



# Figure 4<sup>®</sup> Rigid Gray

## Production Rigid

Figure 4

High contrast gray plastic for long-term use parts with balanced thermal and mechanical properties

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

Figure 4<sup>®</sup> Rigid Gray is a production-grade gray material that delivers a surface finish comparable to injection molding and provides long-term environmental stability. The high contrast gray color is ideal for parts requiring high feature definition like texture and lettering. This material is suitable for painting, plating, and laser-etching, and is recommended for prototyping and production for consumer products and general use small parts requiring high detail and accuracy.

This resin exhibits thermoplastic behavior with necking at break, making it ideal for rigid snap-fit applications such as covers. It also features 72 °C heat deflection temperature and 30% elongation at break. 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

- Static rigid production components like housings and covers
- Small parts requiring detail and accuracy for consumer products and general use
- Parts requiring painting, plating, and laser-etching
- Functional prototyping and low volume production parts where visualization of features is critical

### BENEFITS

- Long-term use parts for indoor and outdoor applications
- High contrast gray color good for detail visualization for textures and lettering
- Fast throughput to finished part; no secondary thermal cure required
- Excellent surface quality, accuracy, and repeatability
- Suitable for painting, plating, and laser-etching

### 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
- Tensile testing shows thermoplastic behavior with necking at break
- 72°C HDT at 0.455MPa
- 30% elongation at break
- 2200MPa flexural modulus
- Biocompatible-capable per ISO10993-5
- UL94 HB flammability
- Fast print speed up to 48 mm/hr at 50-micron layer thickness

## Figure 4 Rigid Gray

### 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)	300 cps	726 lb/ft-hr
Color		Gray	
Liquid Density	Kruss K11 Force Tensiometer @ 25 °C (77 °F)	1.07 g/cm <sup>3</sup>	0.036 lb/in <sup>3</sup>
Default Print Layer Thickness	Internal	50 µm	0.002 in
Speed - Standard Mode	Internal	mm/hr	48
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	1.15 g/cm <sup>3</sup>	0.042 lb/in <sup>3</sup>	ISO 1183	1.15 g/cm <sup>3</sup>	0.042 lb/in <sup>3</sup>
24 Hour Water Absorption	ASTM D570	0.99 %	0.99 %	ISO 62	0.99 %	0.99 %
<b>MECHANICAL</b>				<b>MECHANICAL</b>		
Tensile Strength Ultimate	ASTM D638	61 MPa	8800 psi	ISO 527 -1/2	57 MPa	8200 psi
Tensile Strength at Yield	ASTM D638	61 MPa	8800 psi	ISO 527 -1/2	57 MPa	8200 psi
Tensile Modulus	ASTM D638	2400 MPa	350 ksi	ISO 527 -1/2	2600 MPa	373 ksi
Elongation at Break	ASTM D638	30 %	30 %	ISO 527 -1/2	20 %	20 %
Elongation at Yield	ASTM D638	4.6 %	4.6 %	ISO 527 -1/2	4.4 %	4.4 %
Flex Strength	ASTM D790	87 MPa	12700 psi	ISO 178	90 MPa	12500 psi
Flex Modulus	ASTM D790	2200 MPa	320 ksi	ISO 178	2400 MPa	346 ksi
Izod Notched Impact	ASTM D256	21 J/m	0.4 ft-lb/in	ISO 180-A	2.9 kJ/m <sup>2</sup>	1.4 ft-lb/in <sup>2</sup>
Izod Unnotched Impact	ASTM D4812	150 J/m	3 ft-lb/in	ISO 180-U	12.6 kJ/m <sup>2</sup>	6 ft-lb/in <sup>2</sup>
Shore Hardness	ASTM D2240	82 D	82 D	ISO 7619	82 D	82 D
<b>THERMAL</b>				<b>THERMAL</b>		
Tg (DMA, E")	ASTM E1640 (E"at 1C/min)	60 °C	142 °F	ISO 6721-1/11 (E"at 1C/min)	60 °C	142 °F
HDT @ 0.455 MPa/66 PSI	ASTM D648	72 °C	162 °F	ISO 75- 1/2 B	70 °C	157 °F
HDT @ 1.82 MPa/264 PSI	ASTM D648	59 °C	138 °F	ISO 75-1/2 A	56 °C	133 °F
CTE below Tg	ASTM E831	81 ppm/°C	45 ppm/°F	ISO 11359-2	81 ppm/°K	45 ppm/°F
CTE above Tg	ASTM E831	166 ppm/°C	92 ppm/°F	ISO 11359-2	166 ppm/°K	92 ppm/°F
UL Flammability	UL94	HB	HB			
<b>ELECTRICAL</b>				<b>ELECTRICAL</b>		
Dielectric Strength (kV/mm) @ 3.0 mm thickness	ASTM D149	15				
Dielectric Constant @ 1 MHz	ASTM D150	3.27				
Dissipation Factor @ 1 MHz	ASTM D150	0.02				
Volume Resistivity (ohm-cm)	ASTM D257	7.16x10 <sup>15</sup>				

