RPU 130

RPU 130 is a strong and tough engineering polyurethane offering a unique combination of durability, impact resistance, and performance at elevated temperatures.

Tensile Properties ASTM D638, Type I, 50mm/min	**Metric**	**US**
Tensile Modulus	990 MPa	140 ksi
Yield Strength	28 MPa	4.1 ksi
Strain at Yield	9.6%	9.6%
Ultimate Tensile Strength	34 MPa	4.9 ksi
Elongation at Break	> 50%	> 50%

Tensile Properties ASTM D638, Type V, 10mm/min	**Metric**	**US**
Tensile Modulus	920 MPa	133 ksi
Yield Strength	27 MPa	3.9 ksi
Strain at Yield	10%	10%
Ultimate Tensile Strength	35 MPa	5.1 ksi
Elongation at Break	>50%	> 50%

Flexural Properties ASTM D790-B	**Metric**	**US**
Flexural Stress at 5 % strain	35 MPa	5.1 ksi
Flexural Modulus (Chord, 0.5-1%)	890 MPa	130 ksi

Impact Properties	**Metric**	**US**
Gardner Impact, ASTM D5420	> 30 J	> 22 ft-lb
Notched Charpy (Machined Notch), ISO 179-1/1eA	10 kJ/m^2	4.8 $ft\text{-}lb/in^2$
Notched Izod (Machined Notch), ASTM D256	76 J/m	1.4 ft-lb/in

Thermal Properties	**Metric**	**US**
Heat Deflection Temperature @ 0.455 MPa/66 psi, ASTM D648	119 °C	246 °F
Heat Deflection Temperature @ 1.82 MPa/264 psi, ASTM D648	54 °C	129 °F

NOTES—Results in this data sheet are representative of specific sample generation and testing processes and may vary if the established protocols are not followed. Contact Carbon for the specific process used to generate the test samples to determine each of these values. Tensile and flexural data had a sample size of n=7+/-1; impact data used 10 specimens. Average values are used, unless otherwise noted. Parts were processed using an M-series printer and a Smart Part Washer using DPM as solvent.

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General Properties	
Hardness, ASTM D2240	100, Shore D
Density, ASTM D792	1.069 g/cm^3
Density (liquid)	1.026 g/cm^3
Taber Abrasion, ASTM D4060, CS-17, 1 kg, 100 % vacuum	8.9mg / 1000 cycles
Water Absorption, Short Term (24 hours) ASTM D570	1.8%
Water Absorption, Long Term (14 Days) ASTM D570	5.2%

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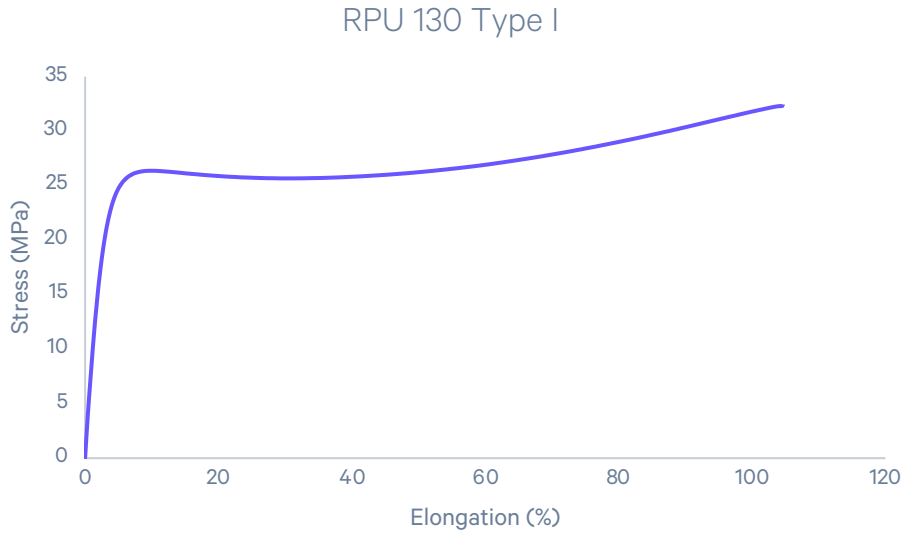
RPU 130

