RPU 70

RPU 70 is a tough, rigid material that is a good choice for parts requiring strength, toughness, and moderate heat-resistance.

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Tensile Properties	Test Standard	Metric	US
Tensile Modulus	ASTM D638 Type I 50 mm/min	1700 MPa	245 ksi
Yield Strength		40 MPa	6 ksi
Strain at Yield		5%	5%
Ultimate Tensile Strength		40 MPa	6 ksi
Elongation at Break		30%	30%
Tensile Modulus	ASTM D638 Type V 10 mm/min	1700 MPa	245 ksi
Yield Strength		40 MPa	6 ksi
Strain at Yield		5%	5%
Ultimate Tensile Strength		40 MPa	6 ksi
Elongation at Break		100%	100%

Flexural Properties	Test Standard	Metric	US
Flexural Stress at 5% strain	ASTM D790-B	55 MPa	8 ksi
Flexural Modulus (Chord, 0.5-1%)		1500 MPa	220 ksi

Impact Properties	Test Standard	Metric	US
Unnotched Charpy	ISO 179-1/1eU	35 kJ/m^2	17 ft-lb/in^2
Notched Charpy	ISO 179-1/1eA	1.5 kJ/m^2	0.7 ft-lb/in^2
Unnotched Izod, 23 °C (-30 °C)	ASTM D4812	300 J/m (320 J/m)	6 ft-lb/in (6 ft-lb/in)
Notched Izod, 23 °C (-30 °C)	ASTM D256	15 J/m (20 J/m)	0.3 ft-lb/in (0.3 ft-lb/in)

Thermal Properties	Test Standard	Metric	US
Heat Deflection Temperature at 0.455 MPa/66 psi	ASTM D648	60 °C	140 °F
Heat Deflection Temperature at 1.82 MPa/264 psi		45 °C	110 °F
Coefficient of Thermal Expansion (-40, 40 °C)	ASTM E831	100 ppm/°C	50 ppm/°F
Heat Capacity, 23 °C	ASTM E1269	1.8 J/g-°C	0.5 BTU/lb-°F
Flammability	UL 94	HB (1.5 mm & 3mm) for L1, M1, M2, M3 and M3 Max printers UL Blue Card® file # E485325	

Dielectric/Electric Properties	Test Standard	Metric	US
Dielectric Constant	ASTM D150	3.3	3.3
Dissipation Factor		0.017	0.017
Dielectric Strength	ASTM D149	16 kV/mm	390 V/mil
Volume Resistivity	ASTM D257	8.0 x 10^{14} ohm-cm	3.2 x 10^{14} ohm-in

Parts were processed using an M series printer and a Smart Part Washer with VF 1 as the solvent. The washed test articles were baked following the standard baking schedule for RPU 70.

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General Properties	Test Standard	
Shore D Hardness	ASTM D2240	80
Bulk Density	ASTM D792	1.08 g/mL
Taber Abrasion	ASTM D4060 CS-17, 1 kg, 100% vacuum	70 mg / 1000 cycles
Water Absorption, Short Term (24 hours)	ASTM D570	< 0.5%
Water Absorption, Long Term (14 days)		< 1.5%

Parts were processed using an M series printer and a Smart Part Washer with VF 1 as the solvent. The washed test articles were baked following the standard baking schedule for RPU 70.

Liquid Properties	
Liquid Density (Part A)	1.03 g/mL
Liquid Density (Part B)	0.98 g/mL
Liquid Density (Part A+B)	1.02 g/mL
Part A:B Volume Ratio (Mass Ratio)	10.0 (10.5)
25 °C Viscosity (Part A)	2800 cP
25 °C Viscosity (Part B)	70 cP
25 °C Viscosity (Part A+B)	2100 cP