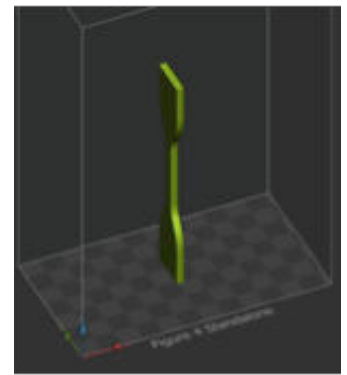
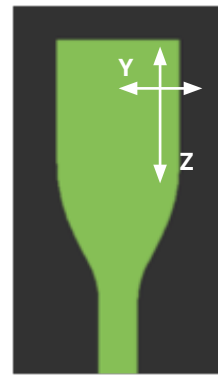
## Figure 4 Rigid Gray

### ISOTROPIC PROPERTIES

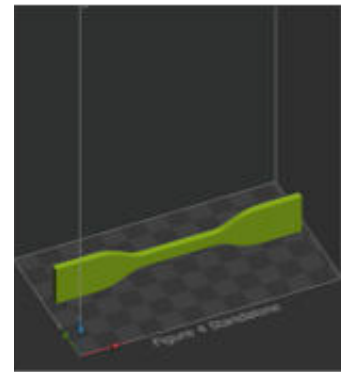
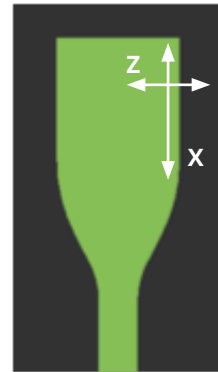
Figure 4 technology prints parts that are generally isotropic in mechanical properties meaning the parts printed along either the XYZ axis will give similar results.

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.

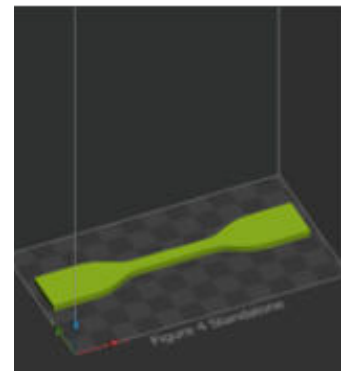
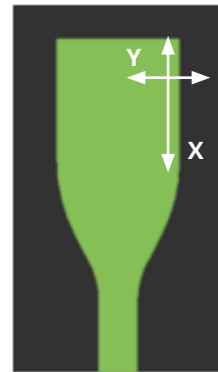
SOLID MATERIAL					
METRIC	METHOD	METRIC			
MECHANICAL					
		ZY	XZ	XY	Z45
Tensile Strength Ultimate	ASTM D638	61 MPa	56 MPa	62 MPa	58 MPa
Tensile Strength at Yield	ASTM D639	61 MPa	56 MPa	62 MPa	58 MPa
Tensile Modulus	ASTM D640	2400 MPa	2300 MPa	2200 MPa	2300 MPa
Elongation at Break	ASTM D641	30 %	17 %	20 %	15 %
Elongation at Yield	ASTM D642	4.6 %	4.5 %	4.8 %	4.3 %
Flex Strength	ASTM D790	87 MPa	88 MPa	78 MPa	71 MPa
Flex Modulus	ASTM D790	2200 MPa	2200 MPa	1800 MPa	1600 MPa
Izod Notched Impact	ASTM D256	21 J/m	24 J/m	23 J/m	24 J/m
Shore Hardness	ASTM D2240	82 D	N/A	N/A	N/A