Extended TDS

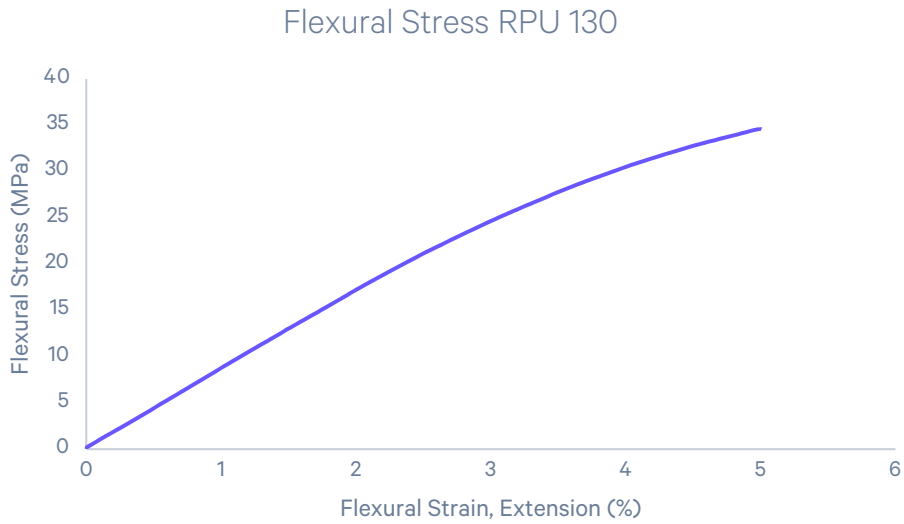
Basic Mechanical Properties

Typical Stress-strain Curve

For Type I Dogbones.



Typical Flex Curve



Thermal Degradation/Aging of RPU 130

RPU 130 was designed to be more thermally resistant than our previous polyurethane offerings. To evaluate this, we subjected RPU 130 to various temperature conditions and monitored the effect of temperature over time. Tensile characteristics from Type I dogbones per ASTM D638 were evaluated along with impact properties based on notched Charpy bars tested per ISO 179. Three temperature conditions were tested: 40°C, 85°C, and 105°C. The longest time period tested was 864 hours. Samples were exposed to elevated temperatures within an enclosed oven in a lab setting.

At 40°C (Figure 1), mechanical characteristics are unchanged out to 864 hours.

At 85°C (Figure 2), RPU 130 exhibits >60% retention after 864 hours of exposure.

At 105°C (Figure 3), RPU 130 exhibits >50% retention after 168 hours of exposure.

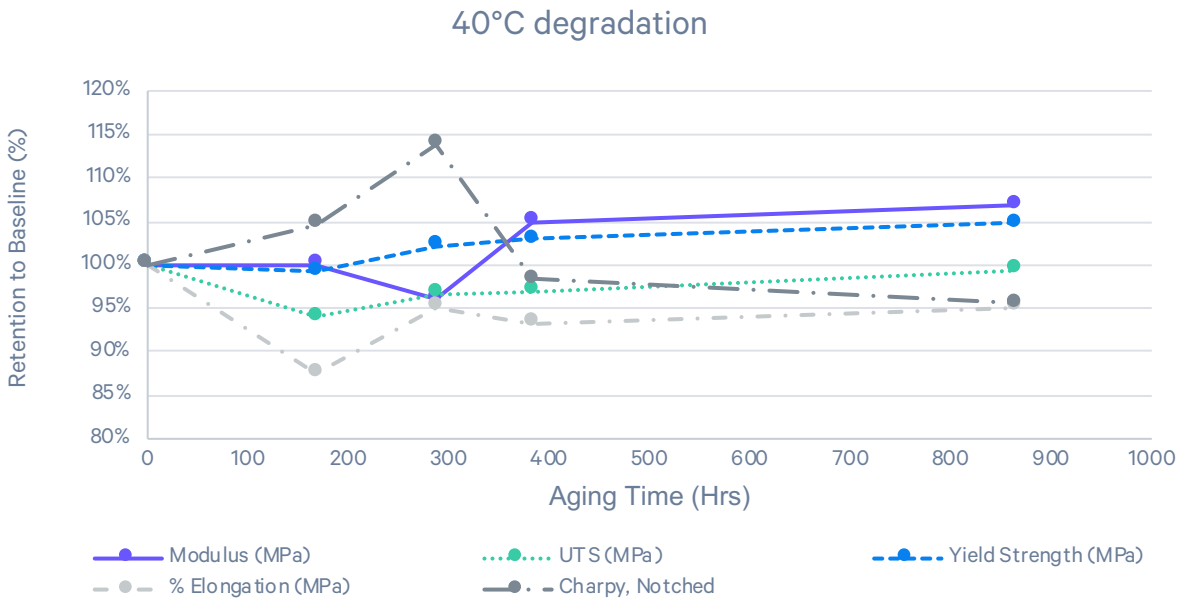


Figure 1: Effect of 40C exposure over time on RPU 130 mechanical properties

Thermal aging cont.

