



# DuraForm<sup>®</sup> PAx Natural

## Nylon Copolymer

High impact, high elongation, high recyclability SLS material with properties similar to injection molded nylon plastic for tough, lightweight, production-grade parts.

Selective Laser Sintering

### PRODUCTION-GRADE HIGH IMPACT NYLON COPOLYMER WITH HIGH ELONGATION AND LONG-TERM STABILITY FOR TOUGH PLASTIC PARTS

DuraForm PAx Natural is a nylon copolymer that offers properties similar to injection molded plastic and features high impact resistance with high elongation at break in any direction, including Z. Engineered for easy processing and high recyclability, DuraForm PAx Natural is ideal for functional prototypes and end-use parts with good mechanical properties and long-term stability.

The low printing temperatures of DuraForm PAx Natural contribute to high throughput when using this material, and its designation as a clean running material means low operator maintenance. With impressive long-term stability of over five years indoor, DuraForm PAx Natural is among the top performing SLS materials for long-term use.

### APPLICATIONS

- General purpose prototypes
- Orthotics
- Tooling handles and grips for use in tough, rugged environments
- Living hinges
- Liquid reservoirs per data sheet specifications
- Enclosures requiring high impact and high toughness

### ADVANTAGES

- Durable and tough for true functional plastic parts
- High reuse rates reduce waste and decrease production costs
- Low temperature printing enables faster parts in hand
- Excellent long-term stability; 5+ years indoor for mechanical properties and color
- Vapor-honed parts have excellent translucency and smooth finish

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

## 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 XY-axis.

SOLID MATERIAL						
METRIC	ASTM METHOD	METRIC	ENGLISH	ISO METHOD	METRIC	ENGLISH
PHYSICAL				PHYSICAL		
Color		Natural				
Solid Density	ASTM D792	1.03 g/cm <sup>3</sup>	0.037 lb/in <sup>3</sup>	ISO 1183	1.03 g/cm <sup>3</sup>	0.037 lb/in <sup>3</sup>
24 Hour Water Absorption	ASTM D570	0.74%	0.74%	ISO 62	0.74%	0.74%
MECHANICAL				MECHANICAL		
Tensile Strength Ultimate	ASTM D638 Type I	40 MPa	5700 psi	ISO 527-1/2	43 MPa	6300 psi
Tensile Strength at Yield	ASTM D638 Type I	40 MPa	5700 psi	ISO 527-1/2	43 MPa	6300 psi
Tensile Modulus	ASTM D638 Type I	1300 MPa	190 ksi	ISO 527-1/2	1500 MPa	214 ksi
Elongation at Break	ASTM D638 Type I	282%	282%	ISO 527-1/2	174%	174%
Elongation at Yield	ASTM D638 Type I	5.5%	5.5%	ISO 527-1/2	4.6%	4.6%
Flex Strength	ASTM D790	37 MPa	5300 psi	ISO 178	40 MPa	5800 psi
Flex Modulus	ASTM D790	880 MPa	130 ksi	ISO 178	1040 MPa	151 ksi
Izod Notched Impact	ASTM D256	41 J/m	0.8 ft-lb/in	ISO 180-A	0.3 kJ/m <sup>2</sup>	0.1 ft-lb/in <sup>2</sup>
Izod Unnotched Impact	ASTM D4812	Does Not Break	Does Not Break	ISO 180-U	Does Not Break	Does Not Break
Shore Hardness	ASTM D2240	66 D	66 D	ISO 7619	66 D	66 D
THERMAL				THERMAL		
Tg (DMA E")	ASTM E1640 (E" Peak)	34 °C	93 °F	ISO 6721-1/11 (E" Peak)	34 °C	93 °F
HDT 0.455MPa/66PSI	ASTM D648	105 °C	221 °F	ISO 75- 1/2 B	102 °C	215 °F
HDT 1.82MPa/264 PSI	ASTM D648	46 °C	114 °F	ISO 75-1/2 A	44 °C	111 °F
CTE -40 to 15C	ASTM E831	100 ppm/°C	55 ppm/°F	ISO 11359-2	100 ppm/°K	55 ppm/°F
CTE 55 to 125C	ASTM E831	231 ppm/°C	128 ppm/°F	ISO 11359-2	231 ppm/°K	128 ppm/°F
UL Flammability	UL94	HB				
ELECTRICAL				ELECTRICAL		
Dielectric Strength (kV/mm) @ 3mm thickness	ASTM D149	15.2				
Dielectric Constant @ MkHz	ASTM D150	2.974				
Dissipation Factor @ MkHz	ASTM D150	0.026				
Volume Resistivity (ohm-cm)	ASTM D257	6.53 x 10 <sup>14</sup>				

