

Figure 4[®] HI TEMP 300-AMB

High Temperature

Industry-leading, ultra-high temperature resistant rigid plastic suitable for the harshest thermal environments

Figure 4

HIGH THERMAL-RESISTANCE, TRANSLUCENT AMBER PLASTIC FOR FLOW VISUALIZATION (HDT >300 °C)

Figure 4 HI TEMP 300-AMB is an ultra-high temperature plastic for use in applications requiring high heat resistance. It is the industry's highest heat resistant material with heat deflection temperature of over 300 °C at both low and high stress (at 0.455 and 1.82 MPa). This material is well suited for the testing of high temperature components in applications including HVAC, consumer appliances, motor enclosures, stators, molds, and the like. It does not require a secondary thermal post-cure.

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.

APPLICATIONS

- High temperature components testing and general use parts including: HVAC, consumer appliances, motor enclosures, stators, etc.
- Low pressure molding/tooling: expanding foams, rubbers, etc.
- Overmolding

BENEFITS

- Production-grade material
- High heat resistance for testing and use in high heat environments
- No secondary thermal post-cure required
- Excellent visualization for parts requiring evaluation of internal features and fluid flow performance

FEATURES

- HDT over 300 °C at both low and high stress (HDT at 0.455 and 1.82 MPa)
- Rigid and translucent
- High tensile modulus for use in molds (4000 MPa)

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) | 1725 cPs | 4100 lb/ft-h |
| Color | | Amber | |
| Liquid Density | Kruss K11 Force Tensiometer @ 25 °C (77 °F) | 1.19 g/cm ³ | 0.04 lb/in ³ |
| Default Print Layer Thickness (Standard Mode) | | 50um | 0.002 in |
| Speed - Standard Mode | | 36 mm/hr | 1.42 in/hr |
| Speed - Draft Mode | | 40 mm/hr | 1.57 in/hr |
| Package Volume | | 1 kg bottle - Figure 4 Standalone 2.5 kg cartridge - Figure 4 Modular 10kg bottle Figure 4 Production | |