ZY - orientation



XZ - orientation

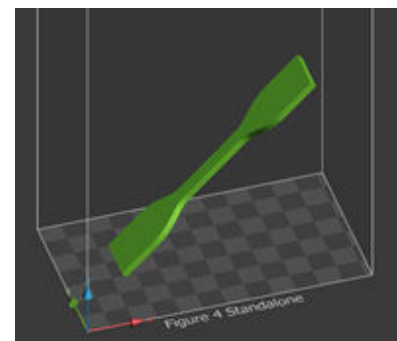
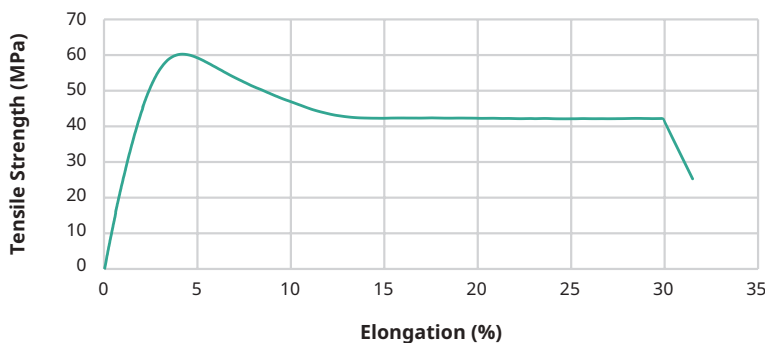


XY - orientation

### STRESS-STRAIN CURVE

Figure 4 Rigid Gray exhibits thermoplastic behavior with a long plastic deformation ductile necking before fracturing which gives better snap and clip performance.

FIGURE 4 RIGID GRAY



Z45-Degree - orientation

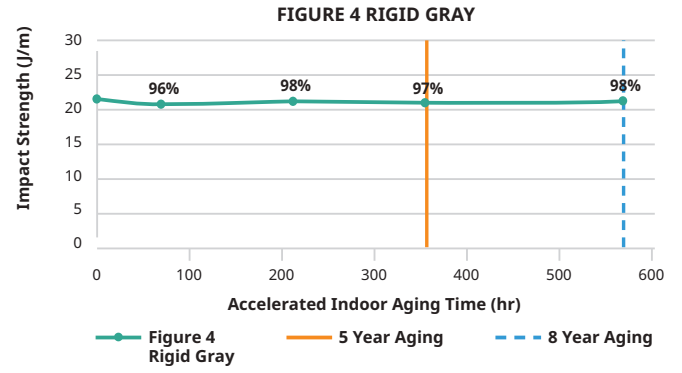
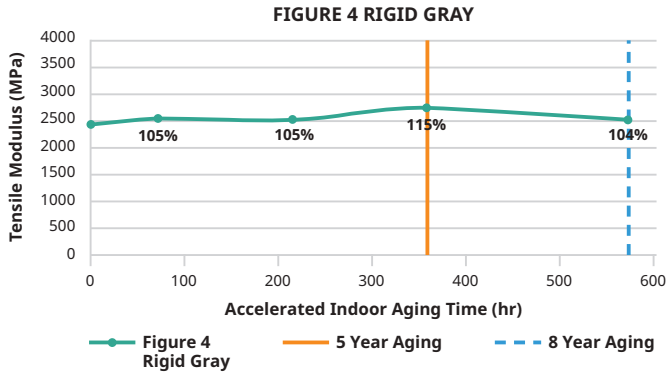
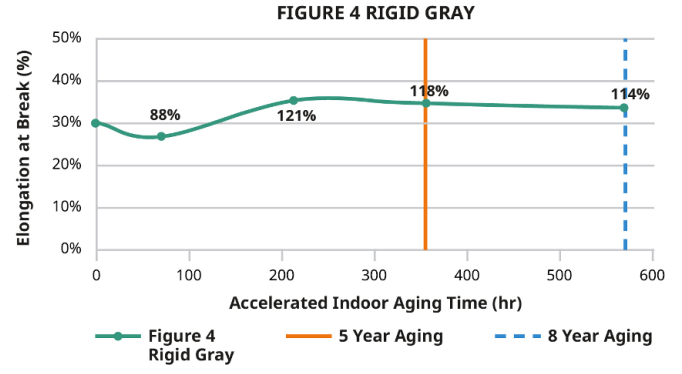
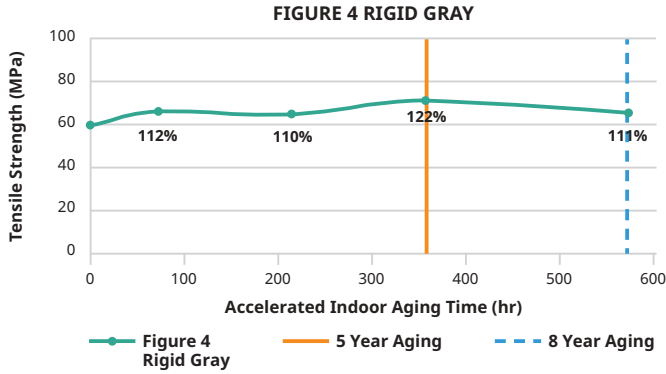
# Figure 4 Rigid Gray

