Figure 4® Tough 75C FR Black

Production Tough

Tough, flame-retardant material that combines UL94 V0 rating at thin wall thicknesses with outstanding electrical properties

FIGURE 4
PSLA

APPLICATIONS

- Electrical boxes, covers and housings
- Printed circuit board assemblies (PCBA)
- Housings and brackets
- Sensors, covers and housings
- Electrical connectors
- Thin wall connectors and components
- Direct production of plastic connectors
- Low volume production of connectors

BENEFITS

- UL94 V0 flame rating @ 0.4mm thickness
- Glow Wire Ignition (GWI) of 800°C
- Comparative Tracking Index (CTI) of 600V (equivalent to a PLC of 0)
- Relative Temperature Index (RTI) for long-term electrical and mechanical use of 150°C and 130°C respectively

MATERIAL PROPERTIES

The full suite of mechanical properties is given per ASTM and ISO standards where applicable. In addition, properties such as flammability, dielectric properties, and 24 hour water absorption are provided. 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 ZY-axis.

LIQUID MATERIAL			
MEASUREMENT	**CONDITION/METHOD**	**METRIC**	**U.S.**
Viscosity	Brookfield Viscometer @ 25 °C (77 °F)	3500 cPs	8467 lb/ft·h
Color		Black	
Liquid density	Kruss K11 Force Tensiometer @ 25 °C (77 °F)	1.26 g/cm³	0.043 lb/in³
Default print layer thickness (standard Mode)	Internal	30 µm	0.001 in
Speed — standard mode	Internal	17.8	0.67 in/hr
Speed — draft mode	Internal	27.4	1.06 in/hr
Package volume		1 kg bottle 2.5 kg cartridge 9 kg container	

SOLID MATERIAL						
METRIC	**ASTM METHOD**	**METRIC**	**U.S.**	**ISO METHOD**	**METRIC**	**U.S.**
	PHYSICAL				**PHYSICAL**	
Solid density	ASTM D792	1.34 g/cm³	0.048 lb/in³	ISO 1183	1.34 g/cm³	0.048 lb/in³
24 hour water absorption	ASTM D570	0.35 %	0.35 %	ISO 62	0.35 %	0.35 %
	MECHANICAL				**MECHANICAL**	
Tensile strength ultimate	ASTM D638*	31 MPa	4600 psi	ISO 527 -1/2	30 MPa	4100 psi
Tensile modulus	ASTM D638	1200 MPa	180 ksi	ISO 527 -1/2	1000 MPa	150 ksi
Elongation at break	ASTM D638	7.8 %	7.8 %	ISO 527 -1/2	9.4 %	9.4 %
Flex strength	ASTM D790	45 MPa	6500 psi	ISO 178	40 MPa	5900 psi
Flex modulus	ASTM D790	1200 MPa	180 ksi	ISO 178	1200 MPa	180 ksi
Izod notched impact	ASTM D256	17 J/m	0.3 ft-lb/in	ISO 180-A	2.4 kJ/m²	1.1 ft-lb/in²
Izod unnotched impact	ASTM D4812	210 J/m	4 ft-lb/in	ISO 180-U	12 kJ/m²	5.6 ft-lb/in²
Shore hardness	ASTM D2240	79 D	79 D	ISO 7619	79 D	79 D
	THERMAL				**THERMAL**	
HDT 0.455 MPa/66 PSI	ASTM D648	80°C	174°F	ISO 75- 1/2 B	81°C	177°F
HDT 1.82 MPa/264 PSI	ASTM D648	52°C	125°F	ISO 75-1/2 A	54°C	128°F
CTE -20 to 75°C	ASTM E831	127 ppm/°C	71 ppm/°F	ISO 11359-2	127 ppm/K	71 ppm/°F
CTE 150 to 200°C	ASTM E831	175 ppm/°C	97 ppm/°F	ISO 11359-2	175 ppm/K	97 ppm/°F
UL Flammability @ 0.4mm thickness	UL94	V-0				
GWIT °C @ 0.4 mm thickness	IEC 60695-2-13	960°C				
GWFI °C @ 0.4 mm thickness	IEC 60695-2-12	775°C				
	ELECTRICAL				**ELECTRICAL**	
Dielectric strength (kV/mm) @ 0.75mm thickness	ASTM D149	26				
Dielectric constant @ 1kHz	ASTM D150	3.581				
Dissipation factor @ 1kHz	ASTM D150	0.042				
Volume resistivity (ohm-cm)	ASTM D257	10^{12} ohm-cm				
CTI (performance level category)	ASTM D3638	Level 0				
R.T.I. (°C) Electrical @ 0.4 mm thickness	UL746B	150°C				
R.T.I. (°C) Mechanical w/o impact @ 0.4 mm thickness	UL746B	130°C				
R.T.I. (°C) Mechanical w/ impact @ 0.4 mm thickness	UL746B	110 °C				

