Figure 4® Rigid Composite White

Production Rigid

Filled resin that produces high stiffness, rigid parts, fast with improved user experience.

Figure 4
PSLA

FAST TURNAROUND, HIGH STIFFNESS ACCURATE PARTS

Figure 4 Rigid Composite White parts possess excellent accuracy, detail, and a smooth surface finish. These high stiffness parts achieve the highest flexural modulus in its class (over 10,000 MPa).

The stiffness and fast turnaround times make it ideally suited for a variety of applications including wind tunnel testing, jigs, fixtures, tools, and injection molding at low temperatures and pressures.

For a filled resin, this is easy to print, store, and maintain than alternatives providing an improved user experience.

APPLICATIONS

- Wind tunnel testing
- Automotive parts
- Motorsports parts
- Small format, short-run tools, jigs, and fixtures
- Parts exposed to automotive fluids and chemicals

BENEFITS

- High stiffness and high strength; highest flexural modulus in its class
- Improved suspension and redispersion characteristics
- Smooth sidewalls and surfaces
- Minimizes the need for post-processing
- Long-term stable
- Excellent resistance to automotive fluids and chemicals
- Improved ease of use; less operator time spent stirring/agitating material
- Higher uptime, faster finished parts in-hand
- Material is available across multiple printer platforms to optimize and right-size production workflow

3D SYSTEMS®

Figure 4 Rigid Composite White

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 the material capabilities to help design decisions using 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	**METHOD**	**METRIC**	**US**
Viscosity (@25C)	Brookfield Viscometer	1260 cPs	3048 lb/ft·h
Color		White	
Liquid Density	Kruss K11 Force Tensiometer	1.66 g/cm³	0.058 lb/in³
Default Print Layer Thickness	Internal	50 µm	0.002 in
Speed - Standard Mode	Internal	19.2 mm/hr	0.75 in/hr
Speed - Draft Mode	Internal	26.6 mm/hr	1.02 in/hr

SOLID MATERIAL						
MEASUREMENT	**ASTM METHOD**	**METRIC**	**US**	**ISO METHOD**	**METRIC**	**US**
	PHYSICAL				**PHYSICAL**	
Solid Density	ASTM D792	1.71 g/cm³	0.062 lb/in³	ISO 1183	1.71 g/cm³	0.062 lb/in³
24 Hour Water Absorption	ASTM D570	0.49 %	0.49 %	ISO 62	0.49 %	0.49 %
	MECHANICAL				**MECHANICAL**	
Tensile Strength Ultimate	ASTM D638 Type IV	85 MPa	12400 psi	ISO 527 -1/2	78 MPa	11400 psi
Tensile Modulus	ASTM D638 Type IV	10200 MPa	1480 ksi	ISO 527 -1/2	9700 MPa	1410 ksi
Elongation at Break	ASTM D638 Type IV	1.9 %	1.9 %	ISO 527 -1/2	1.3 %	1.3 %
Flex Strength	ASTM D790	143 MPa	20800 psi	ISO 527 -1/2	148 MPa	21500 psi
Flex Modulus	ASTM D790	9600 MPa	1390 ksi	ISO 527 -1/2	10700 MPa	1558 ksi
Izod Notched Impact	ASTM D256	15.4 J/m	0.3 ft-lb/in	ISO 178	2.2 J/m²	0.001 ft-lb/in²
Izod Unnotched impact	ASTM D4812	90 J/m	2 ft-lb/in	ISO 178	4.7 J/m²	0.0022 ft-lb/in²
Shore Hardness	ASTM D2240	90 D	90 D	ISO 180-A	90 D	90 D
	THERMAL				**THERMAL**	
Tg (DMA E")	ASTM E1640 (E"Peak)	91 °C	195 °F	ISO 6721-1/11 (E" Peak)	91 °C	195 °F
HDT 0.455MPa/66PSI	ASTM D648	88 °C	191 °F	ISO 75- 1/2 B	87 °C	188 °F
HDT 1.82MPa/264 PSI	ASTM D648	79 °C	174 °F	ISO 75-1/2 A	75 °C	168 °F
CTE -20 TO 50C	ASTM E831	32 ppm/°C	18 ppm/°F	ISO 11359-2	32 ppm/°C	18 ppm/°F
CTE 75 TO 180C	ASTM E831	71 ppm/°C	40 ppm/°F	ISO 11359-2	71 ppm/°C	40 ppm/°F
UL Flammability	UL94					
	ELECTRICAL				**ELECTRICAL**	
Dielectric Strength (kV/mm) @ 3 mm thickness	ASTM D149	15.4				
Dielectric Constant @ 1kHz	ASTM D150	3.464				
Dissipation Factor @ 1kHz	ASTM D150	0.013				
Volume Resistivity (ohm-cm)	ASTM D257	7.12 x 10^15				