## LONG TERM ENVIRONMENTAL STABILITY

Figure 4 Rigid Gray 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.**

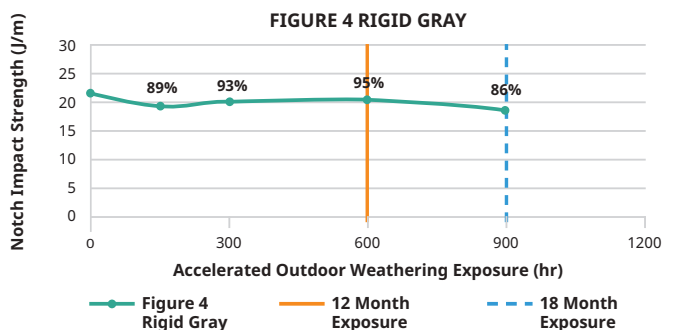
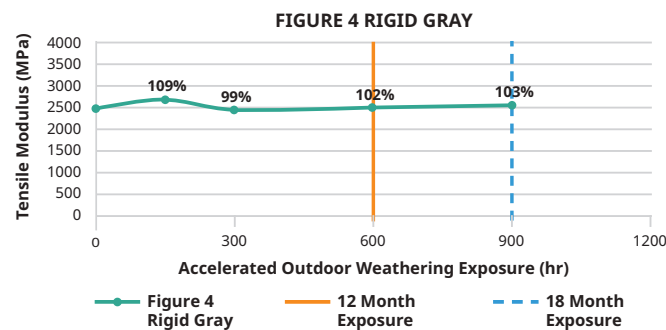
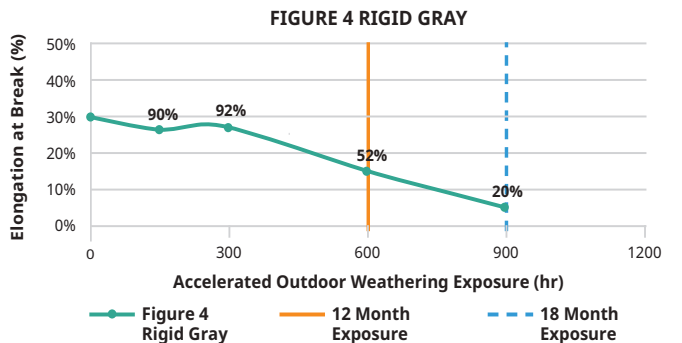
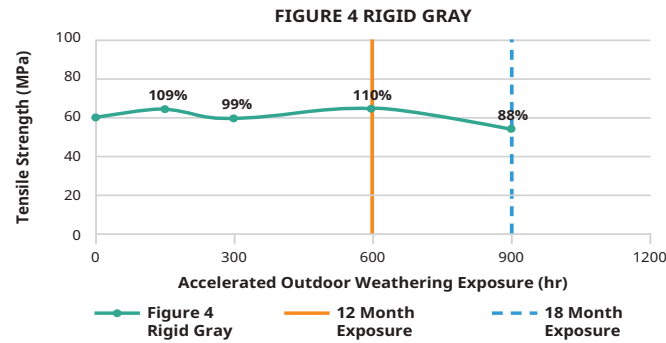
**INDOOR STABILITY:** Tested per ASTM D4329 standard method.