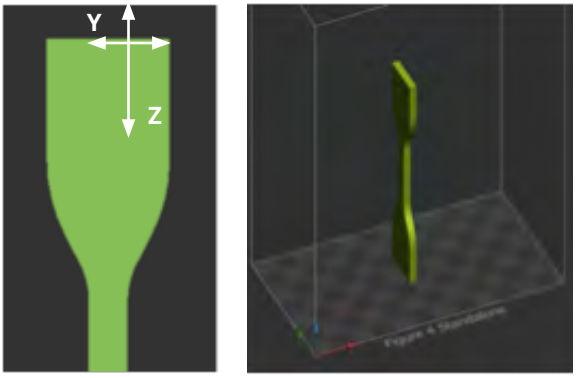
ISOTROPIC PROPERTIES

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.

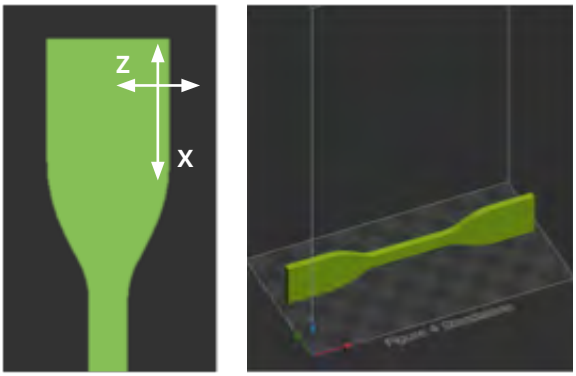
Parts do not need to be oriented to get the highest mechanical properties, further improving the degree of freedom for part orientation for mechanical properties.

SOLID MATERIAL					
METRIC	METHOD	METRIC			
MECHANICAL					
		ZY	XZ	XY	Z45
Tensile strength ultimate	ASTM D638 Type IV	31 MPa	30 MPa	28 MPa	30 MPa
Tensile modulus	ASTM D638 Type IV	1200 MPa	1200 MPa	1100 MPa	1100 MPa
Elongation at break	ASTM D638 Type IV	7.8 %	6.8 %	6.2 %	9.9 %
Flex strength	ASTM D790	45 MPa	46 MPa	38 MPa	42 MPa
Flex modulus	ASTM D790	1200 MPa	1300 MPa	1000 MPa	1100 MPa
Izod notched impact	ASTM D256	17 J/m	18 J/m	18 J/m	19 J/m
Izod unnotched impact	ASTM D4812	210 J/m	97 J/m	78 J/m	164 J/m
Shore D hardness	ASTM D2240	79 D	73 D	N/A*	78 D