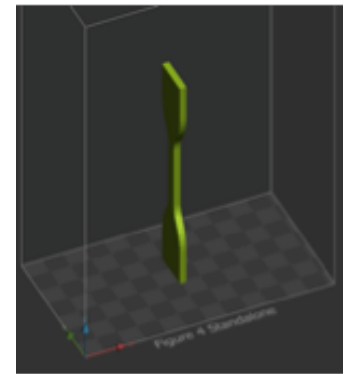
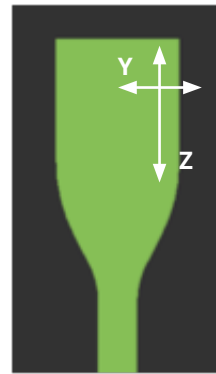
| SOLID MATERIAL | | | | | | |
|--|---------------------|-----------------------|--------------------------|-------------------------|-----------------------|--------------------------|
| METRIC | ASTM METHOD | METRIC | ENGLISH | ISO METHOD | METRIC | ENGLISH |
| PHYSICAL | | | | PHYSICAL | | |
| Solid Density | ASTM D792 | 1.3 g/cm ³ | 0.047 lb/in ³ | ISO 1183 | 1.3 g/cm ³ | 0.047 lb/in ³ |
| 24 Hour Water Absorption | ASTM D570 | 0.36 % | 0.36 % | ISO 62 | 0.36 % | 0.36 % |
| MECHANICAL | | | | MECHANICAL | | |
| Tensile Strength Ultimate | ASTM D638 Type IV | 77 MPa | 11200 psi | ISO 527 -1/2 | 75 MPa | 10900 psi |
| Tensile Strength at Yield | ASTM D638 Type IV | N/A | N/A | ISO 527 -1/2 | N/A | N/A |
| Tensile Modulus | ASTM D638 Type IV | 4100 MPa | 5.9 ksi | ISO 527 -1/2 | 4200 MPa | 6.1 ksi |
| Elongation at Break | ASTM D638 Type IV | 2.3 % | 2.3 % | ISO 527 -1/2 | 2.3 % | 2.3 % |
| Elongation at Yield | ASTM D638 Type IV | N/A | N/A | ISO 527 -1/2 | N/A | N/A |
| Flex Strength | ASTM D790 | 85 MPa | 12300 psi | ISO 178 | 130 MPa | 1900 psi |
| Flex Modulus | ASTM D790 | 4300 MPa | 6.2 ksi | ISO 178 | 4500 MPa | 6.5 ksi |
| Izod Notched Impact | ASTM D256 | 10 J/m | 0.2 ft-lb/in | ISO 180-A | 1.6 J/m ² | N/A |
| Izod Unnotched impact | ASTM D4812 | 102 J/m | 1.9 ft-lb/in | ISO 180-U | | |
| Shore Hardness | ASTM D2240 | 89 D | 89 D | ISO 7619 | 89 D | 89 D |
| THERMAL | | | | THERMAL | | |
| Glass Transition (Tg) | ASTM E1640 (E"Peak) | N/A | N/A | ISO 6721-1/11 (E" Peak) | N/A | N/A |
| HDT 1.82MPa/264 PSI | ASTM D648 | >300 °C | >572 °F | ISO 75-1/2 A | >300 °C | >570 °F |
| HDT 0.455MPa/66PSI | ASTM D648 | >300 °C | >572 °F | ISO 75- 1/2 B | 280 °C | 540 °F |
| HDT 8.0MPa/ 1160PSI | N/A | | | ISO 75-1/2 C | 100 °C | 210 °F |
| CTE 0-110C | ASTM E831 | 69 ppm/°C | 38 ppm/°F | ISO 11359-2 | 69 ppm/K | 38 ppm/°F |
| CTE 165-250C | ASTM E831 | 58 ppm/°C | 32 ppm/°F | ISO 11359-2 | 58 ppm/K | 32 ppm/°F |
| UL Flammability | UL94 | | HB | | | |
| ELECTRICAL | | | | ELECTRICAL | | |
| Dielectric Strength (kV/mm) @ 3.0 mm thickness | ASTM D149 | 18.1 | | | | |
| Dielectric Constant @ 1 MHz | ASTM D150 | 3.29 | | | | |
| Dissipation Factor @ 1 MHz | ASTM D150 | 0.013 | | | | |
| Volume Resistivity (ohm-cm) | ASTM D257 | 6.0x10 ¹⁵ | | | | |

ISOTROPIC PROPERTIES

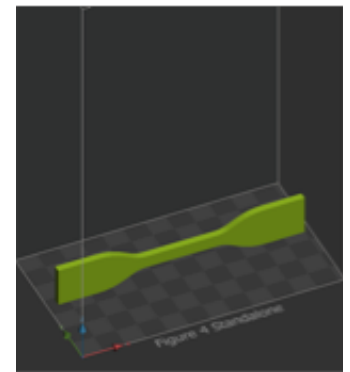
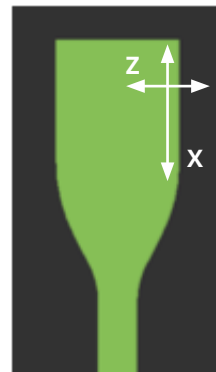
Figure 4 technology prints parts that are isotropic in mechanical properties meaning the parts printed along either the XYZ axis will give similar results.

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.