INDOOR STABILITY



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

OUTDOOR STABILITY



# Figure 4 Rigid Gray

## AUTOMOTIVE FLUID COMPATIBILITY

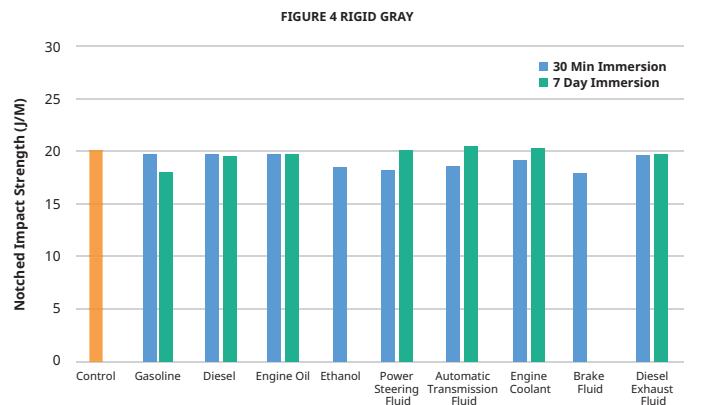
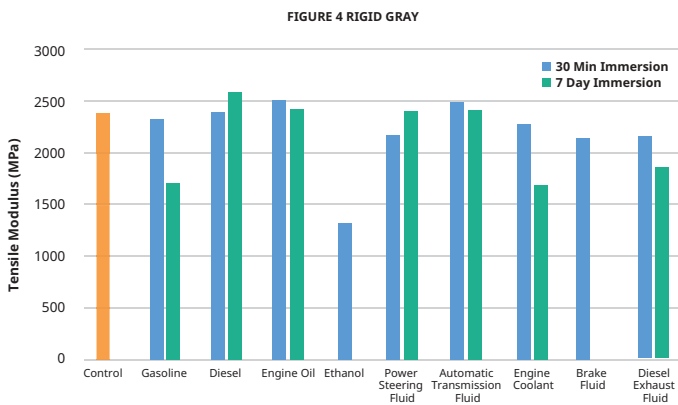
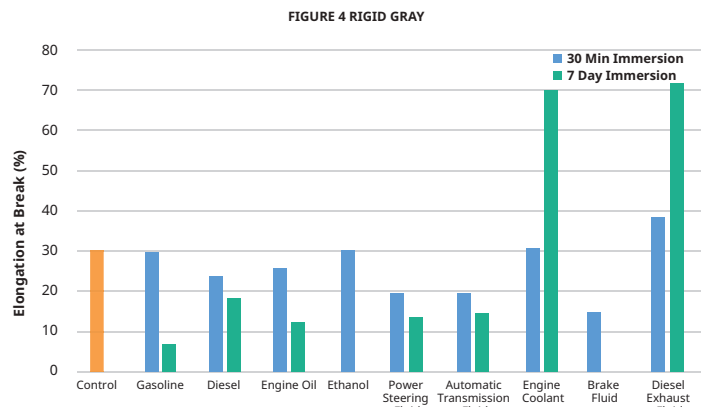
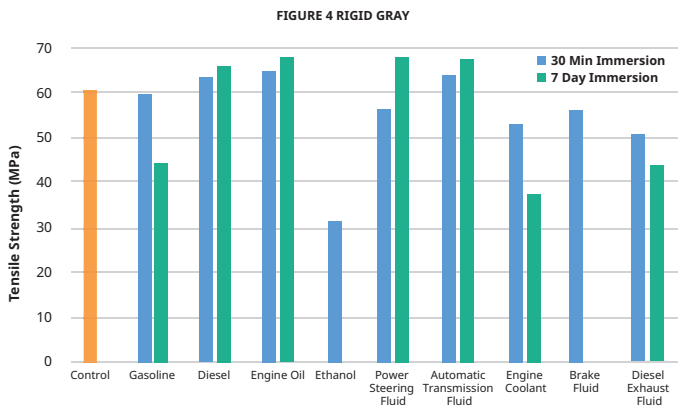
The compatibility of a material with hydrocarbons and cleaning chemicals is critical to part application. Figure 4 Rigid Gray parts were tested for sealed and surface contact compatibility per USCAR2 test conditions. The fluids below were tested in two different ways per the specs.