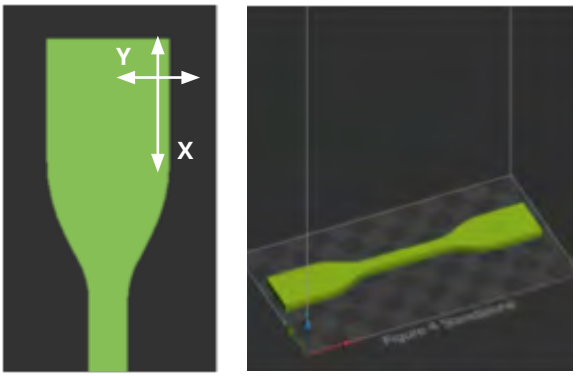
*XY specimen did not print well



ZY - orientation



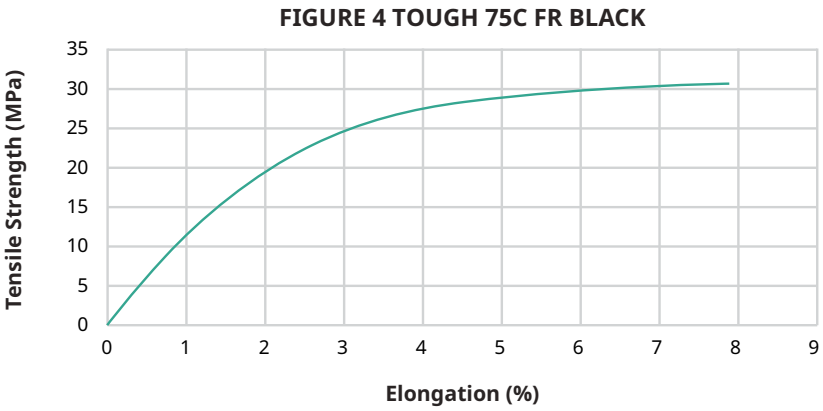
XZ - orientation

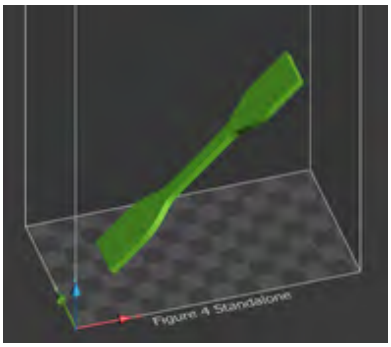


XY - orientation

STRESS-STRAIN CURVE

The graph represents the Stress-Strain curve for Figure 4 Tough 75C FR Black per ASTM D638 testing.



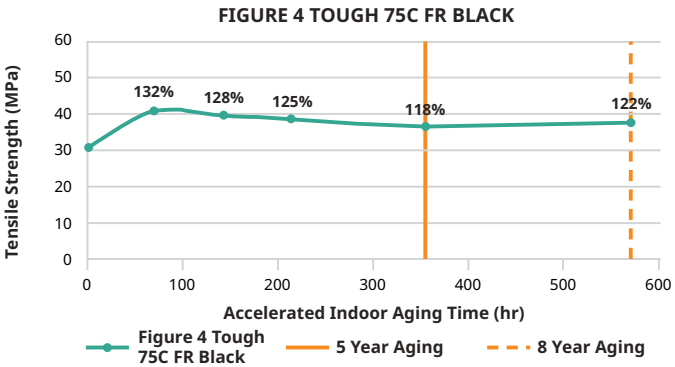


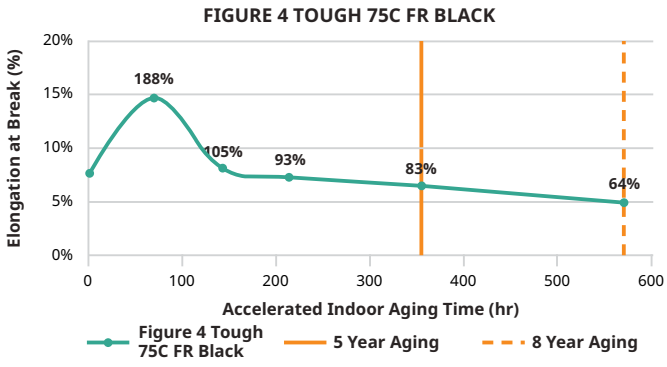
Z45-Degree - orientation

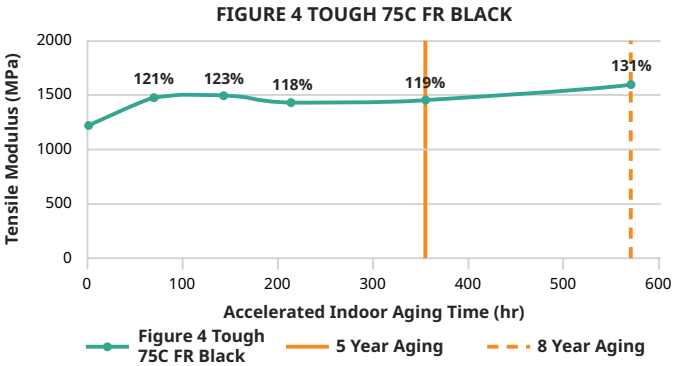
INDOOR STABILITY:

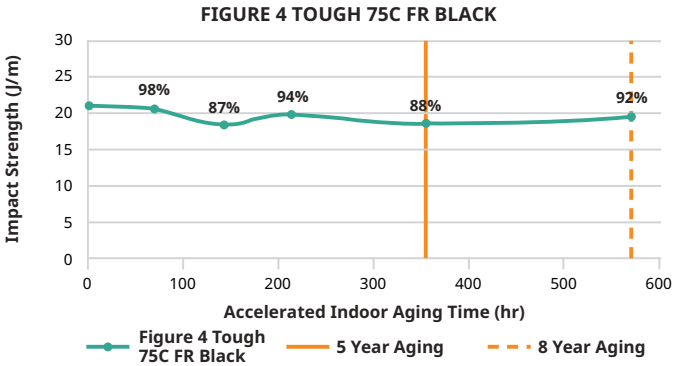
Figure 4 Tough 75C FR Black is engineered to give long term-environmental UV and humidity stability. This means the material is tested for the ability to retain a high percent of the initial mechanical properties over a given period of time. This provides real design conditions to consider for the application or part. **Actual data value is on Y-axis, and data points are % of initial value.**

INDOOR STABILITY: Tested per ASTM D4329 standard method.

