EPU 41

EPU 41 is a production-grade elastomeric material that is especially well-suited for elastomeric lattices where high resiliency is needed.

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EPU 41 Black

Tensile Properties	Test Standard	Metric	US
Tensile Modulus	ASTM D412 Die C 500 mm/min	8 MPa	1160 psi
Elongation at Break		300%	300%
Stress at 50% Elongation		2 MPa	290 psi
Stress at 100% Elongation		4 MPa	580 psi
Stress at 200% Elongation		9 MPa	1300 psi
Ultimate Tensile Strength		15 MPa	2200 psi

Other Mechanical Properties	Test Standard	Metric	US
Tear Strength	ASTM D624 Die C (die cut)	20 kN/m	110 lbf/in
Compression Set	ASTM D395-B 23 °C, 72 h	30%	

Thermal Properties	Test Standard	Metric	US
T_g (DMA, tan(d))	ASTM D4065	-10 °C	14 °F

General Properties	Test Standard	
Shore A Hardness	ASTM D2240	71 (Instant), 70 (5 sec)
Density	ASTM D792	1.03 g/cm^3

Parts were processed using an M series printer and a Smart Part Washer with DPM as the solvent, followed by isopropanol dunk. The washed test articles were baked following the standard baking schedule for EPU 41.

EPU 41 Black

Liquid Properties	
Liquid Density (Part A)	0.99 g/mL
Liquid Density (Part B)	0.94 g/mL
Liquid Density (Part A+B)	0.99 g/mL
Part A:B Volume Ratio (Mass Ratio)	12.4 (13.0)
25 °C Viscosity (Part A)	9900 cP
25 °C Viscosity (Part B)	80 cP
25 °C Viscosity (Part A+B)	8000 cP

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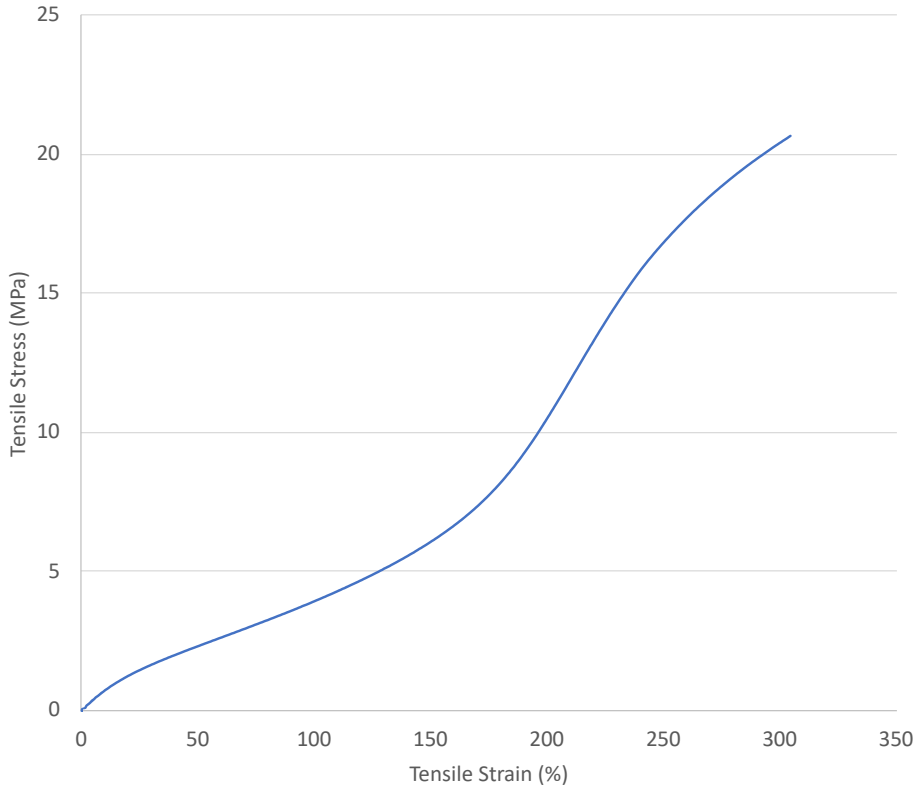
EPU 41