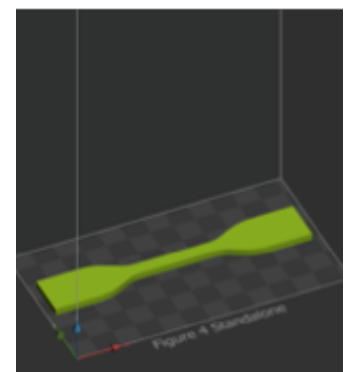
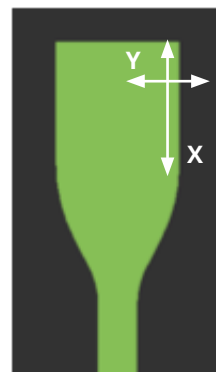
| SOLID MATERIAL | | | | | |
|---------------------------|-------------------|----------|----------|----------|----------|
| METRIC | METHOD | METRIC | | | |
| MECHANICAL | | | | | |
| | | ZY | XZ | XY | Z45 |
| Tensile Strength Ultimate | ASTM D638 Type IV | 77 MPa | 74 MPa | 68 MPa | 79 MPa |
| Tensile Strength at Yield | ASTM D638 Type IV | N/A | N/A | N/A | N/A |
| Tensile Modulus | ASTM D638 Type IV | 4100 MPa | 3800 MPa | 3900 MPa | 3900 MPa |
| Elongation at Break | ASTM D638 Type IV | 2.3 % | 2.3 % | 1.9 % | 2.4 % |
| Elongation at Yield | ASTM D638 Type IV | N/A | N/A | N/A | N/A |
| Flex Strength | ASTM D790 | 85 MPa | 98 MPa | 105 MPa | 96 MPa |
| Flex Modulus | ASTM D790 | 4300 MPa | 4200 MPa | 4000 MPa | 4100 MPa |
| Izod Notched Impact | ASTM D256 | 10 J/m | 9 J/m | 11 J/m | 10 J/m |
| Shore Hardness | ASTM D2240 | 89 D | 90 D | 89 D | 90 D |



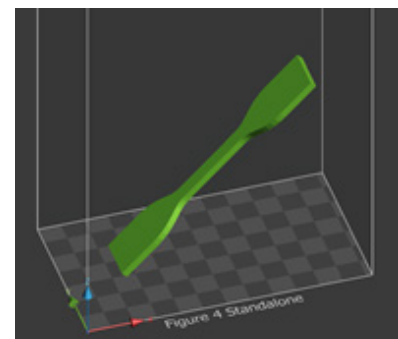
ZY - orientation



XZ - orientation



XY - orientation



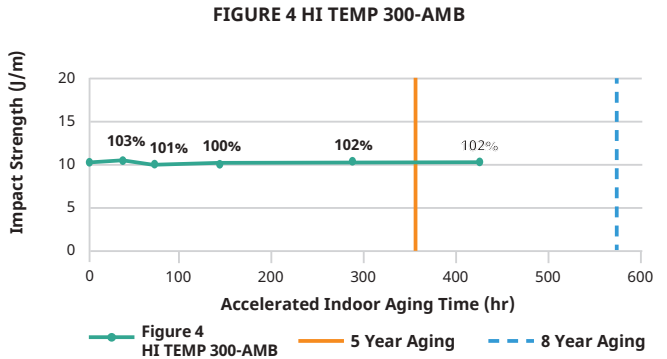
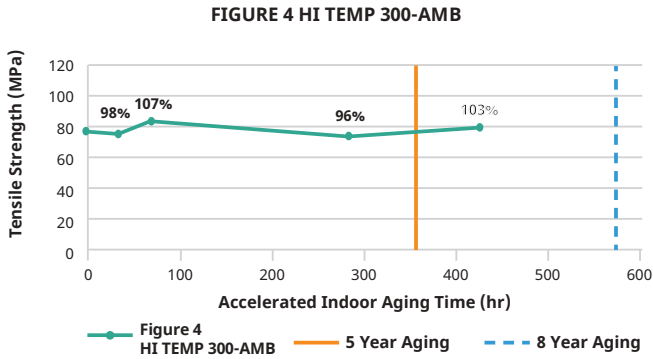
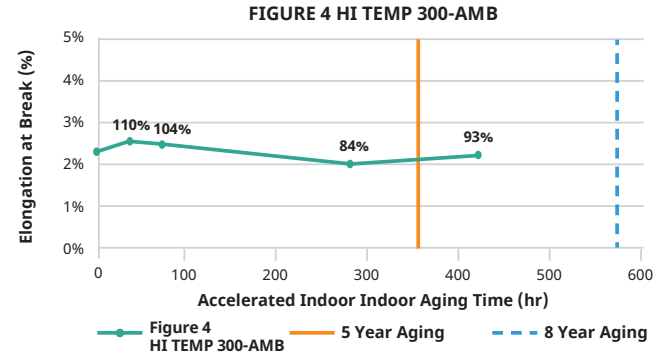
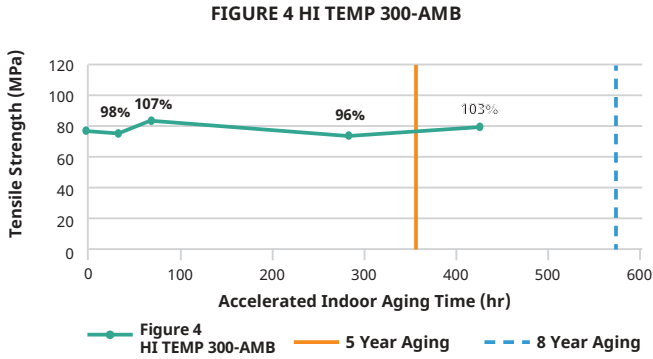
Z45-Degree - orientation

