning chemicals is critical to part application. Figure 4 High Temp 150C FR Black parts were tested for sealed and surface contact compatibility per USCAR2 test conditions. The fluids below were tested in two different ways per the specs.

- 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 High Temp 150C FR Black

## CHEMICAL COMPATIBILITY

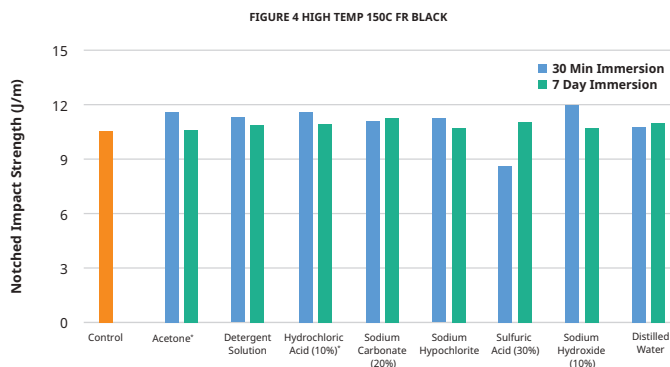
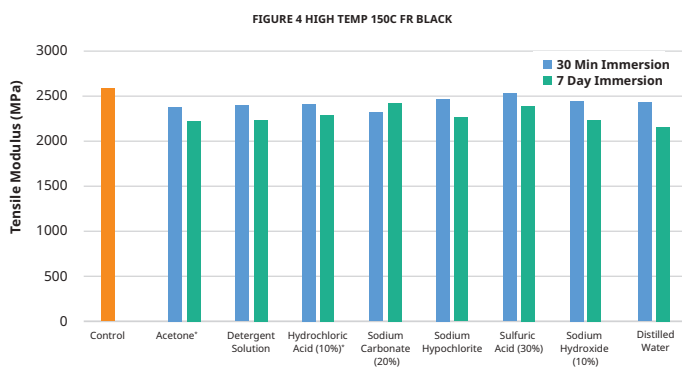
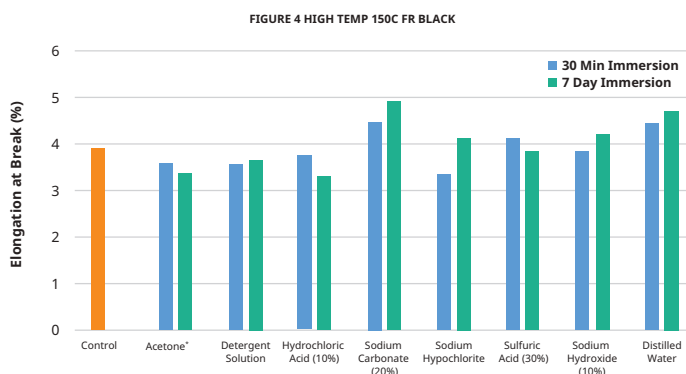
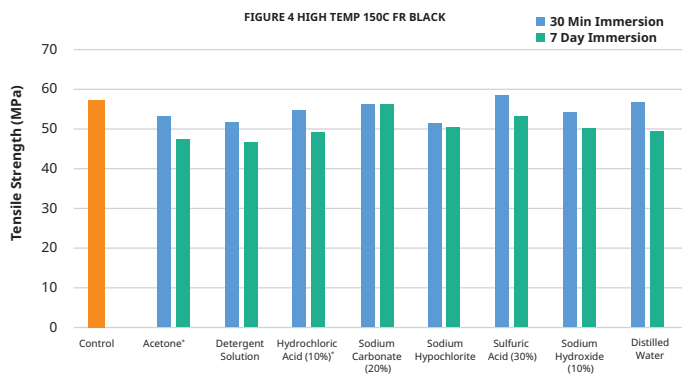
The compatibility of a material with cleaning chemicals is critical to part application. Figure 4 High Temp 150C FR Black parts were tested for sealed and surface contact compatibility per ASTM D543 test conditions. The fluids below were tested in two different ways per the specs.

- 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



## 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 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>