Extended TDS

EPU 41 Black Mechanical Properties

Representative Tensile Curve

ASTM D412, Die C, 500 mm/min



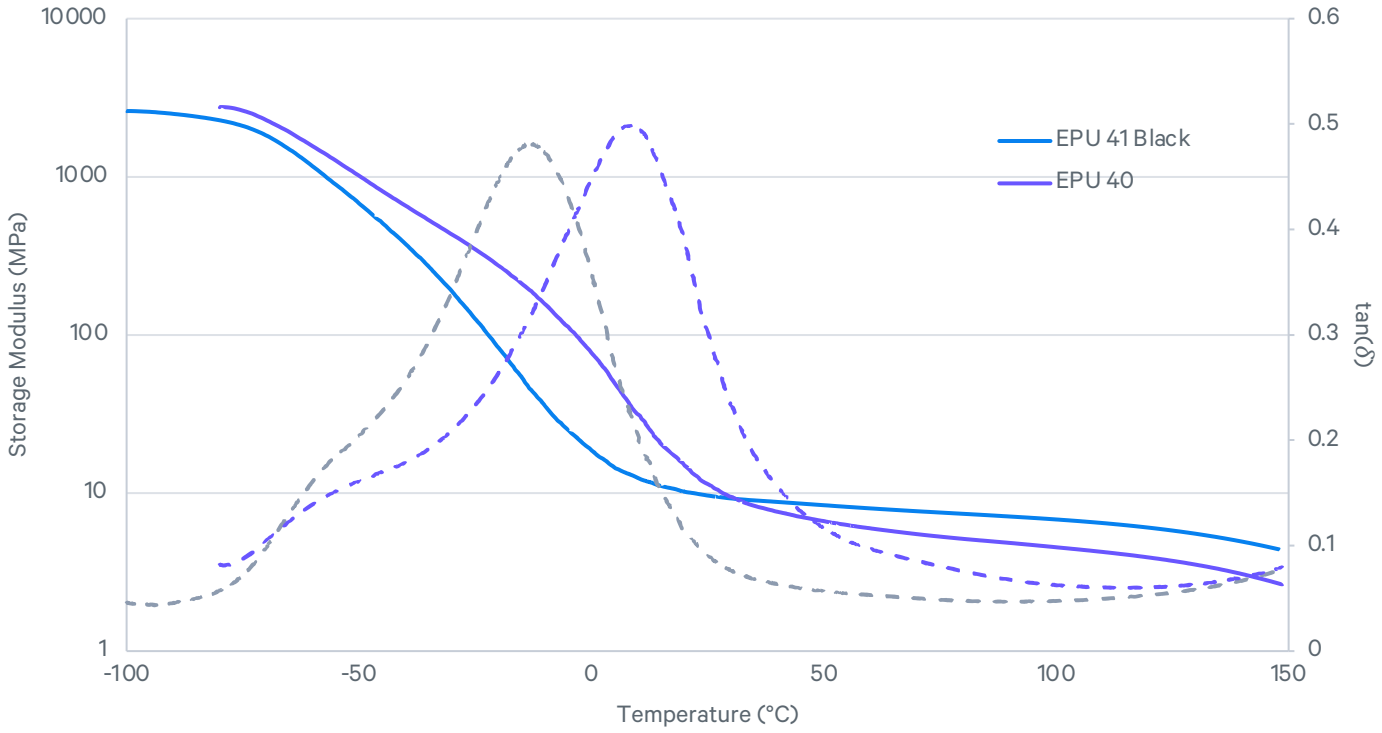
Dynamic Mechanical Analysis (DMA)

EPU 41 Black vs. EPU 40

EPU 41 Black has improved cold temperature performance compared to EPU 40. EPU 41 Black has lower T_g (tan(δ) peak), indicating retention of elastomeric properties down to colder temperatures.

