DuraForm® PAx Black

Nylon Copolymer

Selective Laser Sintering (SLS)

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

DELIVER TOUGH, PRODUCTION-GRADE PARTS WITH HIGH ELONGATION, HIGH IMPACT RESISTANCE, AND LONG-TERM STABILITY

DuraForm PAx Black is a novel nylon copolymer that offers a unique combination of properties. It features high impact resistance with good isotropy, including a high elongation at break in all directions. Engineered for easy processing and high recyclability, DuraForm PAx Black is ideal for functional prototypes and long-term stable end-use parts.

The low printing temperatures of DuraForm PAx Black helps achieve parts in hand faster by shortening the cooling time prior to extracting parts from the unsintered powder. DuraForm PAx Black is easier on printers than comparable nylons and helps to reduce downtime associated with operator maintenance. With impressive long-term indoor stability of over five years, DuraForm PAx Black 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-smoothed parts improve smoothness and offer a sheen similar to injection molded plastics

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

3D SYSTEMS®

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 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.

DURAFORM PAX BLACK

SOLID MATERIAL						
METRIC	ASTM METHOD	METRIC	US	ISO METHOD	METRIC	US
	PHYSICAL				PHYSICAL	
Solid Density	ASTM D792	1.04 g/cm³	0.037 lb/in³	ISO 1183	1.04 g/cm³	0.037 lb/in³
24 Hour Water Absorption	ASTM D570	0.84 %	0.84%	ISO 62	0.84 %	0.84 %
	MECHANICAL				MECHANICAL	
Tensile Strength Ultimate	ASTM D638 Type IV	36 MPa	5200 psi	ISO 527 -1/2	38 MPa	5500 psi
Tensile Strength at Yield	ASTM D638 Type IV	36 MPa	5200 psi	ISO 527 -1/2	38 MPa	5500 psi
Tensile Modulus	ASTM D638 Type IV	1400 MPa	200 ksi	ISO 527 -1/2	1400 MPa	200 ksi
Elongation at Break	ASTM D638 Type IV	82.6 %	82.6 %	ISO 527 -1/2	60.7 %	60.7 %
Elongation at Yield	ASTM D638 Type IV	8.1 %	8.1 %	ISO 527 -1/2	4.9 %	4.9 %
Flexural Strength	ASTM D790	30 MPa	4400 psi	ISO 178	24 MPa	3400 psi
Flexural Modulus	ASTM D790	800 MPa	110 ksi	ISO 178	600 MPa	88 ksi
Izod Notched Impact	ASTM D256	35 J/m	0.6 ft-lb/in	ISO 180-A	4 J/m²	0.002 ft-lb/in²
Izod Unnotched Impact	ASTM D4812	Did not break	Did not break	ISO 180-U	Did not break	Did not break
Shore Hardness	ASTM D2240	74 D	74 D	ISO 7619	74 D	74 D
	THERMAL				THERMAL	
Tg (DMA E")	ASTM E1640	34 °C	94 °F	ISO 6721-1/11	34 °C	94 °F
HDT 0.455MPa/66PSI	ASTM D648	108 °C	227 °F	ISO 75- 1/2 B	93 °C	200 °F
HDT 1.82MPa/264 PSI	ASTM D648	45 °C	112 °F	ISO 75-1/2 A	42 °C	107 °F
CTE -10 TO 40C	ASTM E831	96 ppm/°C	54 ppm/°F	ISO 11359-2	96 ppm/°C	54 ppm/°F
CTE 60 TO 100C	ASTM E831	159 ppm/°C	88 ppm/°F	ISO 11359-2	159 ppm/°C	88 ppm/°F
UL Flammability	UL94	HB	HB			