\*Tensile testing done at 50mm/min after timeout at 5mm/min per ASTM D638 standards



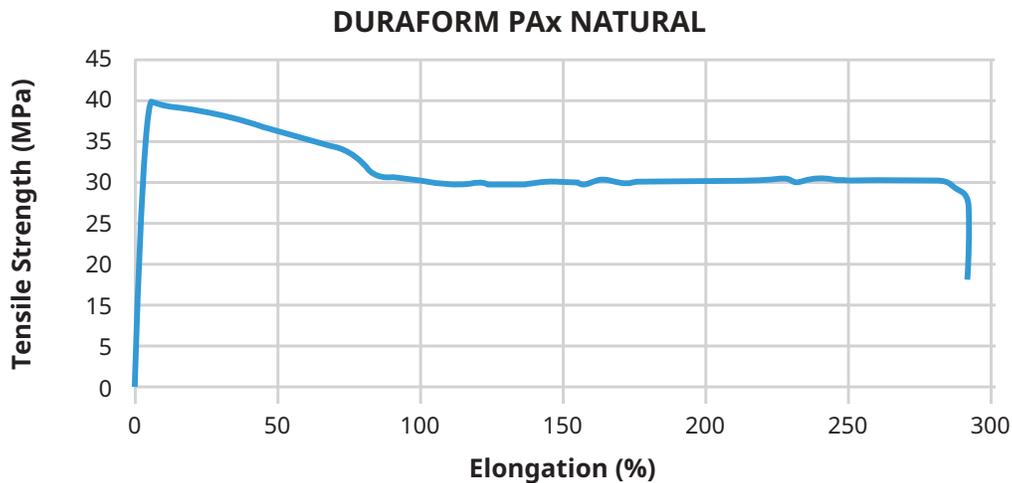
### BLEND RATIO

Parts are tested with various blend ratios to give user operational data for mechanical properties. In addition, the range of blend ratios allows the user to balance blending capability and economical use of DuraForm PAX Natural material. The vapor-honed data at the 30% fresh blend is also included to show the advantages of vapor-honed post-processing.

SOLID MATERIAL					
PROPERTY	ASTM METHOD	30% FRESH	30% FRESH VAPOR HONE	40% FRESH	50% FRESH
<b>PHYSICAL</b>					
Solid Density	ASTM D792	1.03 g/cm <sup>3</sup>	1.02 g/cm <sup>3</sup>	1.02 g/cm <sup>3</sup>	1.02 g/cm <sup>3</sup>
24 Hour Water Absorption	ASTM D570	0.74%	NA	0.86 %	0.79 %
<b>MECHANICAL</b>					
Tensile Strength Ultimate	ASTM D638 Type I	40 MPa	37 MPa	40 MPa	41 MPa
Tensile Strength at Yield	ASTM D638 Type I	40 MPa	29 MPa	40 MPa	41 MPa
Tensile Modulus	ASTM D638 Type I	1300 MPa	1300 MPa	1600 MPa	1600 MPa
Elongation at Break	ASTM D638 Type I	282 %	900 %	282 %	286 %
Elongation at Yield	ASTM D638 Type I	5.5 %	21.2 %	5.2 %	5.1 %
Flexural Strength	ASTM D790	37 MPa	25 MPa	37 MPa	40 MPa
Flexural Modulus	ASTM D790	880 MPa	620 MPa	885 MPa	953 MPa
Izod Notched Impact	ASTM D256	41 J/m	32 J/m	36 J/m	36 J/m
Shore Hardness	ASTM D2240	66 D	60 D	66 D	66 D

### STRESS-STRAIN CURVE

The graph represents the stress-strain curve for DuraForm PAX Natural plastic per ASTM D638 testing.