Figure 4 Rigid Composite White

ISOTROPIC PROPERTIES

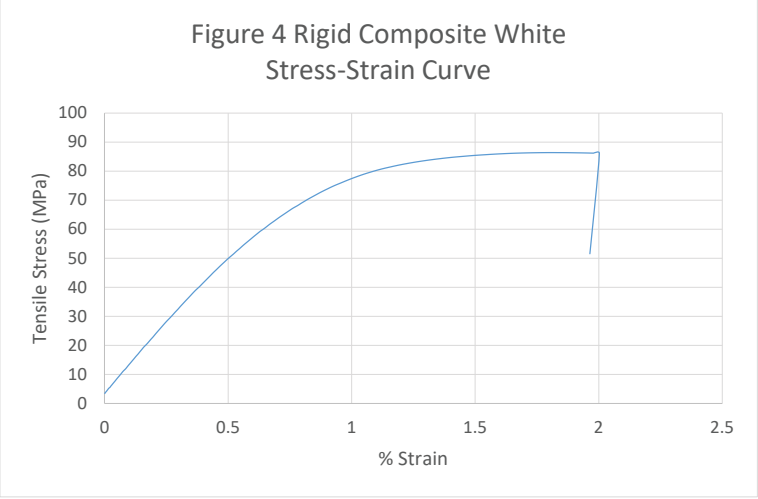
Projector-based platform printed parts are generally isotropic in mechanical properties meaning the parts printed along either the XYZ axis will give similar results.

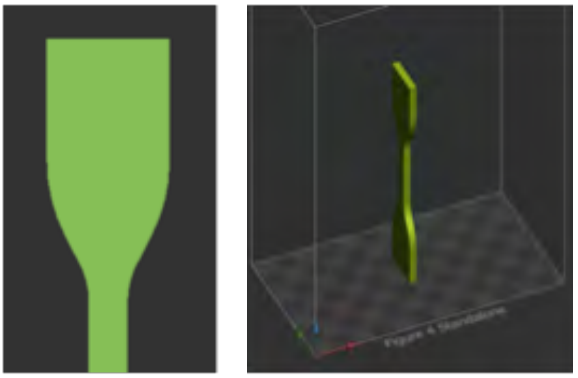
Parts do not need to be oriented to get the highest mechanical properties, further improving the degree of freedom for part orientation for mechanical properties.

SOLID MATERIAL					
METRIC	METHOD	METRIC			
MECHANICAL					
		ZY	XZ	XY	Z45
Tensile Strength Ultimate	ASTM D638 Type IV	85 MPa	81 MPa	82 MPa	83 MPa
Tensile Modulus	ASTM D638 Type IV	10200 MPa	9700 MPa	10100 MPa	10100 MPa
Elongation at Break	ASTM D638 Type IV	1.9 %	1.7 %	1.7 %	2.2 %
Flex Strength	ASTM D790	143 MPa	143 MPa	144 MPa	137 MPa
Flex Modulus	ASTM D790	9600 MPa	9800 MPa	9900 MPa	9800 MPa
Izod Notched Impact	ASTM D256	15.4 J/m	15.6 J/m	15.4 J/m	14.8 J/m
Izod unnotched impact	ASTM D4812	90 J/m	80 J/m	73 J/m	67 J/m
Shore D Hardness	ASTM D2240	90 D	90 D	90 D	89 D

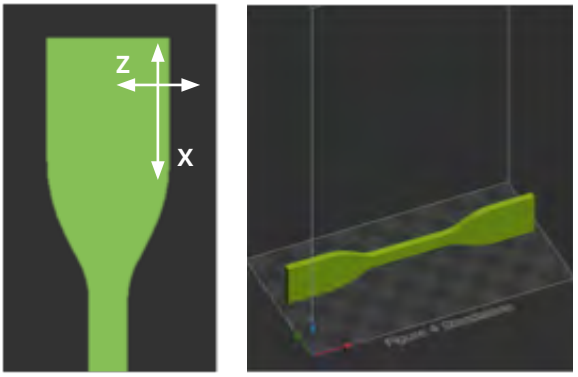
STRESS-STRAIN CURVE

The graph represents the Stress-Strain curve for Figure 4 Rigid Composite White per ASTM D638 testing.