MATERIAL PROPERTIES

DURAFORM PAX BLACK - VAPOR SMOOTHED

SOLID MATERIAL						
METRIC	ASTM METHOD	METRIC	US	ISO METHOD	METRIC	US
PHYSICAL				PHYSICAL		
Solid Density	ASTM D792	1.05 g/cm³	0.038 lb/in³	ISO 1183	1.05 g/cm³	0.038 lb/in³
24 Hour Water Absorption	ASTM D570	0.4 %	0.4%	ISO 62	0.4 %	0.4 %
MECHANICAL				MECHANICAL		
Tensile Strength Ultimate	ASTM D638 Type IV	32 MPa	4600 psi	ISO 527 -1/2	33 MPa	4800 psi
Tensile Strength at Yield	ASTM D638 Type IV	28 MPa	4100 psi	ISO 527 -1/2	33 MPa	4800 psi
Tensile Modulus	ASTM D638 Type IV	800 MPa	120 ksi	ISO 527 -1/2	1200 MPa	170 ksi
Elongation at Break	ASTM D638 Type IV	665 %	665 %	ISO 527 -1/2	25.4 %	25.4 %
Elongation at Yield	ASTM D638 Type IV	28.4 %	28.4 %	ISO 527 -1/2	15.8 %	15.8 %
Flexural Strength	ASTM D790	27 MPa	4000 psi	ISO 178	27 MPa	4000 psi
Flexural Modulus	ASTM D790	670 MPa	100 ksi	ISO 178	800 MPa	110 ksi
Izod Notched Impact	ASTM D256	36 J/m	0.7 ft-lb/in	ISO 180-A	37 J/m²	0.0177 ft-lb/in²
Izod Unnotched Impact	ASTM D4812	Did not break	Did not break	ISO 180-U	Did not break	Did not break
Shore Hardness	ASTM D2240	70 D	70 D	ISO 7619	70 D	70 D
THERMAL				THERMAL		
HDT 0.455MPa/66PSI	ASTM D648	100 °C	213 °F	ISO 75- 1/2 B	88 °C	190 °F

DURAFORM PAX BLACK

ASTM PROPERTIES - 5 CONDITIONS						
METRIC	METHOD	SLS 380	SPRO60	PROX 6100	DOUBLE SCAN	VAPOR SMOOTHED
Solid Density g/cm³	ASTM D792	1.04 g/cm³	1.04 g/cm³	1.01 g/cm³	1.03 g/cm³	1.05 g/cm³
Tensile Strength Ultimate (MPa)	ASTM D638 Type I	36 MPa	40 MPa	31 MPa	34 MPa	32 MPa
Tensile Strength at Yield (MPa)	ASTM D638 Type I	36 MPa	40 MPa	31 MPa	34 MPa	28 MPa
Tensile Modulus (MPa)	ASTM D638 Type I	1400 MPa	1500 MPa	1200 MPa	1200 MPa	800 MPa
Elongation at Break (%)	ASTM D638 Type I	82.6 %	96 %	54 %	136 %	665 %
Elongation at Yield (%)	ASTM D638 Type I	8.1 %	4.8 %	9.5 %	19.3 %	28.4 %
Flex Strength (MPa)	ASTM D790	30 MPa	34 MPa	28 MPa	22 MPa	27 MPa
Flex Modulus (MPa)	ASTM D790	800 MPa	812 MPa	672 MPa	535 MPa	670 MPa
Izod Notched Impact (J/m)	ASTM D256	35 J/m	37 J/m	35 J/m	40 J/m	36 J/m
Izod unnotched impact (J/m)	ASTM D4812	Did not break	Did not break	284 J/m	Did not break	Did not break
HDT @ 0.455MPa/66PSI	ASTM D648	108 °C	107 °C	67 °C	82 °C	100 °C
HDT @ 1.82MPa/264 PSI	ASTM D648	45 °C	44° C	25 °C	44 °C	
Shore Hardness	ASTM D2240	74 D	74 D	72 D	69 D	70 D
24 Hour water absorption (%)	ASTM D570	0.84 %	1.06 %	2.13 %	1.38 %	0.4 %
CTE below Tg (ppm/C)	ASTM E831	96 ppm/°C	101 ppm/°C	84 ppm/°C	103 ppm/°C	
CTE above Tg (ppm/C)	ASTM E831	159 ppm/°C	206 ppm/°C	139 ppm/°C	188 ppm/°C	
Tg (DMA, E")	ASTM E1640	34 °C				

ISOTROPIC PROPERTIES

Selective laser sintering 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.