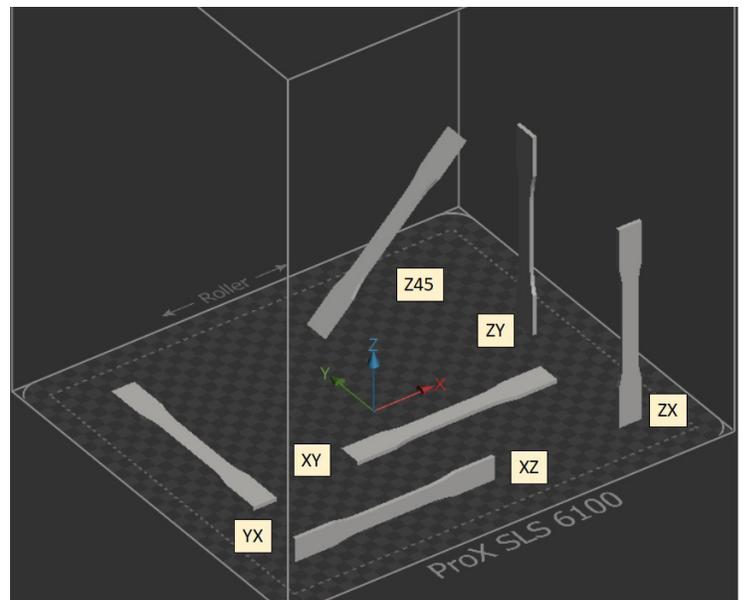
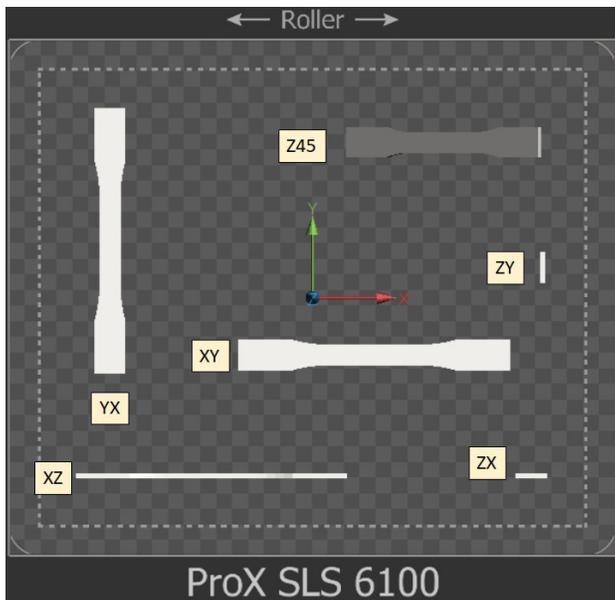


## ISOTROPIC PROPERTIES

Selective laser sintering 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 good isotropic behavior in mechanical properties, further improving the degree of freedom for part orientation for mechanical properties.