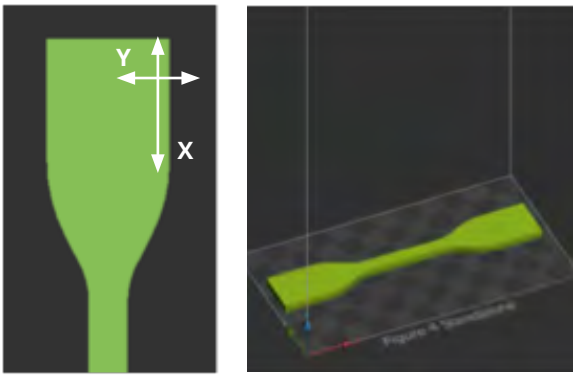




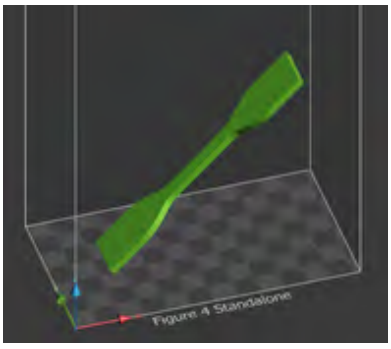
ZY - orientation



XZ - orientation



XY - orientation



Z45-Degree - orientation

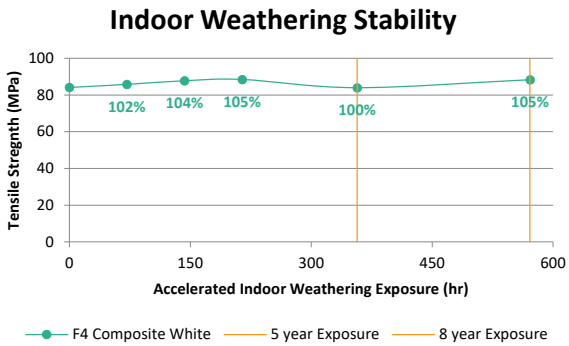
Figure 4 Rigid Composite White

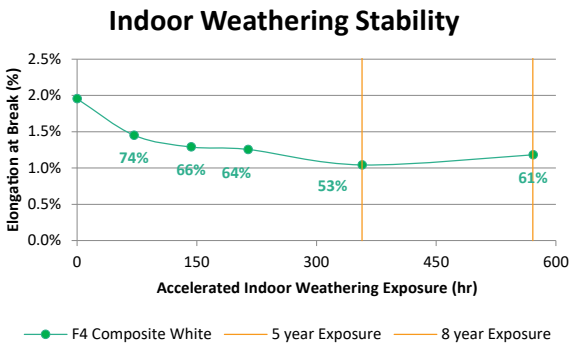
LONG-TERM ENVIRONMENTAL STABILITY

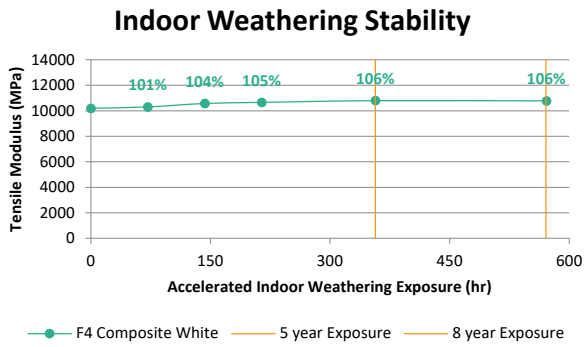
Figure 4 Rigid Composite White is engineered to give long term environmental UV and humidity stability. This means the material is tested for the ability to retain a high percent of the initial mechanical properties over a given period of time. This provides real design conditions to consider for the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

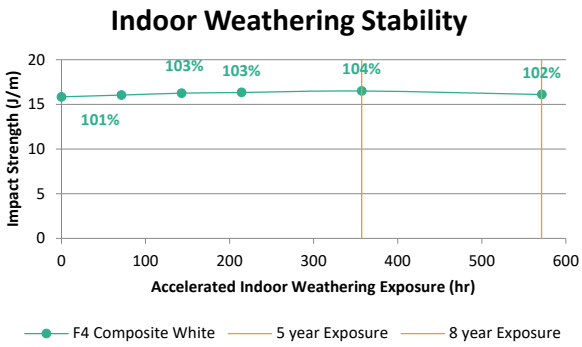
INDOOR STABILITY

INDOOR STABILITY: Tested per ASTM D4329 standard method.