EPU 41 T_g (tan(δ)) = -10 °C

EPU 40 T_g (tan(δ)) = 10 °C



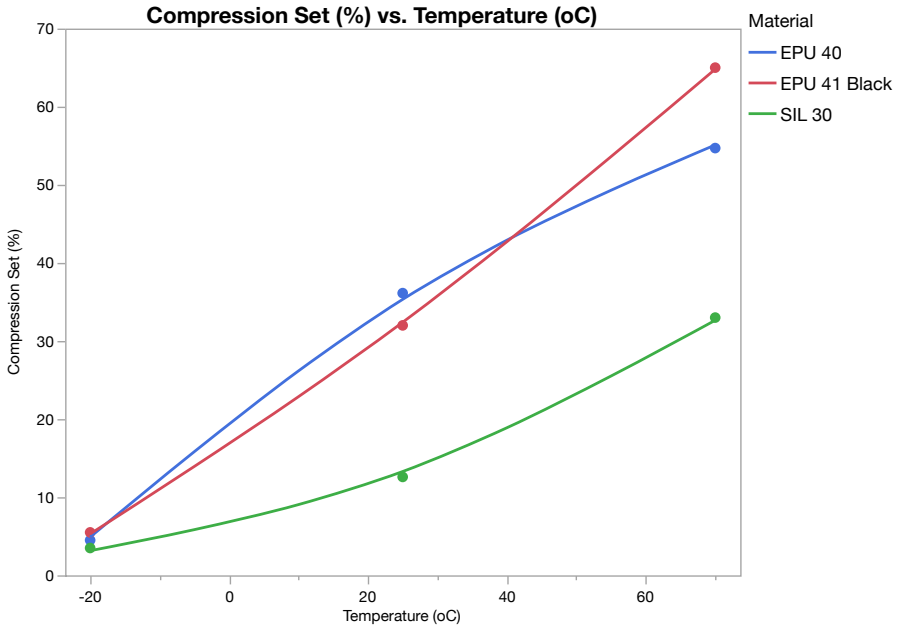
ASTM D4065

Q800 Tension Mode, Ramp Rate 2 °C/min, 1 Hz, 0.1% strain

Samples were post processed using a Smart Part Washer with DPM as the solvent, followed by isopropanol dunk.

EPU 41 Black Compression Set

In many elastomeric applications, compression set is an important property that reflects the amount of residual deformation after holding compression at a fixed time, temperature, and displacement. EPU 40, EPU 41 Black, and SIL 30 were compressed to 25% of its original sample height and held at various temperatures (-20, 25, and 70 °C) for 72 hours. The compression set measurement is the residual deformation of a test specimen where 0% represents full recovery of the original thickness and 100% indicates no recovery. The image below summarizes the compression set results for various Carbon elastomers.



ASTM D395-B

EPU 41 Green

Tensile Properties	Test Standard	Metric	US
Tensile Modulus	ASTM D412 Die C 500 mm/min	6 MPa	870 psi
Elongation at Break		250%	250%
Stress at 50% Elongation		3 MPa	440 psi
Stress at 100% Elongation		5 MPa	730 psi
Stress at 200% Elongation		9 MPa	1300 psi
Ultimate Tensile Strength		15 MPa	2200 psi

Other Mechanical Properties	Test Standard	Metric	US
Tear Strength	ASTM D624 Die C (die cut)	20 kN/m	110 lbf/in
Compression Set	ASTM D395-B, 23 °C, 72 h	30%	
Bayshore Rebound Resilience	ASTM D2632	30%	
Ross Flexing Fatigue (Notched), 23 °C	Based on ASTM D1052 60° bending 100 cycles/min 2 mm thickness	> 50,000 cycles (no crack propagation)	
Ross Flexing Fatigue (Notched), -10 °C		> 40,000 cycles (no crack propagation)	