DURAFORM PAx NATURAL 30% FRESH							DURAFORM PAx NATURAL VAPOR HONED					
	METHOD	METRIC						METRIC				
MECHANICAL							MECHANICAL					
		XY	YX	XZ	ZY	Z45		XY	YX	XZ	ZY	Z45
Tensile Strength Ultimate	ASTM D638 Type I	40 MPa	38 MPa	41 MPa	40 MPa	39 MPa	ASTM D638 Type I	37 MPa	35 MPa	36 MPa	36 MPa	34 MPa
Tensile Strength at Yield	ASTM D638 Type I	40 MPa	38 MPa	41 MPa	40 MPa	39 MPa	ASTM D638 Type I	29 MPa	27 MPa	28 MPa	26 MPa	26 MPa
Tensile Modulus	ASTM D638 Type I	1300 MPa	1400 MPa	1500 MPa	1400 MPa	1400 MPa	ASTM D638 Type I	1300 MPa	1300 MPa	1400 MPa	1300 MPa	1200 MPa
Elongation at Break	ASTM D638 Type I	282 %	327 %	31 %	33 %	42 %	ASTM D638 Type I	900 %	950 %	41 %	46 %	482 %
Elongation at Yield	ASTM D638 Type I	5.5 %	5.5 %	5.4 %	5.9 %	6.9 %	ASTM D638 Type I	21.2 %	17.7 %	16 %	16.3 %	19.2 %
Flex Strength	ASTM D790	37 MPa	32 MPa	34 MPa	34 MPa	32 MPa	ASTM D790	25 MPa	23 MPa	25 MPa	25 MPa	25 MPa
Flex Modulus	ASTM D790	880 MPa	740 MPa	820 MPa	870 MPa	820 MPa	ASTM D790	620 MPa	540 MPa	600 MPa	620 MPa	590 MPa
Izod Notched Impact	ASTM D256	41 J/m	36 J/m	26 J/m	38 J/m	32 J/m	ASTM D256	32 J/m	33 J/m	25 J/m	24 J/m	30 J/m
Izod Unnotched Impact	ASTM D4812	Does Not Break	270 J/m	280 J/m	350 J/m	330 J/m	ASTM D4812	Does Not Break				
Shore Hardness	ASTM D2240	66 D	65 D	64 D	65 D	65 D	ASTM D2240	60 D	60 D	59 D	60 D	60 D

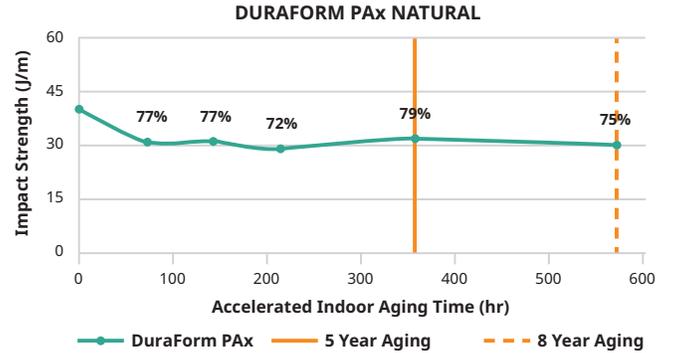
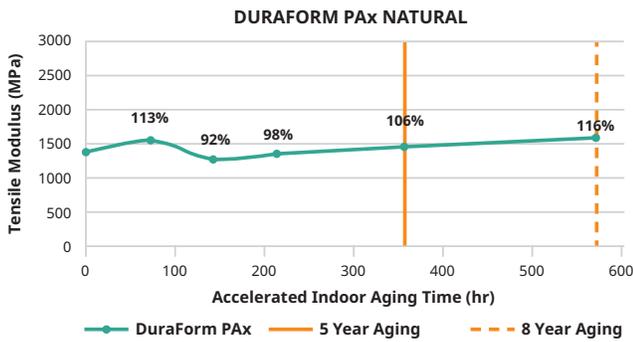
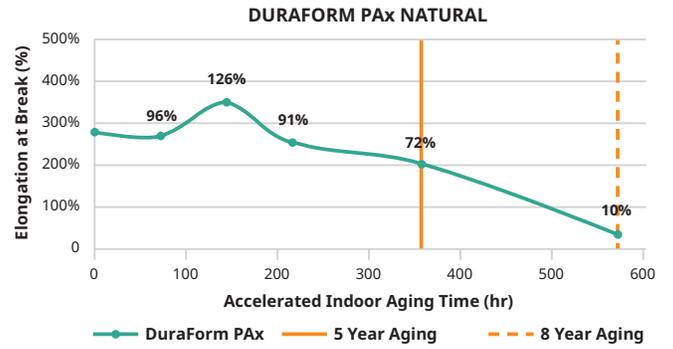
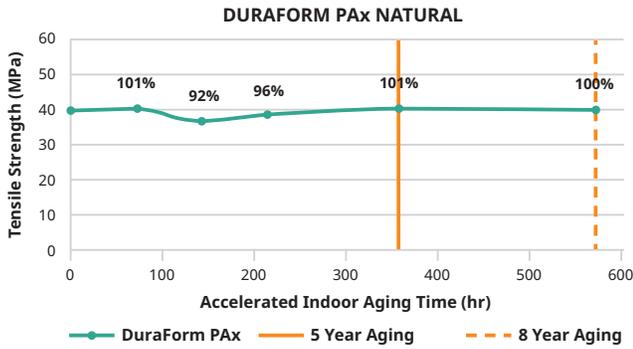