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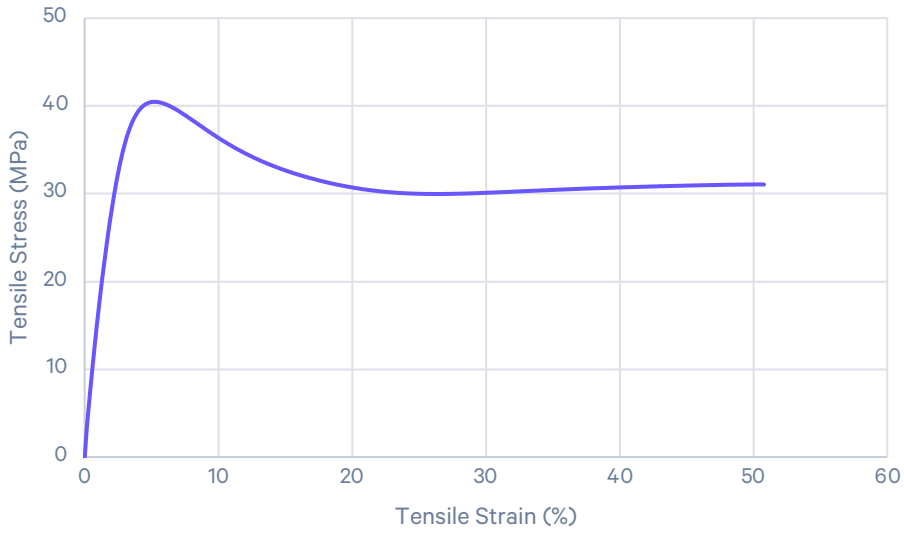
RPU 70