LONG TERM ENVIRONMENTAL STABILITY

Figure 4 HI TEMP 300-AMB 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.**

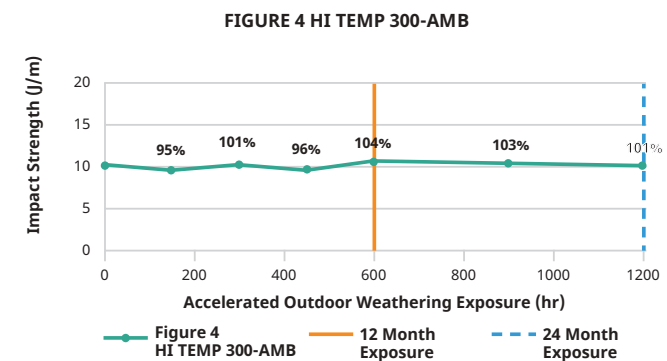
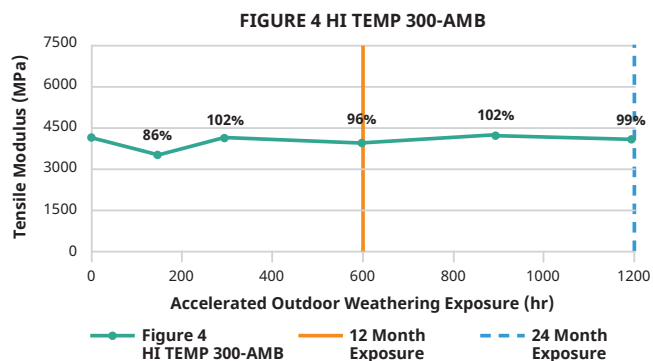
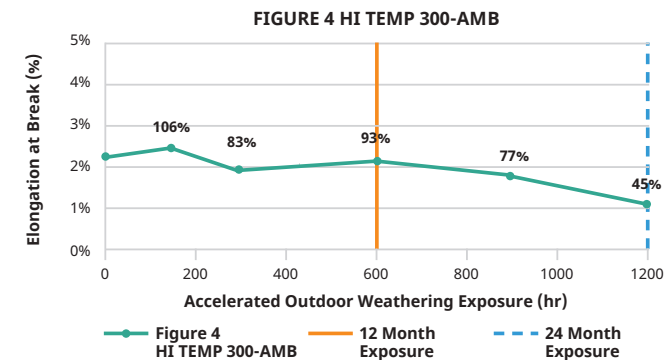
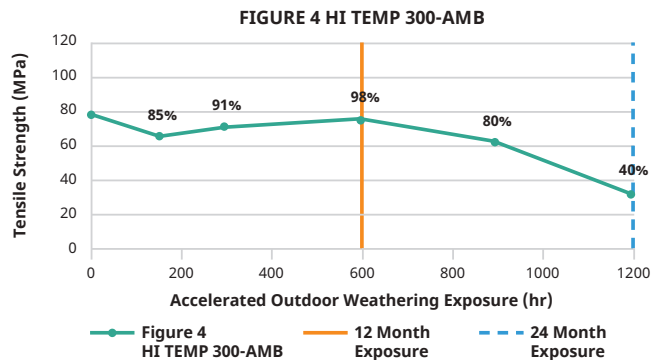
INDOOR STABILITY: Tested per ASTM D4329 standard method.