## LONG-TERM ENVIRONMENTAL STABILITY

DuraForm PAx Natural is engineered to give long-term environmental UV and humidity stability. This means the material is tested for the ability to retain a high percentage 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.**

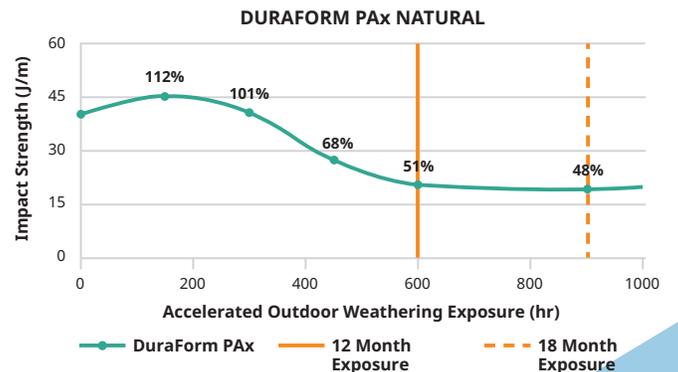
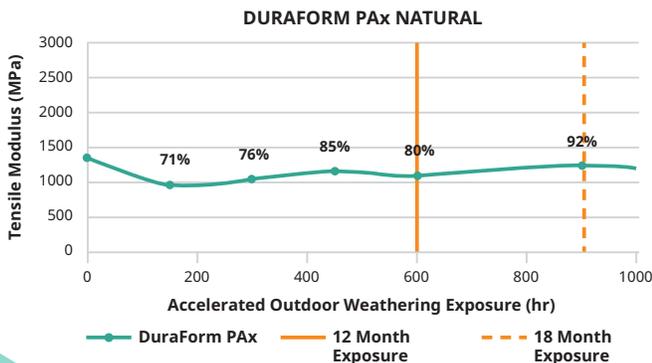
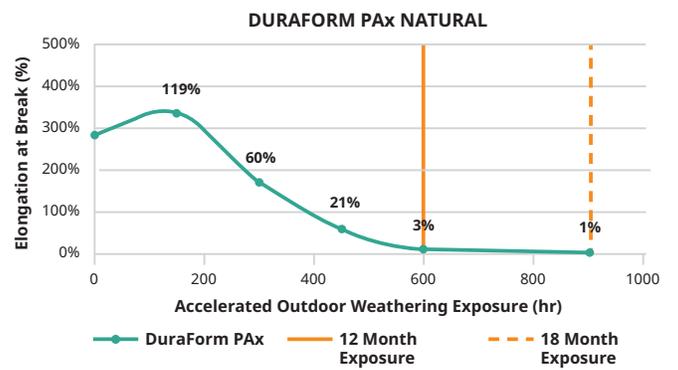
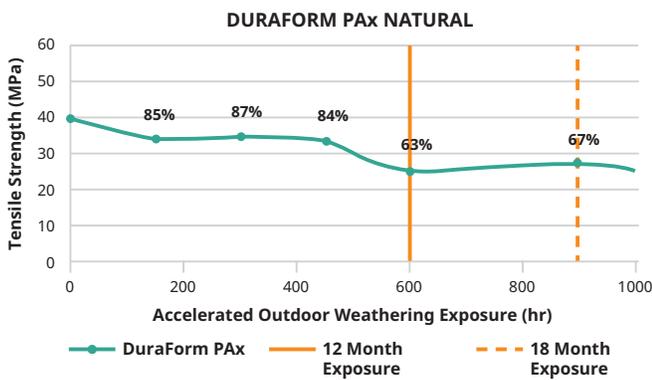
**INDOOR STABILITY:** Tested per ASTM D4329 standard method.