DURAFORM PAX BLACK - SLS 380

SOLID MATERIAL					
MECHANICAL					
METRIC	METHOD	XY	Z45	ZX	ZY
Tensile Strength Ultimate	ASTM D638 Type 1	36 MPa	35 MPa	37 MPa	33 MPa
Tensile Strength at Yield	ASTM D638 Type 1	36 MPa	35 MPa	37 MPa	33 MPa
Tensile Modulus	ASTM D638 Type 1	1400 MPa	1300 MPa	1400 MPa	1200 MPa
Elongation at Break	ASTM D638 Type 1	82.6 %	31 %	22.7 %	32.7 %
Elongation at Yield	ASTM D638 Type 1	8.1 %	9.5 %	5 %	17 %
Flex Strength	ASTM D790	30 MPa	30 MPa	31 MPa	22 MPa
Flex Modulus	ASTM D790	800 MPa	800 MPa	800 MPa	600 MPa
Izod Notched Impact	ASTM D256	35 J/m	34 J/m	33 J/m	29 J/m
Izod unnotched impact	ASTM D4812	Did not break	395 J/m	202 J/m	241 J/m

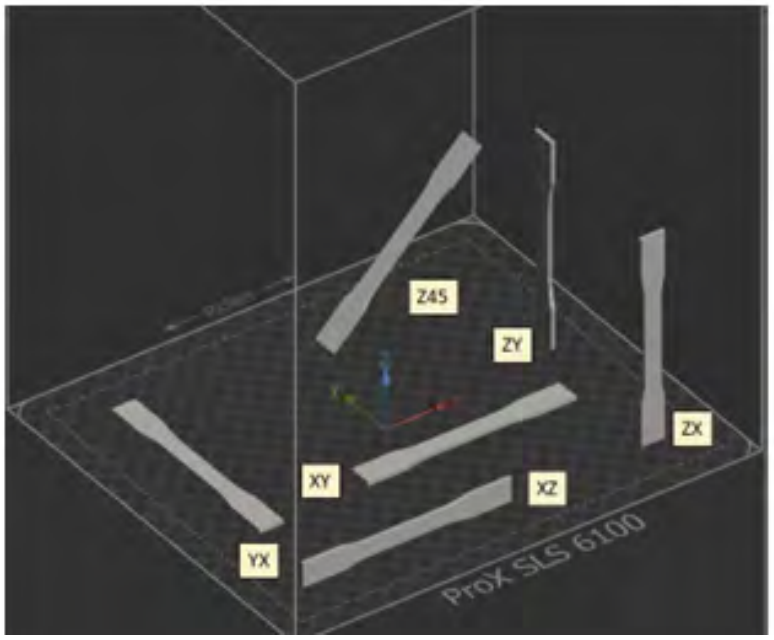
DURAFORM PAX BLACK - DOUBLE SCAN

SOLID MATERIAL					
MECHANICAL					
METRIC	METHOD	XY	Z45	ZX	ZY
Tensile Strength Ultimate	ASTM D638 Type 1	34 MPa	33 MPa	34 MPa	32 MPa
Tensile Strength at Yield	ASTM D638 Type 1	34 MPa	33 MPa	34 MPa	32 MPa
Tensile Modulus	ASTM D638 Type 1	1200 MPa	1100 MPa	1200 MPa	1100 MPa
Elongation at Break	ASTM D638 Type 1	136 %	53 %	24.4 %	29.2 %
Elongation at Yield	ASTM D638 Type 1	19.3 %	21.7 %	16 %	16 %
Flex Strength	ASTM D790	22 MPa	24 MPa	25 MPa	25 MPa
Flex Modulus	ASTM D790	535 MPa	600 MPa	700 MPa	600 MPa
Izod Notched Impact	ASTM D256	40 J/m	34 J/m	32 J/m	30 J/m
Izod unnotched impact	ASTM D4812	Did not break	545 J/m	271 J/m	258 J/m