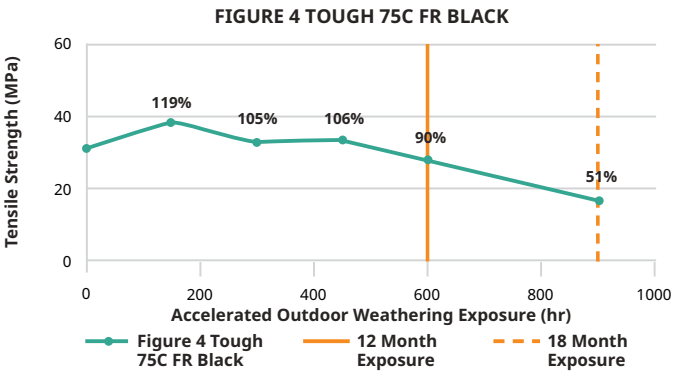


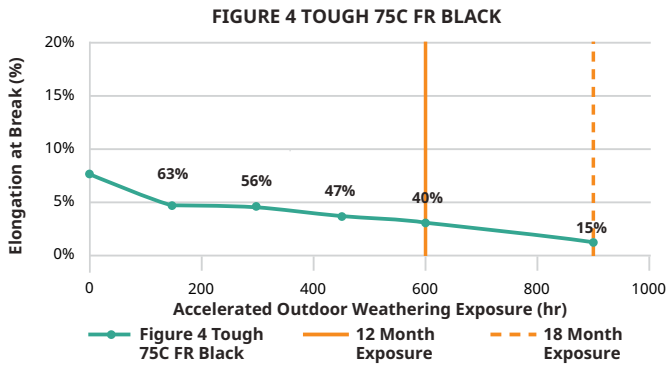


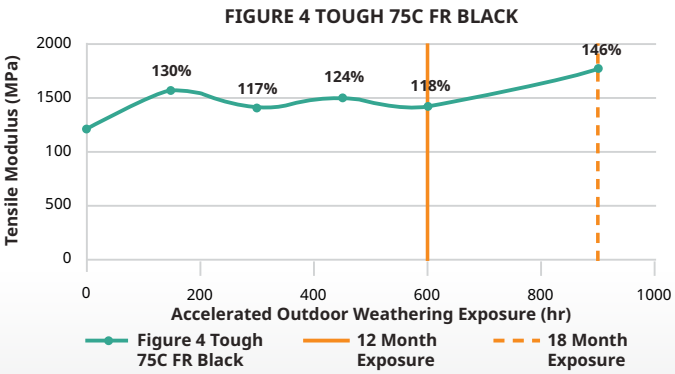


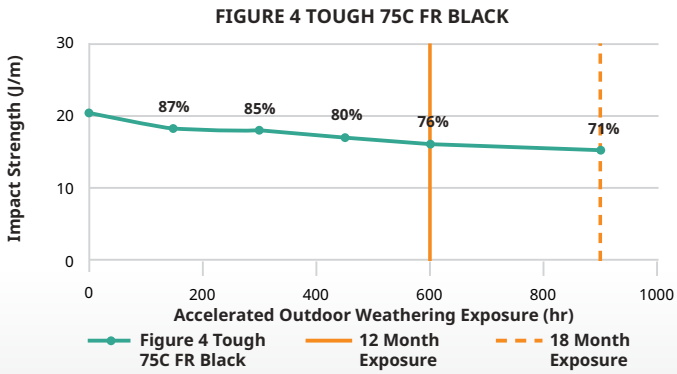


OUTDOOR STABILITY: Tested per ASTM G154 standard method.









AUTOMOTIVE FLUID COMPATIBILITY

The compatibility of a material with hydrocarbons and cleaning chemicals is critical to part application. Figure 4 Tough 75C 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 30 minutes, remove and store for 7 days, then take mechanical property data for comparison.
- Immerse for 7 days, then take mechanical property data for comparison.