INDOOR STABILITY



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

OUTDOOR STABILITY



## AUTOMOTIVE FLUID COMPATIBILITY

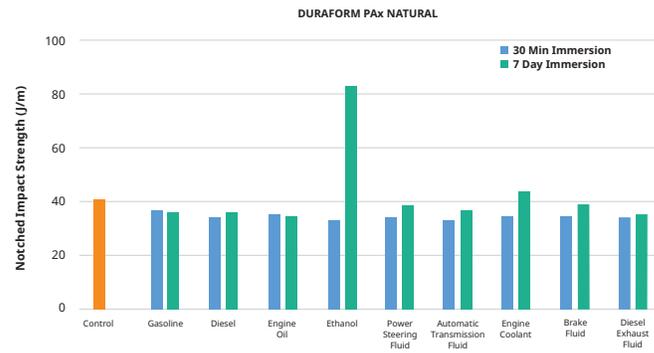
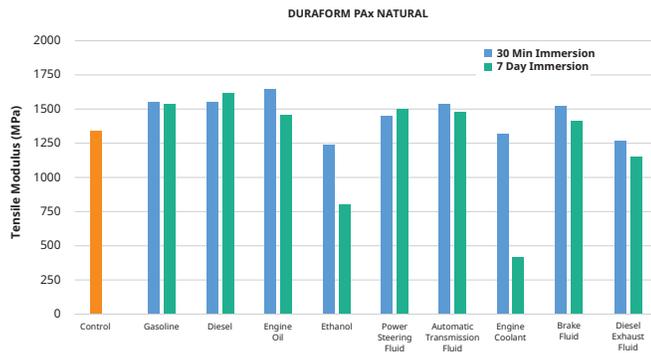
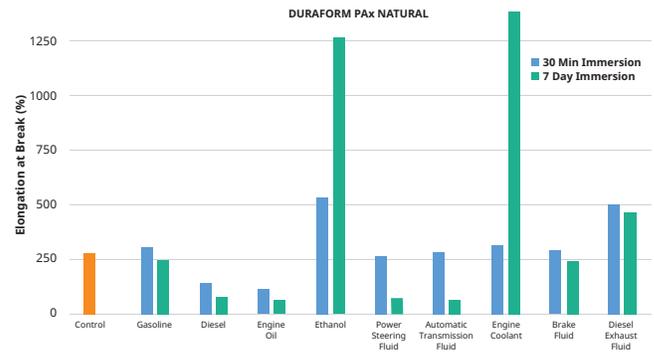
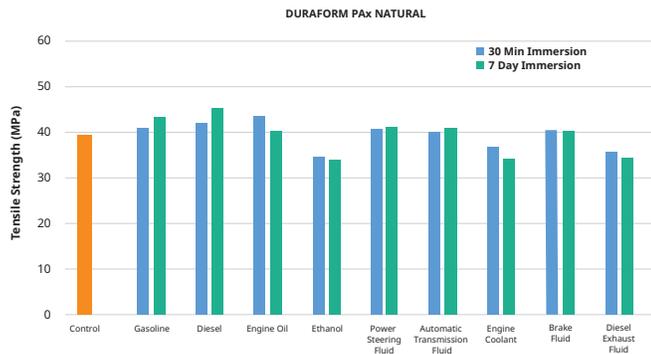
The compatibility of a material with hydrocarbons and cleaning chemicals is critical to part applications. DuraForm PAx Natural plastic parts have been tested for sealed and surface contact compatibility per USCAR2 test conditions. The fluids below were tested in two different ways per the specs.