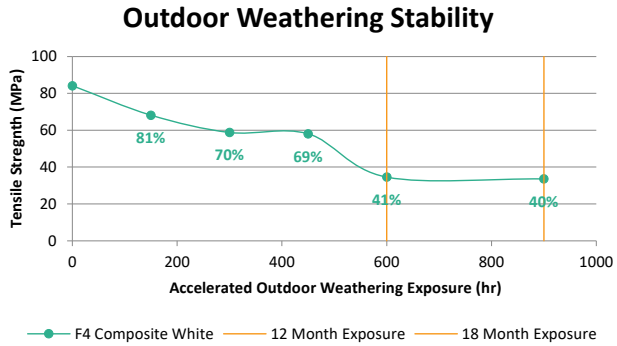


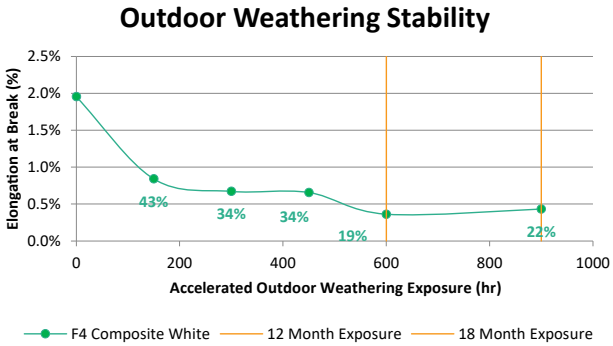


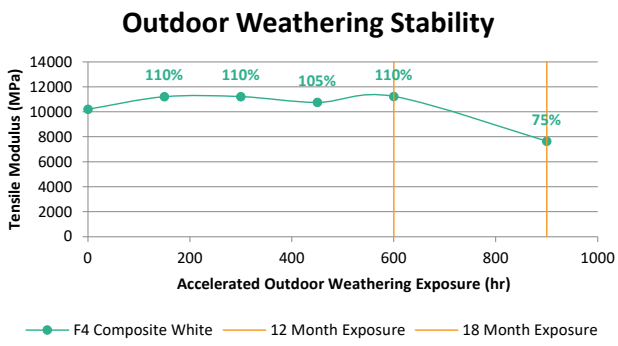


OUTDOOR STABILITY

OUTDOOR STABILITY: Tested per ASTM G154 standard method.







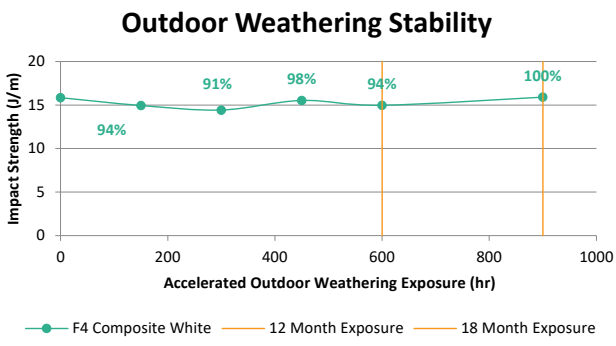


Figure 4 Rigid Composite White

AUTOMOTIVE FLUID COMPATIBILITY

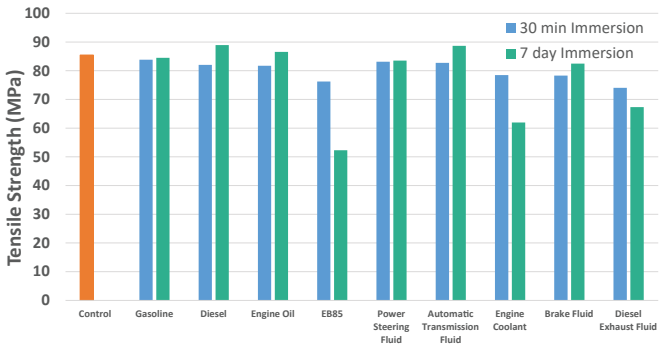
The compatibility of a material with hydrocarbons and cleaning chemicals is critical to part application. Figure 4 Rigid Composite White parts were tested for sealed and surface contact compatibility per USCAR2 test conditions. The fluids below were tested in two different ways per the specs.

