

# CE 221

**CE 221 is a high-performance material with excellent strength, stiffness, and temperature resistance.**

<b>Tensile Properties</b> ASTM D638, Type V, 1 mm/min	<b>Metric</b>	<b>US</b>
Tensile Modulus	3900 MPa	570 ksi
Ultimate Tensile Strength	85 MPa	12 ksi
Elongation at Break	3%	3%

<b>Flexural Properties</b> ASTM D790-B	<b>Metric</b>	<b>US</b>
Flexural Stress at 5% strain	130 MPa	19 ksi
Flexural Modulus (Chord, 0.5-1%)	3800 MPa	550 ksi

<b>Impact Properties</b>	<b>Metric</b>	<b>US</b>
Notched Charpy (Machined Notch), ISO 179-1/1eA	1.2 kJ/m <sup>2</sup>	0.6 ft-lb/in <sup>2</sup>
Notched Izod (Machined Notch), ASTM D256	15 J/m	0.3 ft-lb/in
Unnotched Izod, ASTM D4812	290 J/m	5 ft-lb/in

<b>Thermal Properties</b>	<b>Metric</b>	<b>US</b>
Heat Deflection Temperature at 0.455 MPa/66 psi, ASTM D648	230 °C	450 °F
Heat Deflection Temperature at 1.82 MPa/264 psi, ASTM D648	200 °C	390 °F
Coefficient of Thermal Expansion (-60, 100 °C), ASTM E831	50 ppm/°C	30 ppm/°F
Coefficient of Thermal Expansion (100, 180 °C), ASTM E831	90 ppm/°C	50 ppm/°F
Coefficient of Thermal Expansion (180, 200 °C), ASTM E831	150 ppm/°C	80 ppm/°F
Heat Capacity, 23 °C, ASTM E1269	1.2 J/g-°C	0.3 BTU/lb-°F
Thermal Conductivity, ASTM C518	0.17 W/m-k	0.1 BTU/hr-ft-°F

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Parts were processed using an M series printer and washed using 50/50 (v/v) propylene glycol/isopropyl alcohol solvent.

<b>Dielectric/Electric Properties</b>	
Dielectric Strength, ASTM D149	22 kV/mm
Dielectric Constant, ASTM D150	3.1
Dissipation Factor, ASTM D150	0.05
Volume Resistivity, ASTM D257	2.2 E+14 ohm-cm

<b>General Properties</b>	
Hardness, ASTM D2240	92, Shore D
Density, ASTM D792	1.20 g/cm <sup>3</sup>
Density (liquid resin)	1.15 g/cm <sup>3</sup>
Taber Abrasion, ASTM D4060, CS-17, 1 kg, 100% vacuum	40 mg/ 1000 cycles
Water Absorption, Short Term (24 hours) ASTM D570	< 0.5%
Water Absorption, Long Term (14 days) ASTM D570	< 1%

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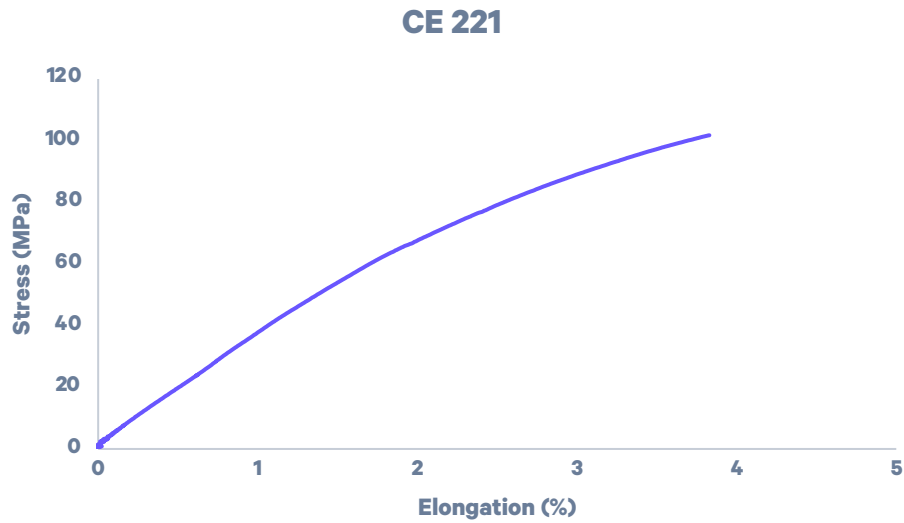
# CE 221