Extended TDS

RPU 70 Mechanical Properties

Representative Tensile Curve

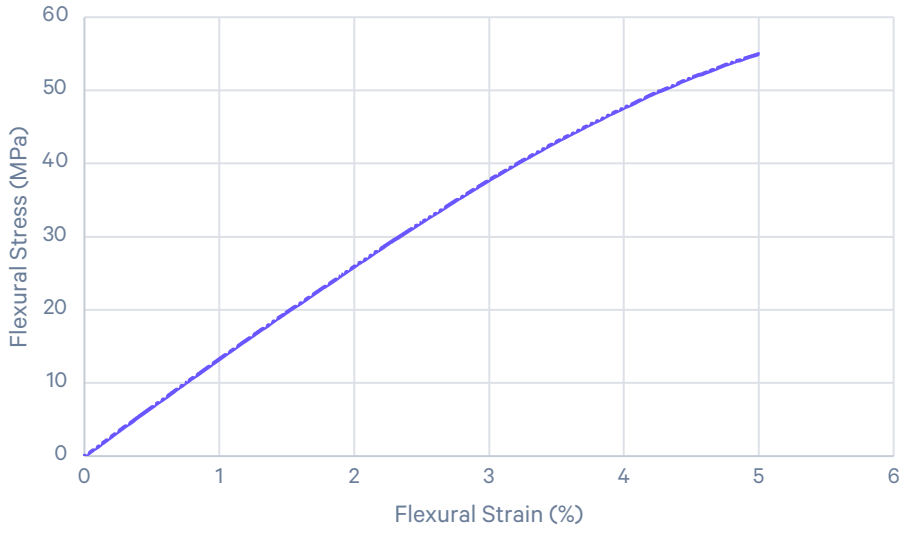
ASTM D638, Type I, 50 mm/min



Representative Flexural Curve

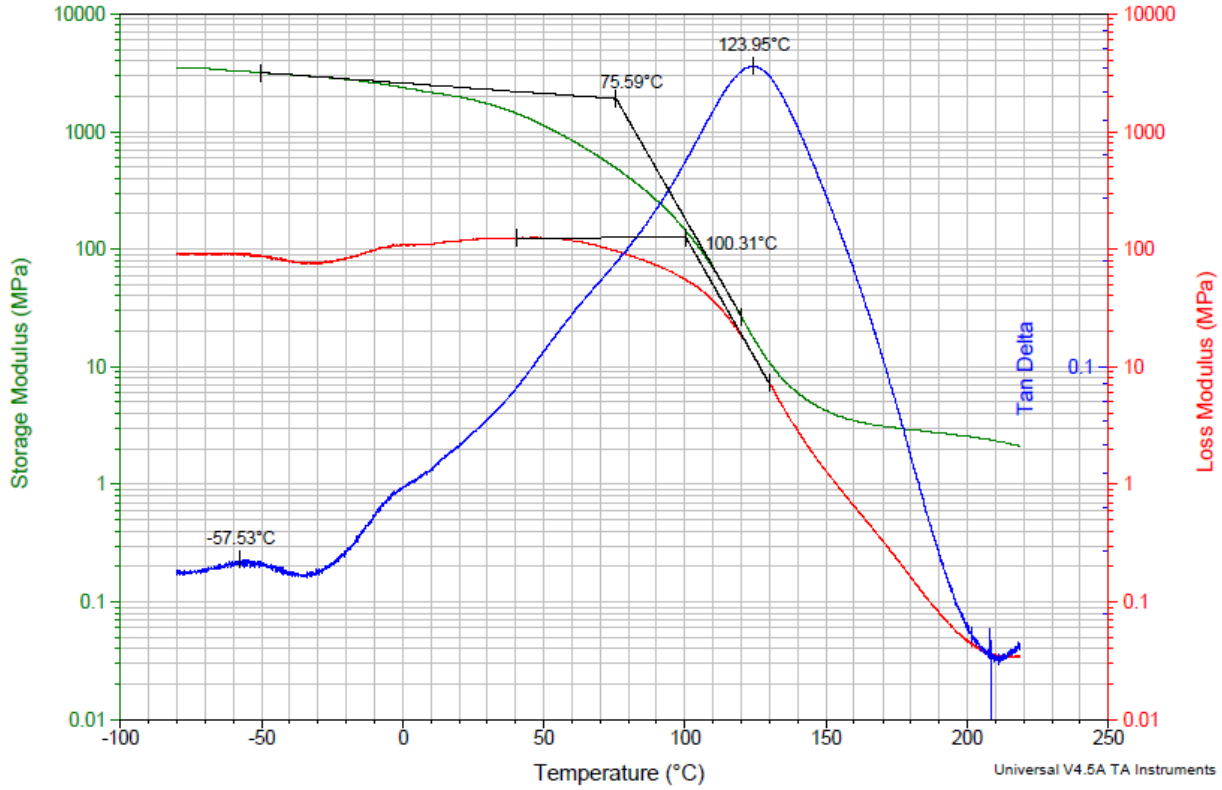
ASTM D790-B

Samples are tested to 5% extension.



RPU 70 Dynamic Mechanical Analysis (DMA)

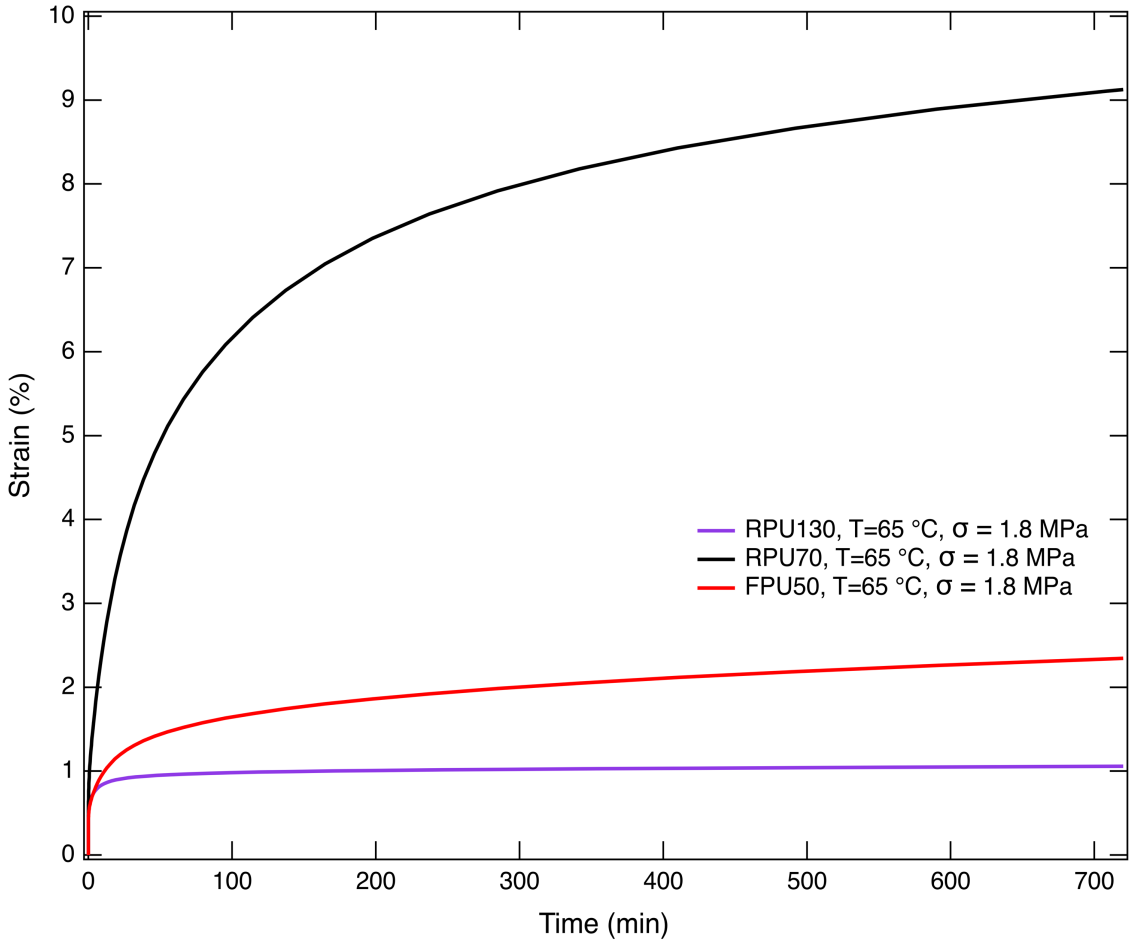
Dynamic mechanical analysis provides insight into a resin's viscoelastic properties across a range of temperatures. The figure below shows a temperature ramp of RPU 70. RPU 70 exhibits a storage modulus softening temperature at 75 °C. The peak in the tan(d) curves indicates that the glass transition temperature of RPU 70 is approximately 125 °C.