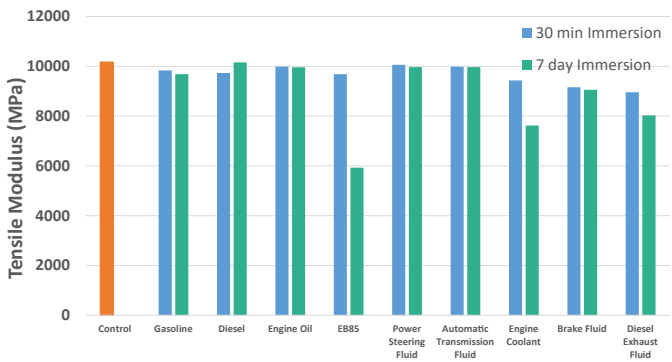
- Immerse for 30 minutes, remove and store for 7 days, then take mechanical property data for comparison.
- Immerse for 7 days, then take mechanical property data for comparison.

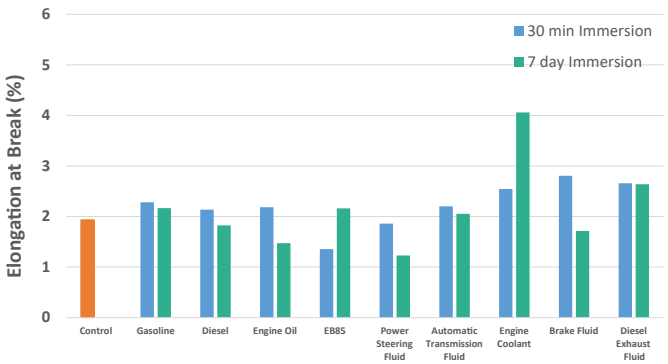
Data reflects the measured value of properties over that period of time.

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







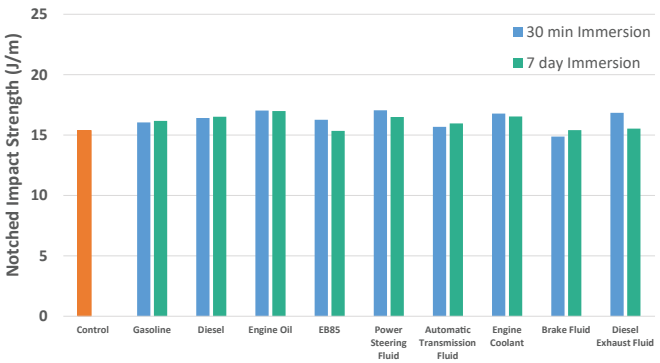


Figure 4 Rigid Composite White

CHEMICAL COMPATIBILITY

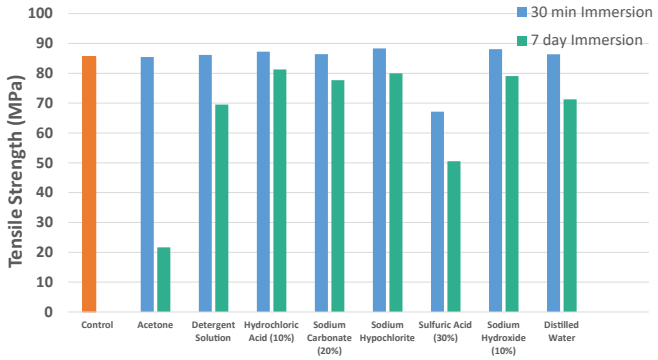
The compatibility of a material with cleaning chemicals is critical to part application. Figure 4 Rigid Composite White parts were tested for sealed and surface contact compatibility per ASTM D543 test conditions. The fluids below were tested in two different ways per the specs.

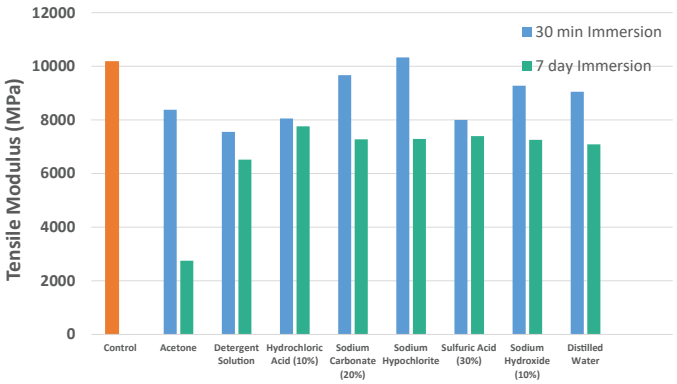
- Immerse for 30 minutes, then take mechanical property data for comparison.
- Immerse for 7 days, then take mechanical property data for comparison.