INDOOR STABILITY



OUTDOOR STABILITY: Tested per ASTM G154 standard method.

OUTDOOR STABILITY



AUTOMOTIVE FLUID COMPATIBILITY

The compatibility of a material with hydrocarbons and cleaning chemicals is critical to part application. Figure 4 HI TEMP 300-AMB 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 HI TEMP 300-AMB

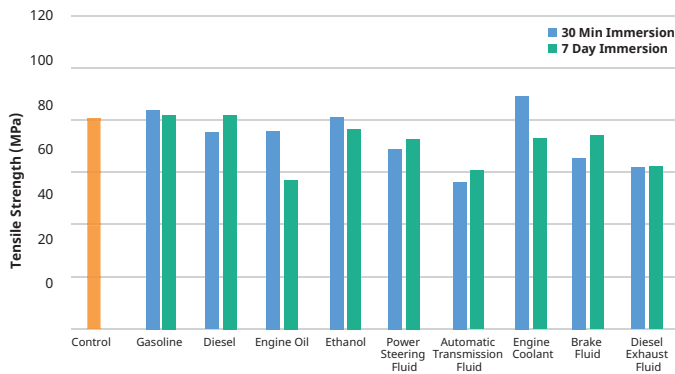


FIGURE 4 HI TEMP 300-AMB

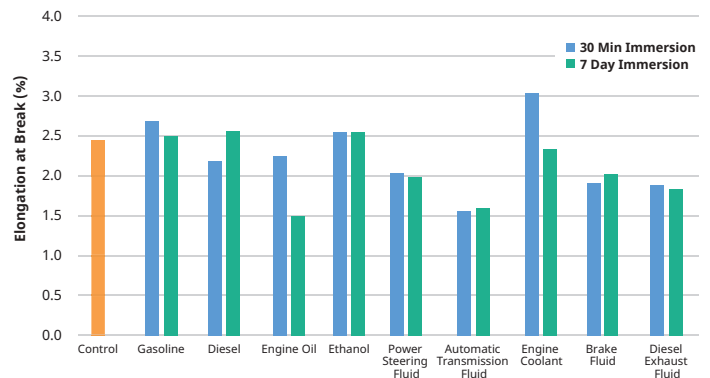


FIGURE 4 HI TEMP 300-AMB

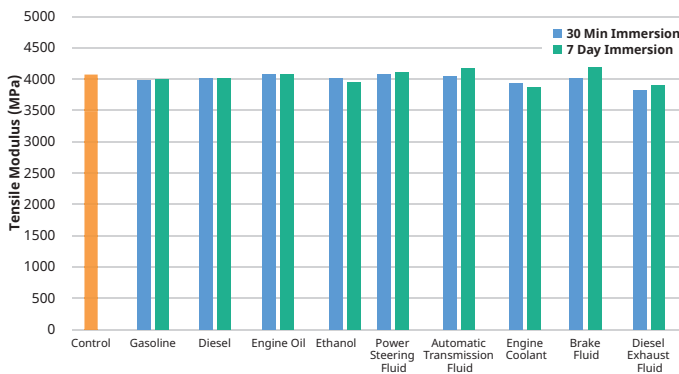
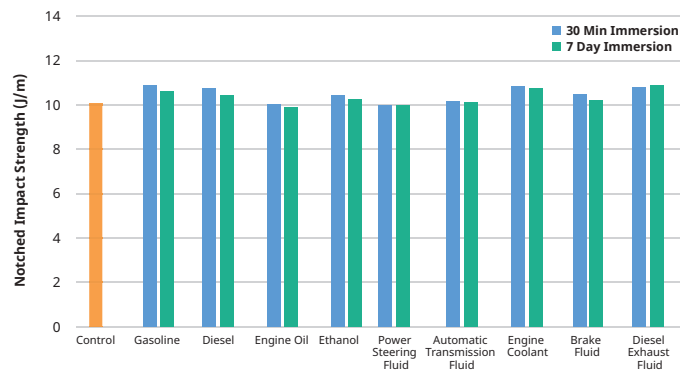