ISOTROPIC PROPERTIES

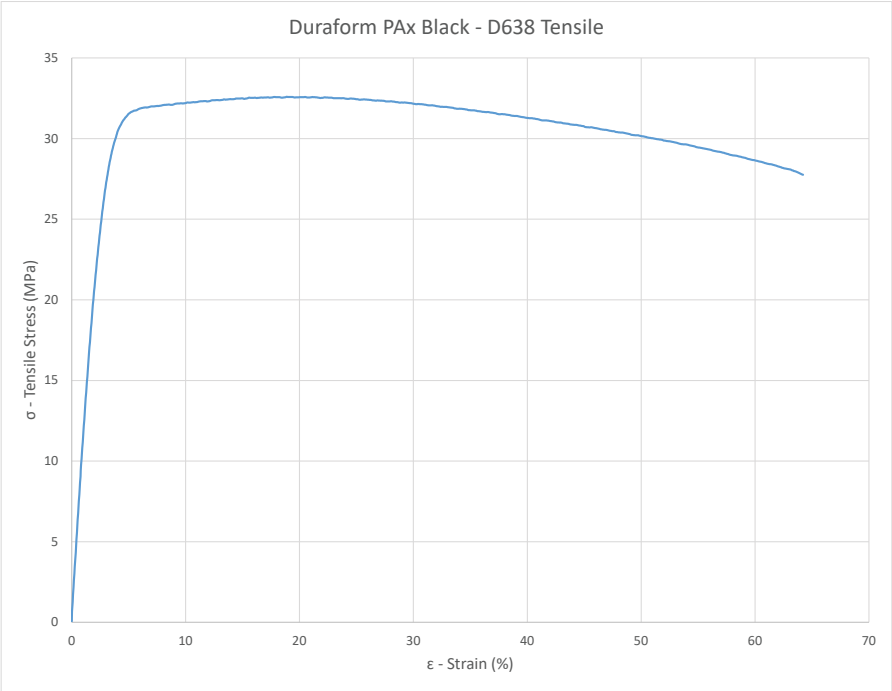
DURAFORM PAX BLACK - VAPOR SMOOTHED

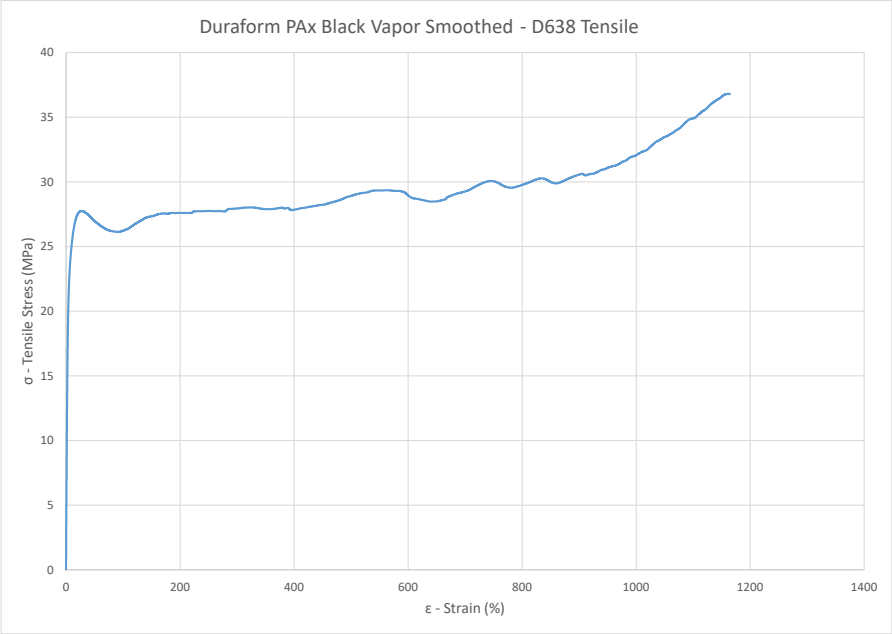
SOLID MATERIAL					
MECHANICAL					
METRIC	METHOD	XY	Z45	ZX	ZY
Tensile Strength Ultimate	ASTM D638 Type 1	32 MPa	28 MPa	34 MPa	31 MPa
Tensile Strength at Yield	ASTM D638 Type 1	28 MPa	28 MPa	34 MPa	31 MPa
Tensile Modulus	ASTM D638 Type 1	800 MPa	800 MPa	1100 MPa	1100 MPa
Elongation at Break	ASTM D638 Type 1	665 %	72 %	34.3 %	38.9 %
Elongation at Yield	ASTM D638 Type 1	28.4 %	40.4 %	25 %	19 %
Flex Strength	ASTM D790	27 MPa	23 MPa	29 MPa	20 MPa
Flex Modulus	ASTM D790	670 MPa	600 MPa	700 MPa	500 MPa
Izod Notched Impact	ASTM D256	36 J/m	40 J/m	29 J/m	33 J/m
Izod unnotched impact	ASTM D4812	Did not break	Did not break	Did not break	Did not break