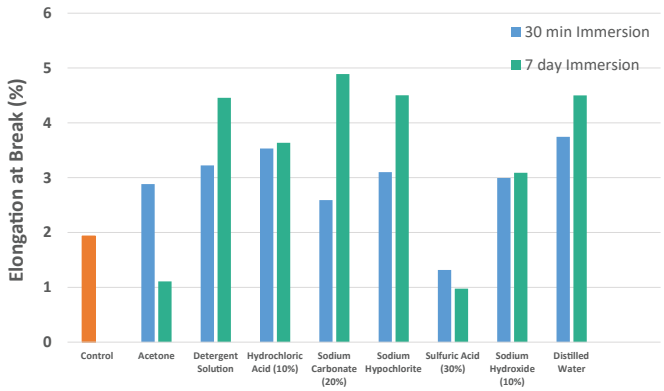
Data reflects the measured value of properties over that period of time.

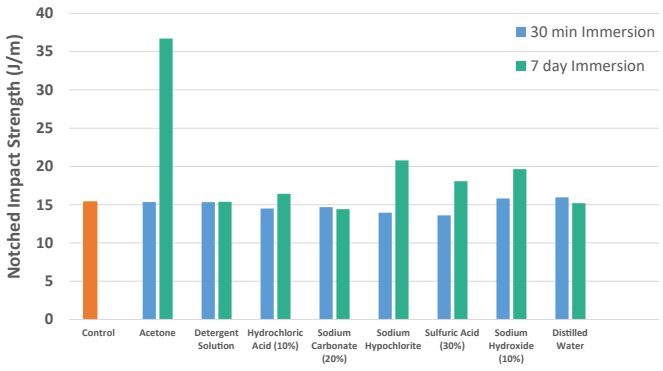
*Denotes materials did not go thru 7-day soak conditioning.

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









RIGID COMPOSITE WHITE - CLEANING QUICK SUMMARY

MIXING INSTRUCTIONS

This material is a composite (filled) material and requires consistent stirring to produce the best results.

1 kg bottle

Before first use, or after storage for >1 month:

- Roll bottle for 1 hour on a 3D Systems LC-3D Mixer
- After pouring, allow material to rest in vat for at least 30 minutes to allow air bubbles to escape. Re-stir vat using a resin mixer for 30s before printing.

Subsequent uses (<1 month storage time):

- Roll bottle for 10-15 minutes before dispensing.

2.5 kg cartridge

Before first use, or after storage for >1 month:

- Shake cartridge vigorously for 5-10 minutes before installing.

During use, at least once every 72 hours:

- Close the cartridge vent, remove the cartridge, and gently agitate or rock the bottle for 1-2 minutes to re-mix the filler.

9 kg container

- Shake container vigorously for 2 minutes before installing.

Resin vat stirring

Before starting a print:

- Stir material in the vat using a *dedicated* Resin Mixer tool for approx. 1min.
- Stir until any visible separation (marbling) has disappeared, and the material is a uniform yellow color.

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

MANUAL CLEANING INSTRUCTIONS

- Dedicate 2 containers to use with this material only. Fill with IPA (wash and rinse)
- Clean in “wash” IPA for 3 to 5 minutes, while gently agitating the part
- **Optional** - While part is still wet with IPA, use a *dedicated* soft paintbrush to brush all exterior part surfaces. This will remove a large percentage of the loose filler particles from the surface, for cleaner handling and use. Re-dip the part in the “wash” IPA before moving to the “clean” IPA tank.
- Rinse in “clean” IPA for 2 to 5 minutes, while gently agitating part.
- Replace IPA solution when cleaning becomes ineffective.
- Between replacement cycles, remove the sediment build-up from the tank to keep cleaning effectiveness high. Allow the sediment to settle to the bottom of the cleaning tank (overnight), then pour off liquid IPA, leaving the sediment to be cleaned out from the bottom of the tank.
- **Note**: It is possible to use a soak method, without agitation, with this material. Cleaning times may need to be extended.

DRYING INSTRUCTIONS

- **Drying oven**: Dry parts on a wire rack in a circulated oven for 25min at 35°C before post-cure.
- **Ambient Air Drying**: If an oven is not available, allow parts to dry on a wire rack or screen for >1 hour before post-cure.

UV CURE TIME

- 3D Systems LC-3DPrint Box UV Post-Curing Unit, or Figure 4 UV Cure Unit: 90 minutes

In order to avoid cross contamination with other materials and achieve comparable mechanical properties to the published test results, Figure 4 Rigid Composite White must be run in dedicated hardware including the resin tray and print platform.