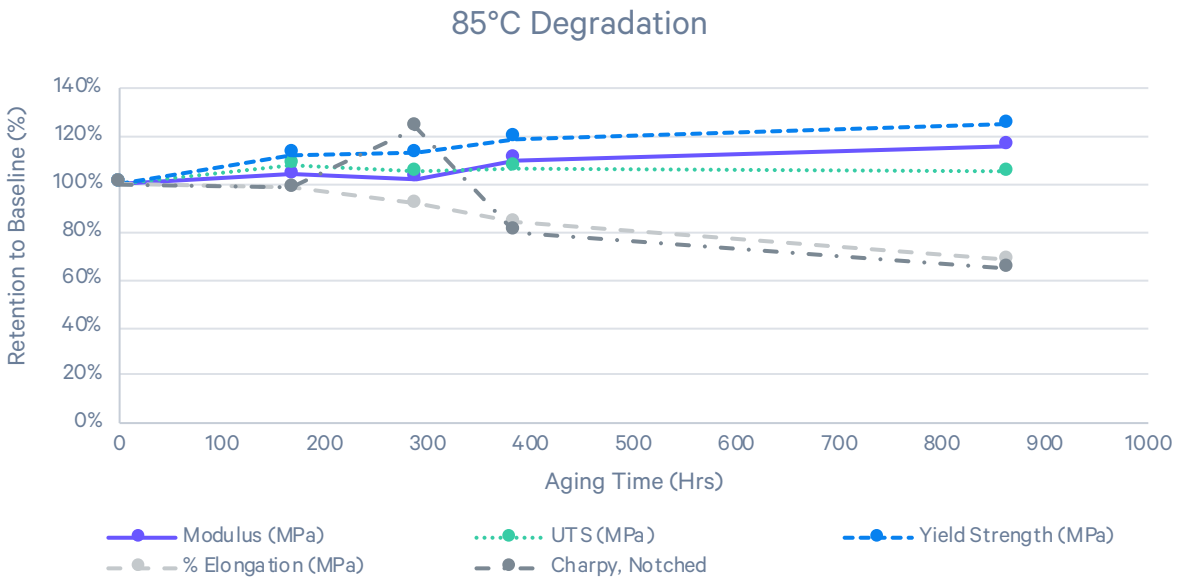


Figure 2: Effect of 85C exposure over time on RPU 130 mechanical properties

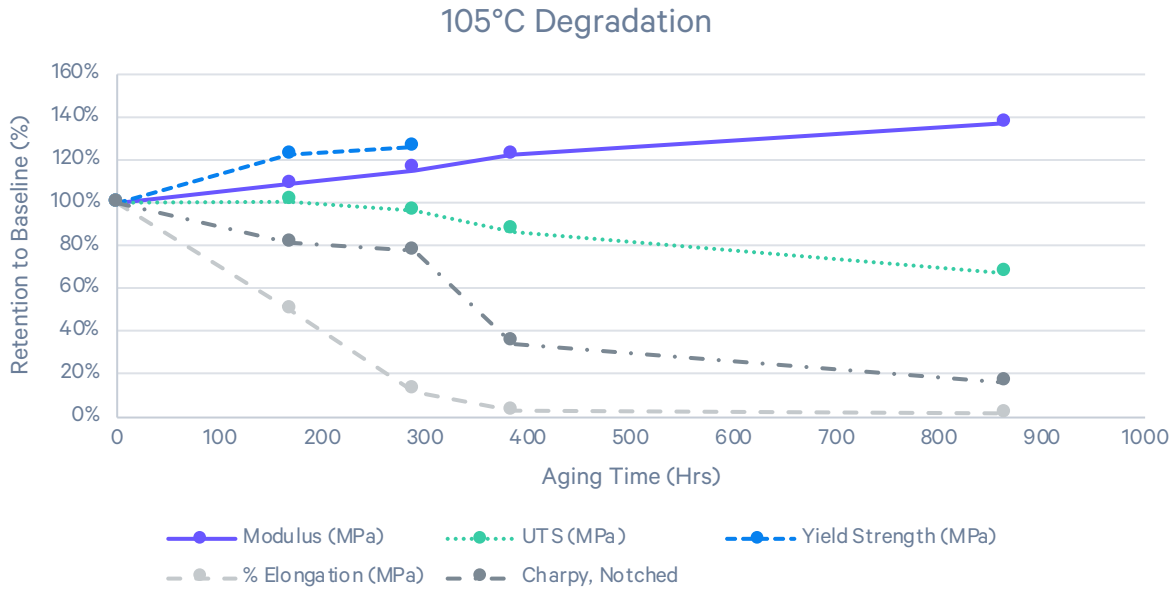


Figure 3: Effect of 105C exposure over time on RPU 130 mechanical properties

Environmental Aging

Per PV1200

Stability to environmental factors such as temperature and humidity is a key performance aspect for plastic materials. PV1200 is a standard developed by Volkswagen group to evaluate material durability that is used here as a representative climate cycling test. This standard designates one cycle to be a 720 minute period in which both temperature and humidity are varied from 80°C/80%RH to -40°C (Figure 1).

Carbon evaluated RPU 130 after 20 cycles per PV1200 with the results reported in Table 1 below. RPU 130 shows >75% retention in tensile and impact properties after this exposure.

Further testing is recommended for applications that require performance under differing environmental conditions.