- 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



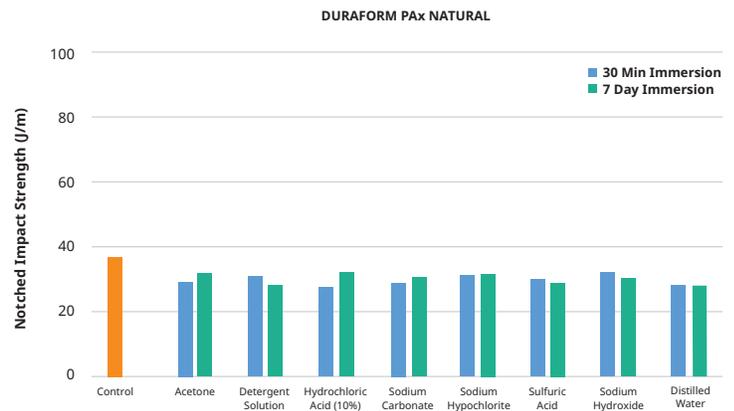
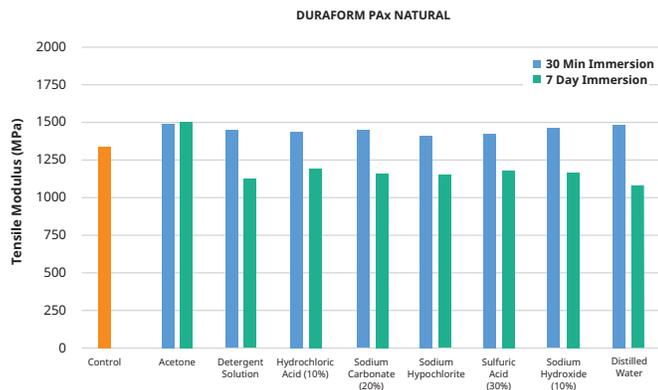
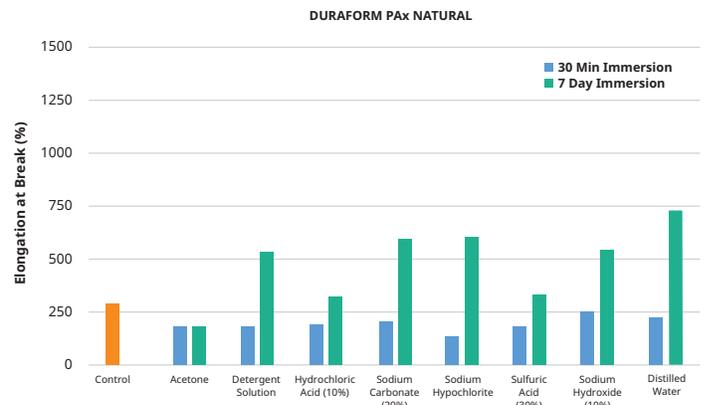
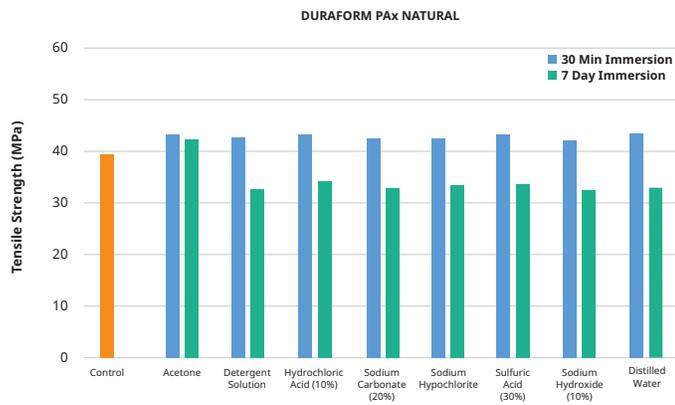
## CHEMICAL COMPATIBILITY

The compatibility of a material with cleaning chemicals is critical to part applications. DuraForm PAx Natural parts have been tested for sealed and surface contact compatibility per ASTM D543 test conditions. The fluids below were tested using two different methods per the specs.

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

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



## MEDICAL FLUID COMPATIBILITY

The compatibility of a material with disinfecting chemicals is critical to part applications. DuraForm PAX Natural parts have been tested for surface contact and prolonged compatibility per ASTM D543 test conditions. The fluids below were tested using two different methods per the specs.

- Immerse for 5-minutes, then take mechanical property data for comparison.
- Immerse for 30-minutes, then take mechanical property data for comparison.