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

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 Solution (10%)
6.3.15 Distilled Water

FIGURE 4 TOUGH 75C FR BLACK

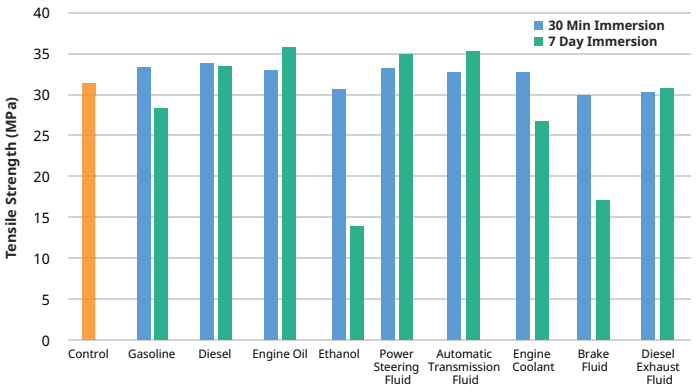
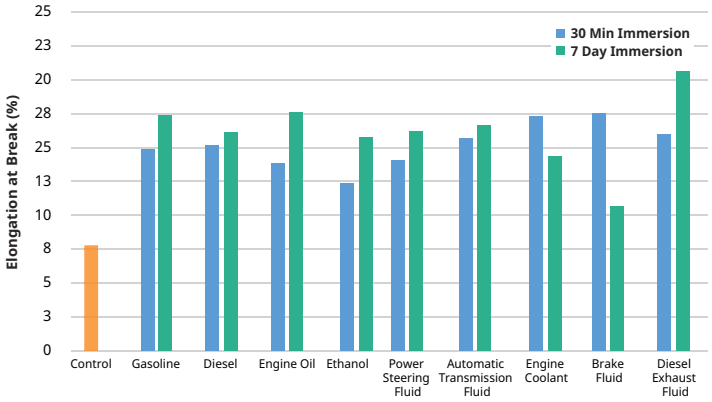


FIGURE 4 TOUGH 75C FR BLACK



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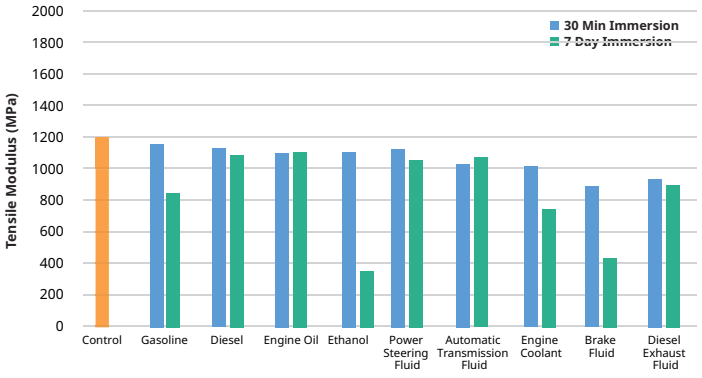

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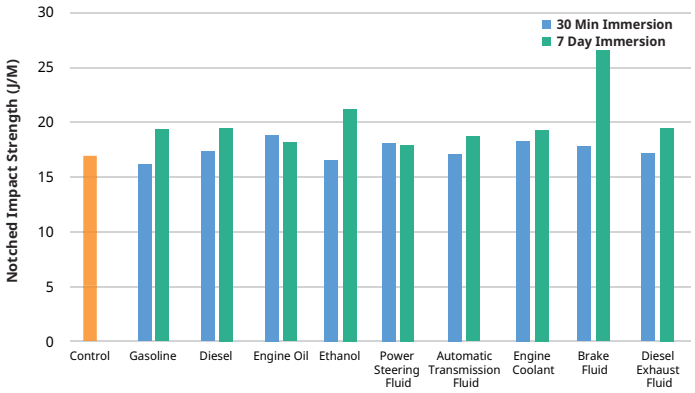

CHEMICAL COMPATIBILITY

The compatibility of a material with cleaning chemicals is critical to part application. Figure 4 75C FR Black 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 30 minutes, then take mechanical property data for comparison.
- Immerse for 7 days, then take mechanical property data for comparison.

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

*Denotes materials did not go through 7 day soak conditioning.