Thermal Properties	Test Standard	Metric	US
T_g (DMA, tan(d))	ASTM D4065	-10 °C	14 °F

Dielectric/Electric Properties	Test Standard	
Dielectric Constant	ASTM D150	5
Dissipation Factor		0.03
Dielectric Strength	ASTM D149	17 kV/mm
Volume Resistivity	ASTM D257	3.1 x 10^{11} ohm-cm

General Properties	Test Standard	
Shore A Hardness	ASTM D2240	72 (Instant), 71 (5 sec)
Bulk Density	ASTM D792	1.03 g/mL
Relative Abrasion Volume Loss	ISO-4649 A	70 mm^3

Parts were processed using an M series printer and a Smart Part Washer with DPM as the solvent, followed by isopropanol dunk. The washed test articles were baked following the standard baking schedule for EPU 41.

Liquid Properties	
Liquid Density (Part A)	0.99 g/mL
Liquid Density (Part B)	0.94 g/mL
Liquid Density (Part A+B)	0.99 g/mL
Part A:B Volume Ratio (Mass Ratio)	12.4 (13.0)
25 °C Viscosity (Part A)	9900 cP
25 °C Viscosity (Part B)	80 cP
25 °C Viscosity (Part A+B)	8000 cP

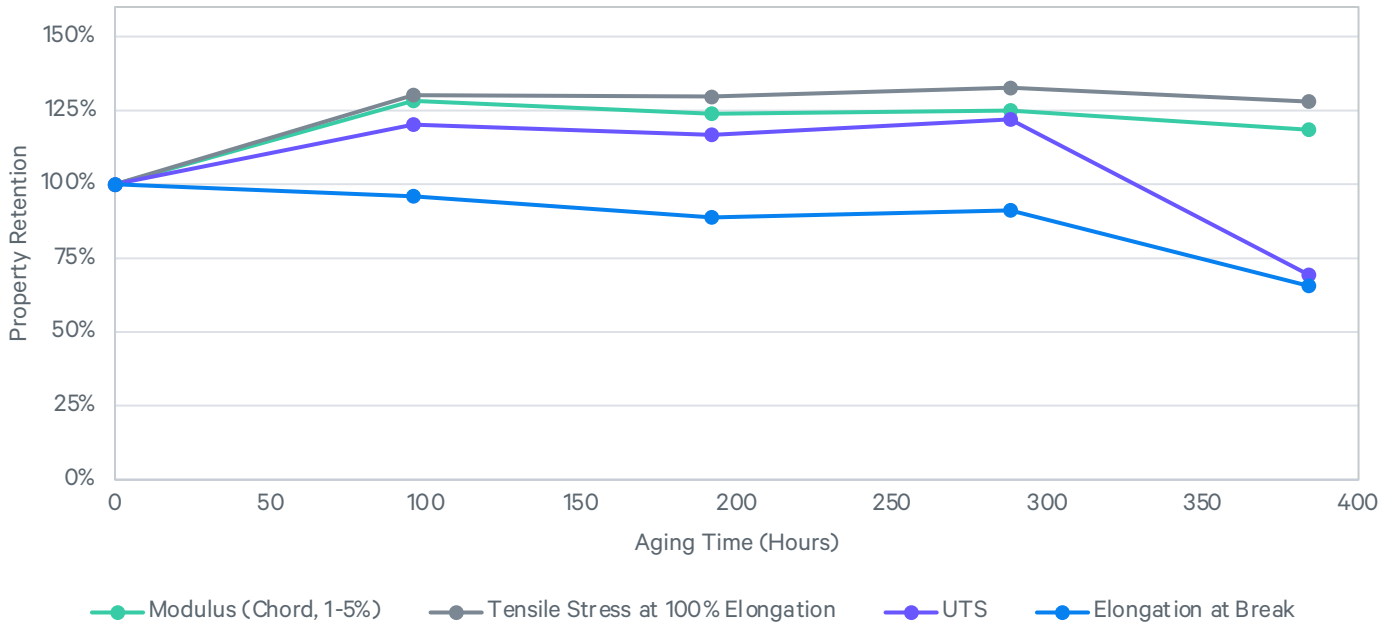
EPU 41 Green Chemical Compatibility

	Mass Gain* (%)
Household Chemicals	
Bleach (NaClO, 5%)	< 5%
Sanitizer (NH_4Cl, 10%)	< 5%
Distilled Water	< 5%
Sunscreen (Banana Boat, SPF 50)	> 30%
Detergent (Tide, Original)	5 - 15%
Windex Powerized Formula	5 - 15%
Hydrogen Peroxide (30%)	15 - 30%
Ethanol (95%)	> 30%
Industrial Fluids	
Engine Oil (Havoline SAE 5W-30)	< 5%
Brake Fluid (Castrol DOT-4)	15 - 30%
Transmission Fluid (Havoline Synthetic ATF)	5 - 15%
Engine Coolant (Havoline XLC, 50%/50% premixed)	< 5%
Diesel (Chevron #2)	> 30%
Skydrol 500B-4	> 30%
Strong Acid/Base	
Sulfuric Acid (30%)	15 - 30%
Sodium Hydroxide (10%)	< 5%

*Percent weight gained after one week submersion following ASTM D543. Values do not represent changes in dimension or mechanical properties.

EPU 41 Green UV Aging

Natural polymer aging can occur in the presence of light, sun, and heat. Carbon evaluated the UV aging performance of EPU 41 using ASTM D4459, which is intended to simulate indoor exposure of solar radiation through glass.