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

## DISINFECTANTS CHEMICAL COMPATIBILITY

6.6.1 Quaternary ammonium compound (QAC) 0.8 % with isopropyl alcohol 60% by weight

6.6.3 Bleach, represented by 2 % sodium hypochlorite

6.6.4 Hydrogen peroxide, 5 % with benzyl alcohol 5 % by weight

6.6.6 70% Isopropyl alcohol

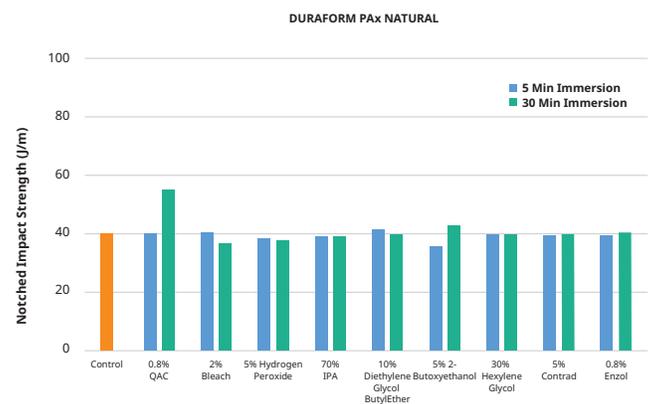
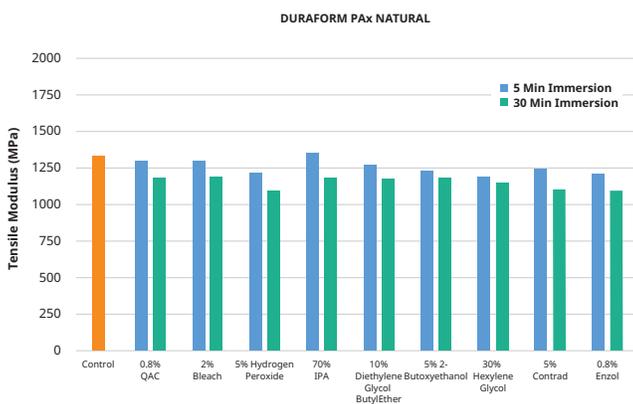
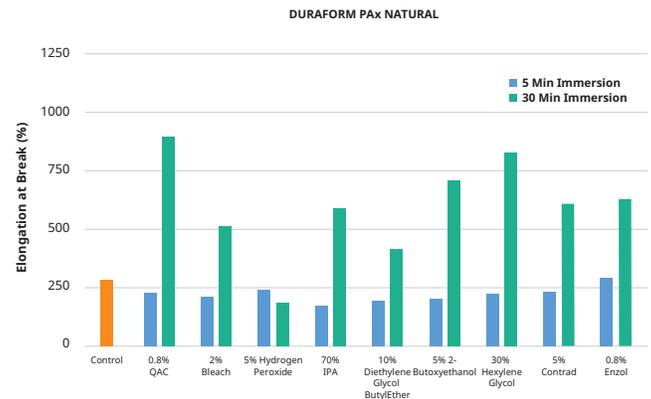
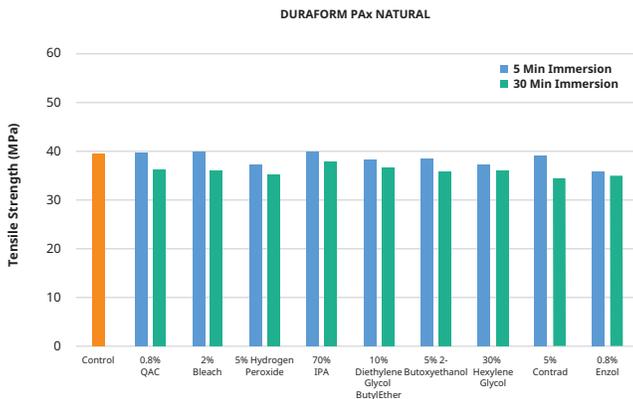
6.6.7 Diethylene glycol butyl ether, 10 %

6.6.8 2-butoxyethanol, 5 %

6.6.9 Hexylene glycol, 30 %

Contrad, 5%

Enzol, 0.8%



## BIOCOMPATIBILITY STATEMENT

DuraForm PAX Natural test coupons printed and processed according to the standard methods 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 DuraForm PAX Natural has passed the requirements for biocompatibility according to the above test.

It is the responsibility of each customer to determine that its use of DuraForm PAX Natural 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.