FIGURE 4 HI TEMP 300-AMB



CHEMICAL COMPATIBILITY

The compatibility of a material with cleaning chemicals is critical to part application. Figure 4 HI TEMP 300-AMB 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 HI TEMP 300-AMB

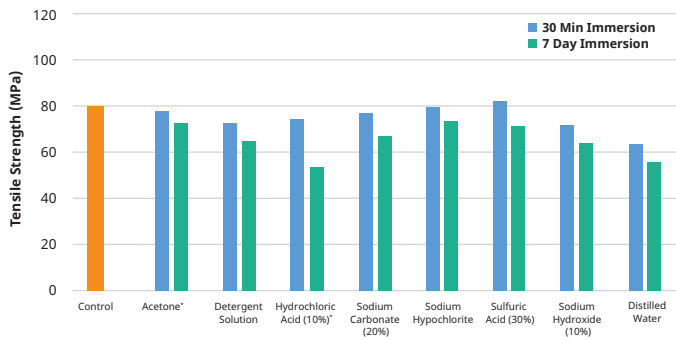


FIGURE 4 HI TEMP 300-AMB

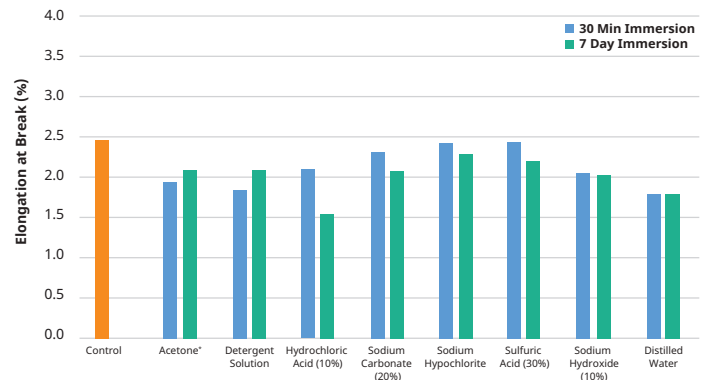


FIGURE 4 HI TEMP 300-AMB

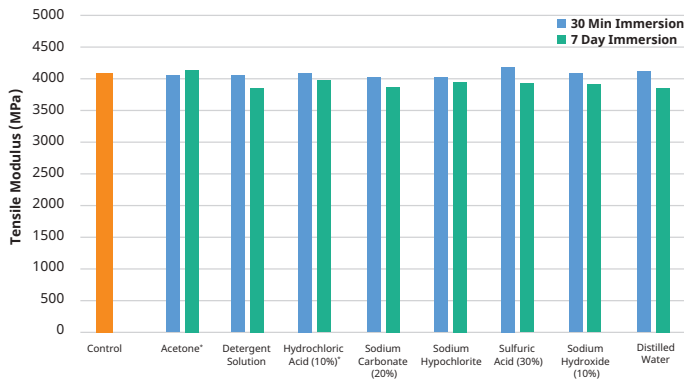
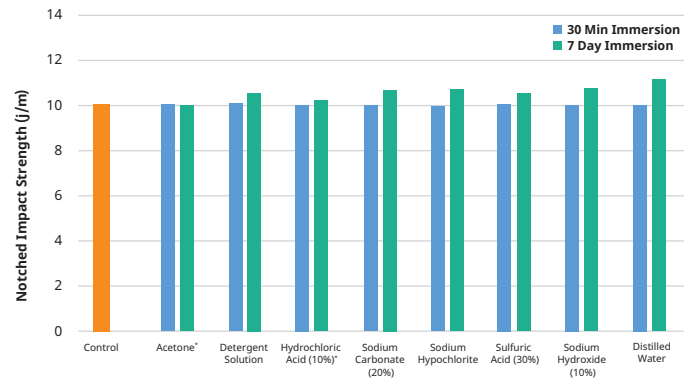


FIGURE 4 HI TEMP 300-AMB



POST-PROCESSING

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

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