ASTM D4459: Q-Sun XE-1, 0.8 W/m^2/nm at 420 nm, 55 °C
ASTM D412: Die C, 500 mm/min, average values represented

Color Fastness

After UV Aging

EPU 41 Green has excellent color fastness after UV aging. Color change is calculated from L*a*b* values measured by colorimeter.

Color change after UV aging, dE = 0.7

ISO 4892-1/4892-2: Xenon-arc lamp, UV-Quartz filter, 1.2 W/m^2/nm, at 420 nm, 70 °C, 6 hours

EPU 41 Biocompatibility

Biocompatibility Testing

Test articles in the form of printed parts were provided to NAMSA for evaluation and met the requirements of the following tests:

Biocompatibility Testing	Test Standard
Cytotoxicity (VF1 washed)*	ISO 10993-5: Biological evaluation of medical devices – Part 5: Tests for *in vitro* cytotoxicity (MEM extract)
Cytotoxicity (DPM washed)**	ISO 10993-5: Biological evaluation of medical devices – Part 5: Tests for *in vitro* cytotoxicity (MEM extract)
Sensitization***	ISO 10993-10: Biological evaluation of medical devices – Part 10: Tests for skin sensitization (Closed patch sensitization study in guinea pigs)
Irritation***	ISO 10993-23: Biological evaluation of medical devices – Part 23: Tests for irritation (Intracutaneous study in rabbits)

*Test articles were processed using an M series printer and a Smart Part Washer with VF1 as the solvent. The washed test articles were baked following the standard baking schedule for EPU 41: 120 °C for 8 hours.
**Test articles were processed using an M series printer and a Smart Part Washer with DPM as the solvent, followed by isopropanol dunk. The washed test articles were baked following the standard baking schedule for EPU 41: 120 °C for 8 hours.
***Test articles were processed using an L series printer and a centrifugal spinner. The cleaned test articles were baked following the standard baking schedule for EPU 41: 120 °C for 8 hours.
Additional details about the tests are available upon request.

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