CHEMICAL COMPATIBILITY
6.3.3 Acetone
6.3.12 Detergent Solution, Heavy Duty
6.3.23 Hydrochloric Acid (10%)
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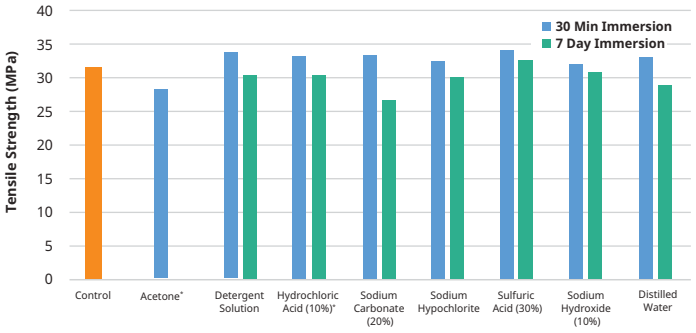

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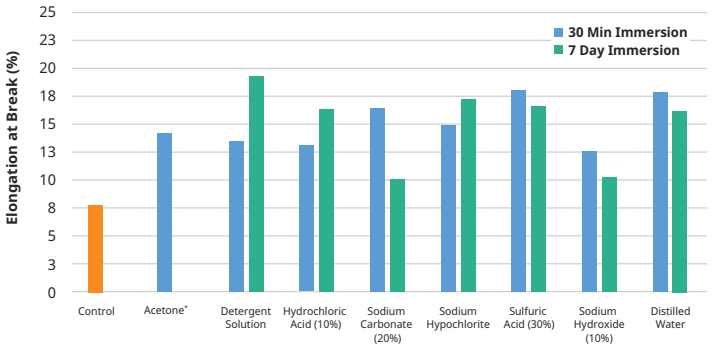

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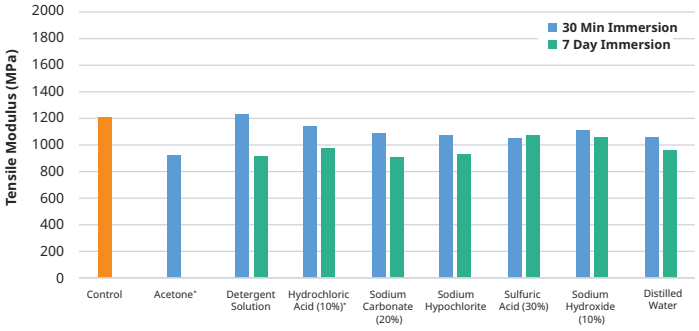

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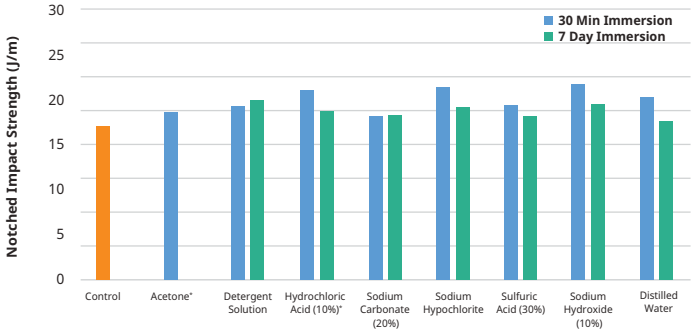

HANDLING AND POST PROCESSING INSTRUCTIONS FOR FIGURE 4 TOUGH 75C FR BLACK

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

- 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

- Vigorously shake the bottle for 2 minutes before installing cartridge.

9 kg cartridge

- 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.

CLEANING INSTRUCTIONS

- Fill one plastic or metal container with TPM to a level to cover the parts.
- Place the TPM container inside the sonicator and place parts inside the solution. Sonicate parts for no more than 5 minutes on the lowest frequency setting.
- Using a spray bottle filled with IPA, rinse parts thoroughly ensuring that all surfaces have been rinsed with IPA (over empty container dedicated to IPA waste).
- Use a soft brush if necessary to remove material from difficult areas. Rinse with a small amount of clean IPA from a spray bottle after brushing.
- If desired, blow the part off with low-pressure compressed air.

UV CURE TIME

- The recommended UV cure time for Figure 4 Tough 75C FR Black is 90 minutes. Only curing equipment used/tested; recommend 90 minutes curing (generally) and our testing used the PostCure 1050.

More details can be found in the User Guides and Best Practices Documentation available at
https://support.3dsystems.com/

ALSO CERTIFIED TO IEC/ISO REQUIREMENTS

We worked with UL Solutions to obtain 3rd party, science-backed flammability certification for our Figure 4 Tough 75C FR Black in accordance with IEC 60695-11-10; Fire Hazard Testing- Part 11-10: Test Flames-50 W Horizontal and Vertical Flame Test Methods.