STRESS-STRAIN CURVE

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



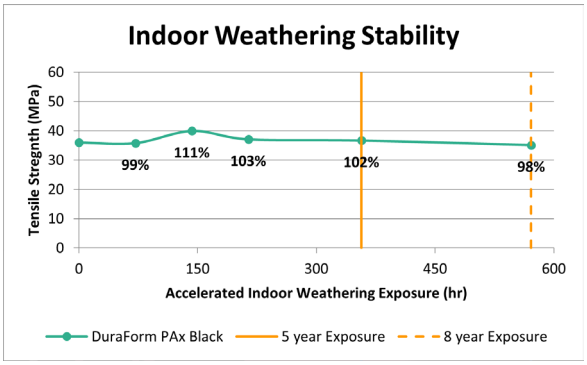


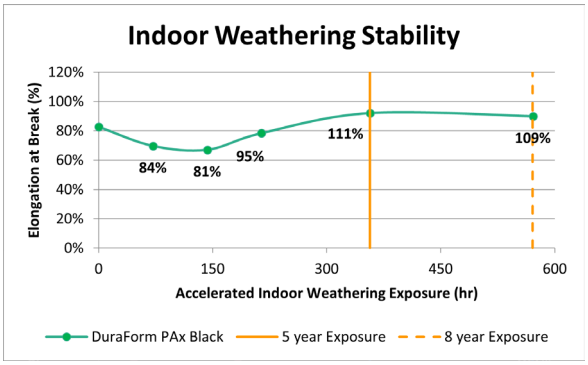
LONG-TERM ENVIRONMENTAL STABILITY

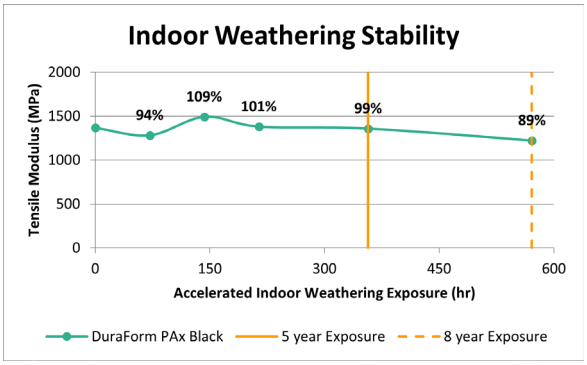
DuraForm PAx Black is engineered to give long term environmental UV and humidity stability. This means the material is tested for the ability to retain a high percent of the initial mechanical properties over a given period of time. This provides real design conditions to consider for the application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

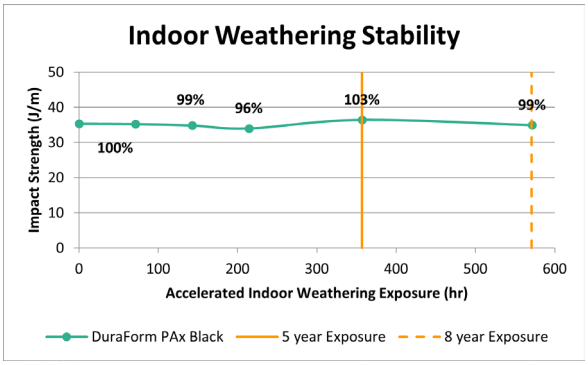
INDOOR STABILITY

INDOOR STABILITY: Tested per ASTM D4329 standard method.