- 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 Rigid Gray

## CHEMICAL COMPATIBILITY

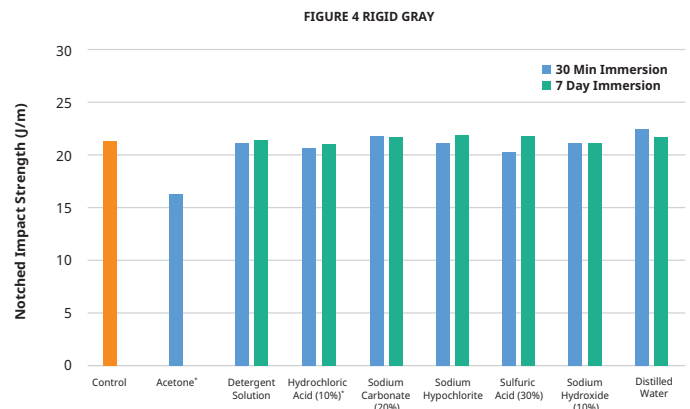
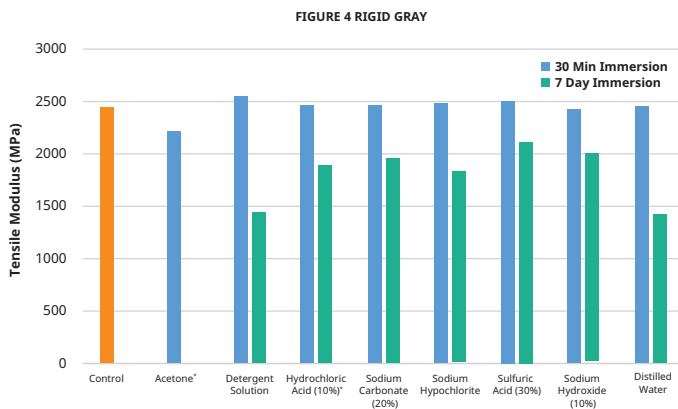
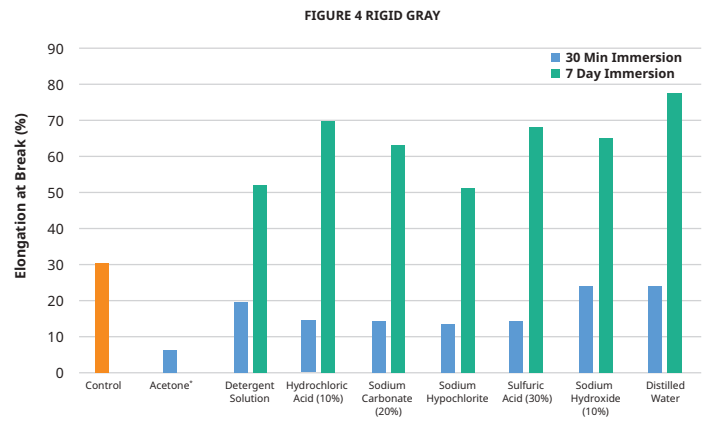
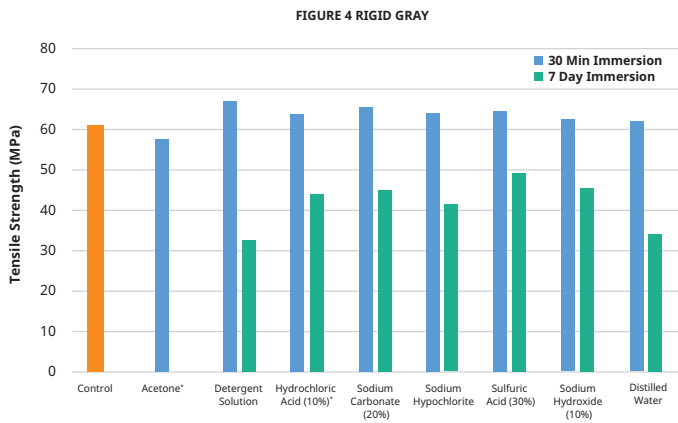
The compatibility of a material with cleaning chemicals is critical to part application. Figure 4 Rigid Gray parts were tested for sealed and surface contact compatibility per ASTM D543 test conditions. The fluids below were tested in two different ways per the specs.

- 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 Rigid Gray

### BIOCOMPATIBILITY STATEMENT

Figure 4<sup>®</sup> Rigid Gray 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, Biological evaluation of medical devices - Part 5: Tests for in vitro cytotoxicity*. The test results indicate that Figure 4 Rigid Gray has passed the requirements for biocompatibility according to the above tests.

It is the responsibility of each customer to determine that its use of Figure 4<sup>®</sup> Rigid Gray 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 Rigid Gray

### 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' 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>