Standard: ASTM D4065
Instrument: TA DMA Q800
DMA Mode: Tension
Sample Dimensions: L=20mm, W=10mm, t=1mm (rectangular block)
Strain Amplitude: 0.1% (linear regime of viscoelasticity)
Oscillation frequency: 1 Hz
Temperature Range: -100°C to 200°C
Ramp Rate: 1.5 °C/min
Print Conditions: Samples were hand-wiped and not washed with solvent. The thermal cure for all materials complies with the Carbon user manual. Values may differ based on post processing conditions.

RPU 70 Creep Behavior

A creep test measures a polymer's rate of deformation under constant load at a fixed temperature and is a fundamental property for materials that need to operate under load. The figure below shows that RPU 70 creeps up to 10% strain over 12 hours at 65 °C and 1.8 MPa applied load. Low creep behavior is necessary for dimensional stability over time and loads.



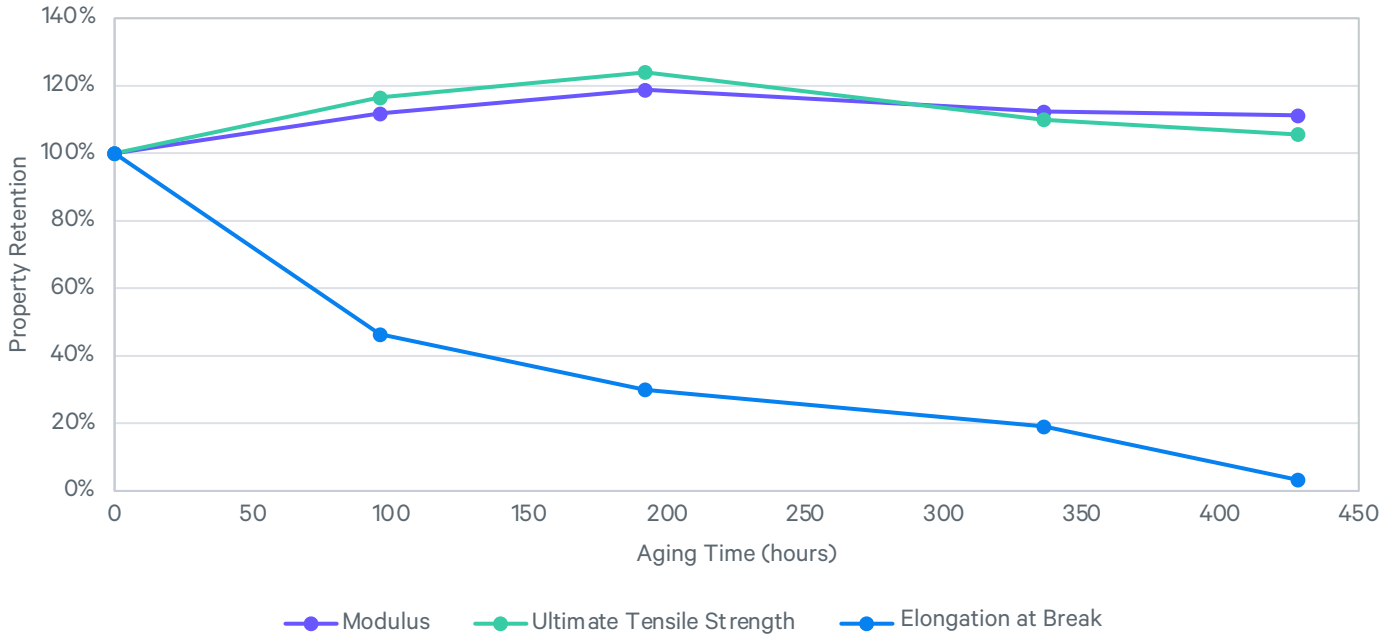
RPU 70 Chemical Compatibility

	Mass Gain* (%)
Household Chemicals	
Bleach (NaClO, 5%)	< 5%
Sanitizer (NH_4Cl, 10%)	< 5%
Distilled Water	< 5%
Sunscreen (Banana Boat, SPF 50)	< 5%
Detergent (Tide, Original)	< 5%
Windex Powerized Formula	< 5%
Hydrogen Peroxide (30%)	< 5%
Ethanol (95%)	15 – 30%
Industrial Fluids	
Engine Oil (Havoline SAE 5W-30)	< 5%
Brake Fluid (Castrol DOT-4)	< 5%
Airplane Deicing Fluid (Type I Ethylene Glycol)	< 5%
Airplane Deicing Fluid (Type I Propylene Glycol)	< 5%
Airplane Deicing Fluid (Type IV Ethylene Glycol)	< 5%
Airplane Deicing Fluid (Type IV Propylene Glycol)	< 5%
Transmission Fluid (Havoline Synthetic ATF)	< 5%
Engine Coolant (Havoline XLC, 50%/50% premixed)	< 5%
Diesel (Chevron #2)	< 5%
Gasoline (Chevron #91)	> 30%
Skydrol 500B-4	5 – 15%
Strong Acid/Base	
Sulfuric Acid (30%)	< 5%
Sodium Hydroxide (10%)	< 5%

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

RPU 70 UV Aging

Natural polymer aging can occur in the presence of light, sun, and heat. Carbon evaluated the UV aging performance of RPU 70 using ASTM D4459, which is intended to simulate indoor exposure of solar radiation through glass. RPU 70 retained up to 46% of the original elongation at break after 96 hours of exposure.



ASTM 4459: Q-Sun XE-1, 0.8 W/m^2/nm at 420 nm, 55 °C
ASTM D638: Type V, 10 mm/min, average values represented

RPU 70 Biocompatibility

Biocompatibility Testing

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

Biocompatibility Testing	Test Standard
Cytotoxicity	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)
Hemolysis	ASTM F756, Standard Practice for Assessment of Hemolytic Properties of Materials & ISO 10993-4, Biological evaluation of medical devices - Part 4: Selection of tests for interactions with blood (Extract and direct contact method)
Systemic Toxicity	ISO 10993-11: Biological evaluation of medical devices — Part 11: Tests for systemic toxicity (Acute systemic toxicity study in mice)

Test articles were processed using an M series printer and a Smart Part Washer with VF 1 as the solvent. The washed test articles were baked following the standard baking schedule for RPU 70: 120 °C for 4 hours. Additional details about the tests are available upon request.

Disclaimer

Each Carbon customer using the resin is solely responsible for testing and evaluating the performance of any resin within the context of the customer's application or use of the resin. Many variables can affect the properties of the resin and printed article. Test results may vary based on printing and/or post-processing procedures. The information provided herein is for informational purposes only based on present data available to Carbon. The information applies only to the Resin designated herein as sold by Carbon as used to make the test article and does not apply to use in any process, use, application, or in combination with any other material. Accordingly, Carbon makes no guarantee or representation and assumes no liability for customer's use of a resin in any process, use, application, or in combination with any other material.

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