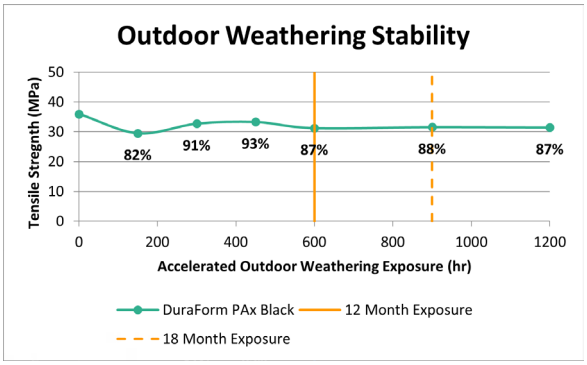


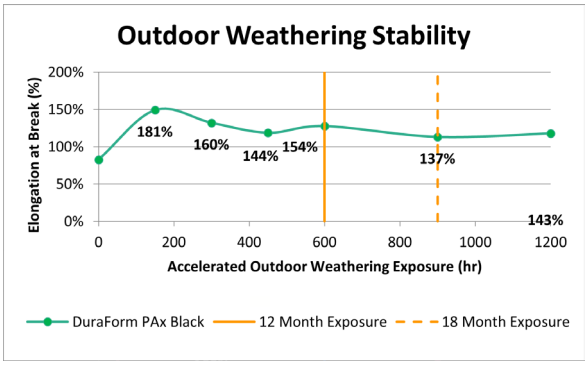


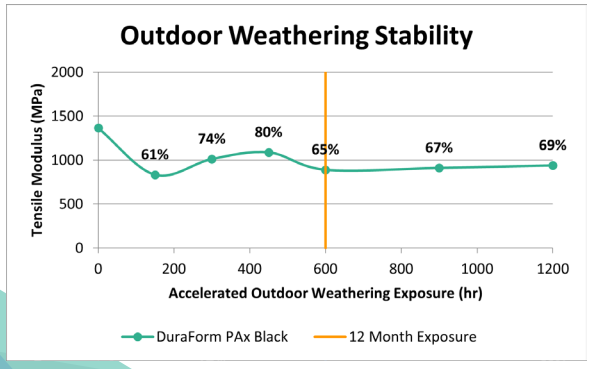


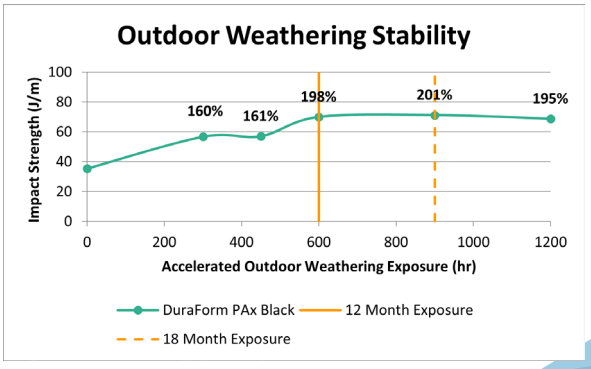
OUTDOOR STABILITY

OUTDOOR STABILITY: Tested per ASTM G154 standard method.









AUTOMOTIVE FLUID COMPATIBILITY

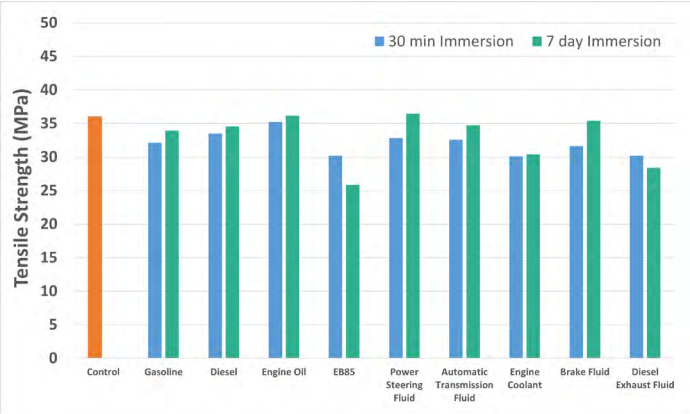
The compatibility of a material with hydrocarbons and cleaning chemicals is critical to part application. DuraForm PAx Black parts were tested for sealed and surface contact compatibility per USCAR2 test conditions. The fluids below were tested in two different ways per the specs.