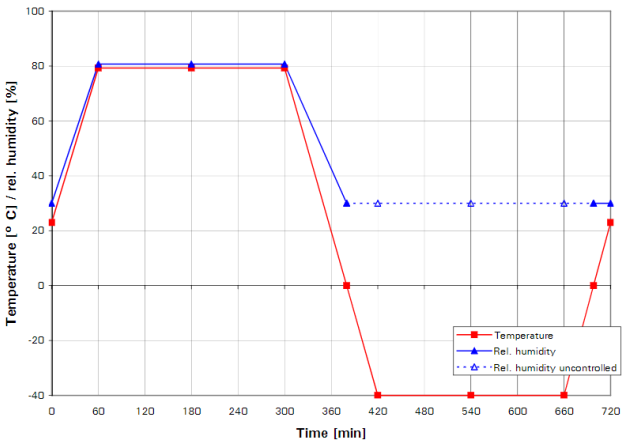


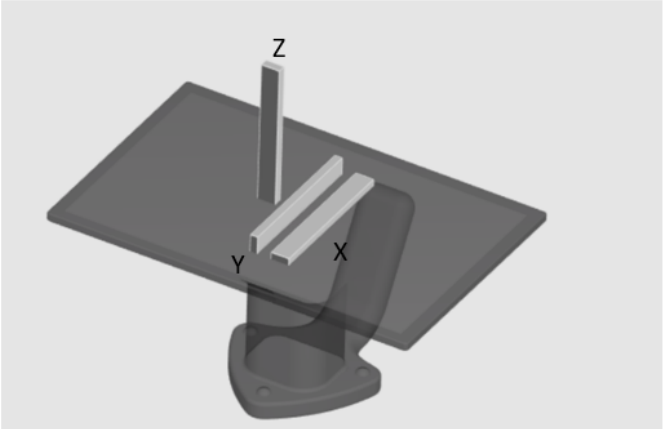
Figure 1 – Test cycle for PV 1200

Resin			n	Baseline RT (Dense)	20 Cycles, PV1200
RPU 130	Type I ASTM D638	Modulus (MPa)	6	1020	981
		UTS (MPa)		33.6	29.7
		Yield Strength (MPa)		26.8	25
		% Elongation (MPa)		104	110
	Impact	Charpy, Notched	8	10.5	8.22

Isotropy

Type I and Charpy bars

Carbon's dual cure materials yield parts that have a higher degree of isotropy than other additive manufacturing processes. To highlight this, we evaluated the tensile properties of Type I dogbones (ASTM D638) and the impact properties of Charpy samples (ISO 179) in three main orientations—flat on the platform (x), on edge lengthwise (y), and on end (z)*. The gage length on the y-orientation prints required additional supports to be properly adhered on the platform. All sample bars were machine notched. Table 2 below shows the results of the tested samples in the three orientations.

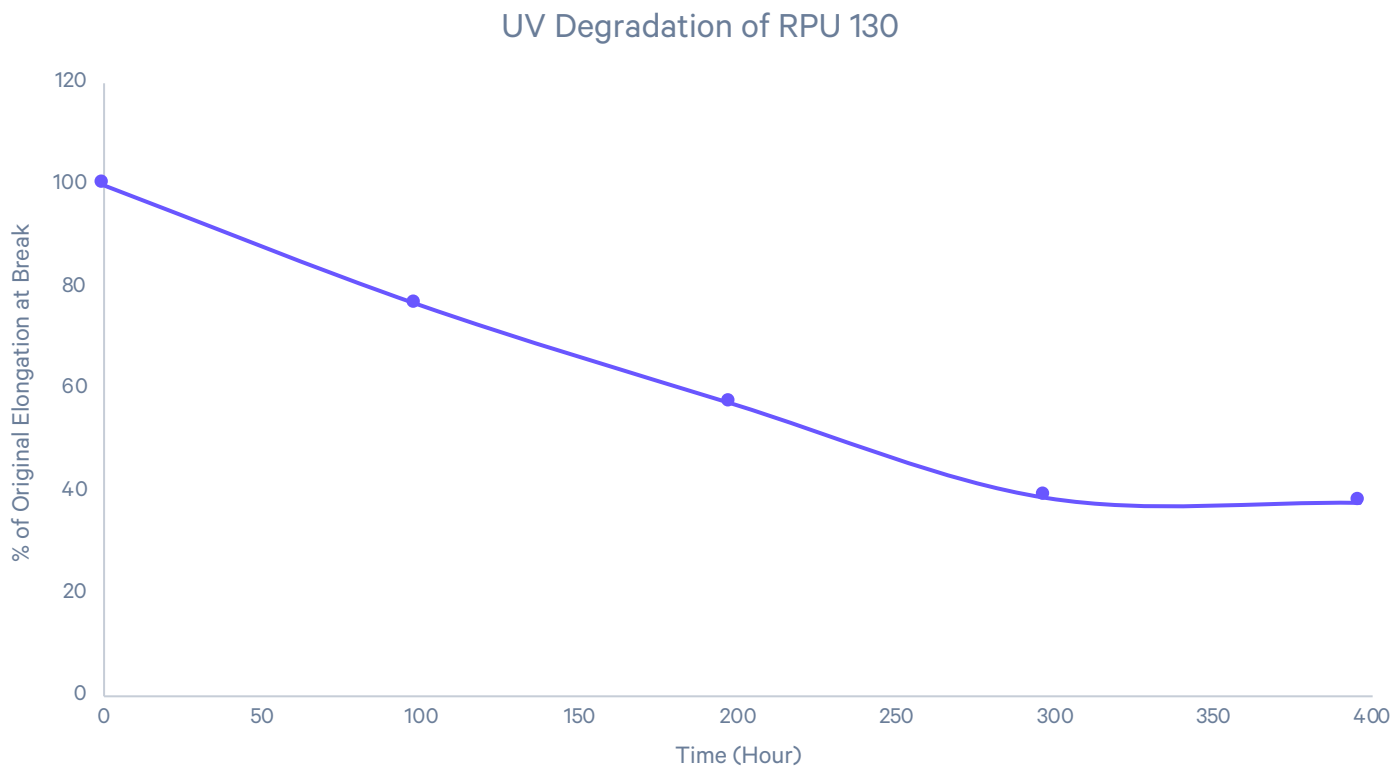


		Orientation	X	Y	Z (Baseline)
RPU 130	Type I	Modulus (MPa)	980	960	990
		UTS (MPa)	31	33	35
		Yield Strength (MPa)	26	26	27
		% Elongation	105	109	104
	Impact	Charpy, Notched (kJ/m2)	19	30	11

UV Degradation of RPU 130

Type V Dogbones

Carbon evaluated UV Degradation per ASTM D4459 using Type V dogbones per ASTM D638. Test samples were subjected to up to 396 hours of simulated UV exposure in a Q-Sun XE-1 set at 0.8W/m2 at 420nm and 55°C. RPU 130 retained up to 57% of it's baseline elongation at break at 198 hours of exposure. After 396 hours, RPU 130 retained approximately 38% of initial elongation at break.



Creep Behavior of RPU 130

At 65°C, 85°C, and 105°C