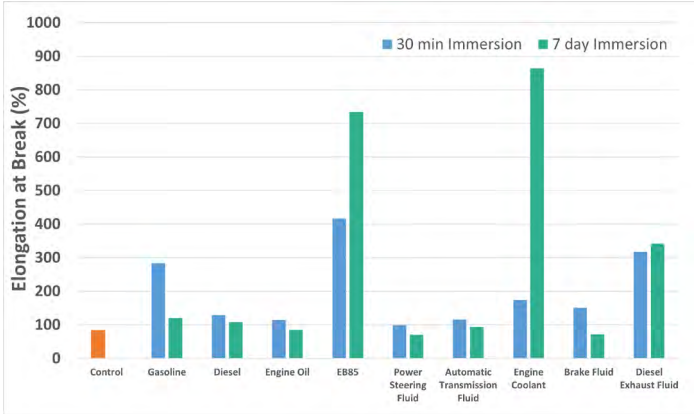
- Immerse for 7 days, then take mechanical property data for comparison.
- Immerse for 30 minutes, remove, and take mechanical property data for comparison in 7 days

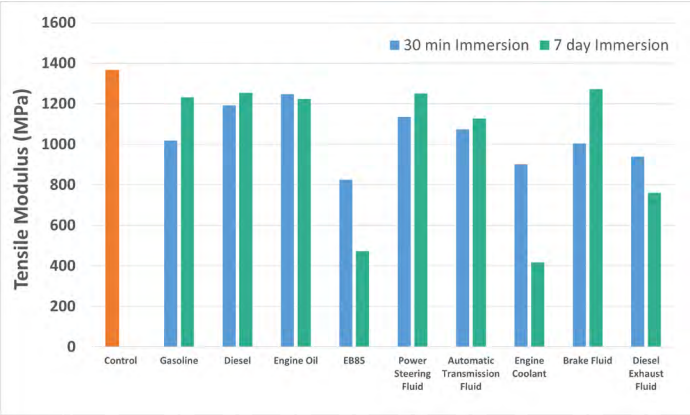
Data reflects the measured value of properties over that period of time.

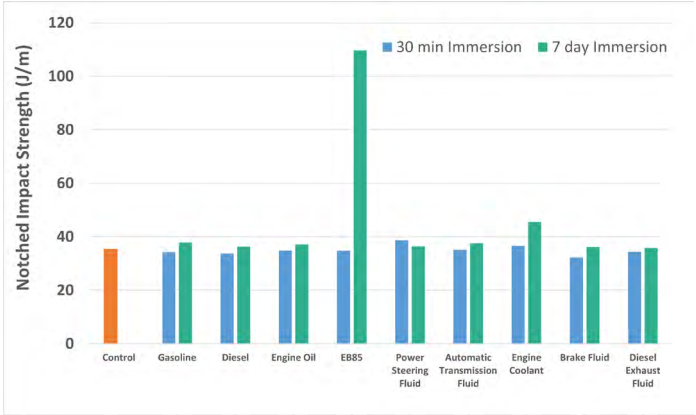
AUTOMOTIVE FLUIDS		
FLUID	**SPECIFICATION**	**TEST TEMP °C**
Gasoline	ISO 1817, liquid C	23 ± 5
Diesel Fuel	905 ISO 1817, Oil No. 3 + 10% p-xylene*	23 ± 5
Engine Oil	ISO 1817, Oil No. 2	50 ± 3
Ethanol	85% Ethanol + 15% ISO 1817 liquid C*	23 ± 5
Power Steering Fluid	ISO 1917, Oil No. 3	50 ± 3
Automative 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









CHEMICAL COMPATIBILITY

The compatibility of a material with cleaning chemicals is critical to part application. DuraForm PAx Black 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.

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