## Extended TDS

# CE 221 Mechanical Properties

## Representative Tensile Curve

ASTM D638, Type V, 1 mm/min



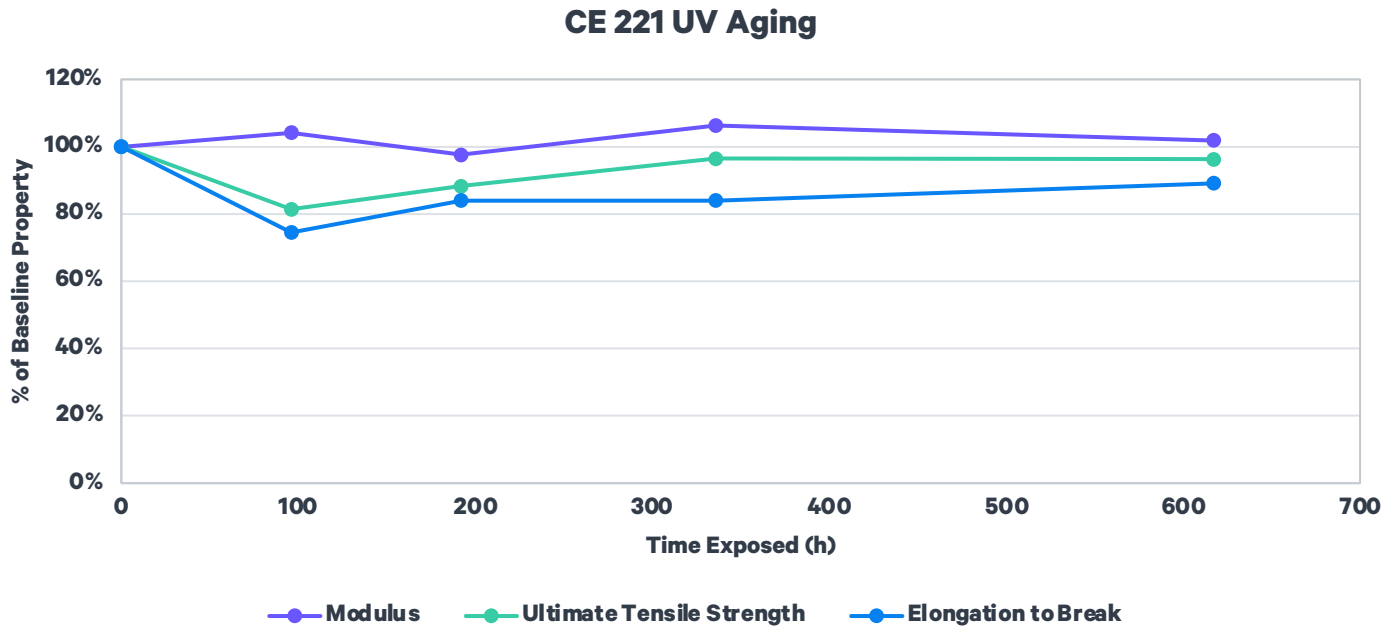
# CE 221 Chemical Compatibility

	Mass Gain* (%)
<b>Household Chemicals</b>	
Bleach (NaClO, 5%)	< 5%
Sanitizer (NH <sub>2</sub> Cl, 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%)	< 5%
<b>Industrial Fluids</b>	
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)	< 5%
Skydrol 500B-4	< 5%
<b>Strong Acid/Alcohol/Base</b>	
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.*

# CE 221 UV Aging

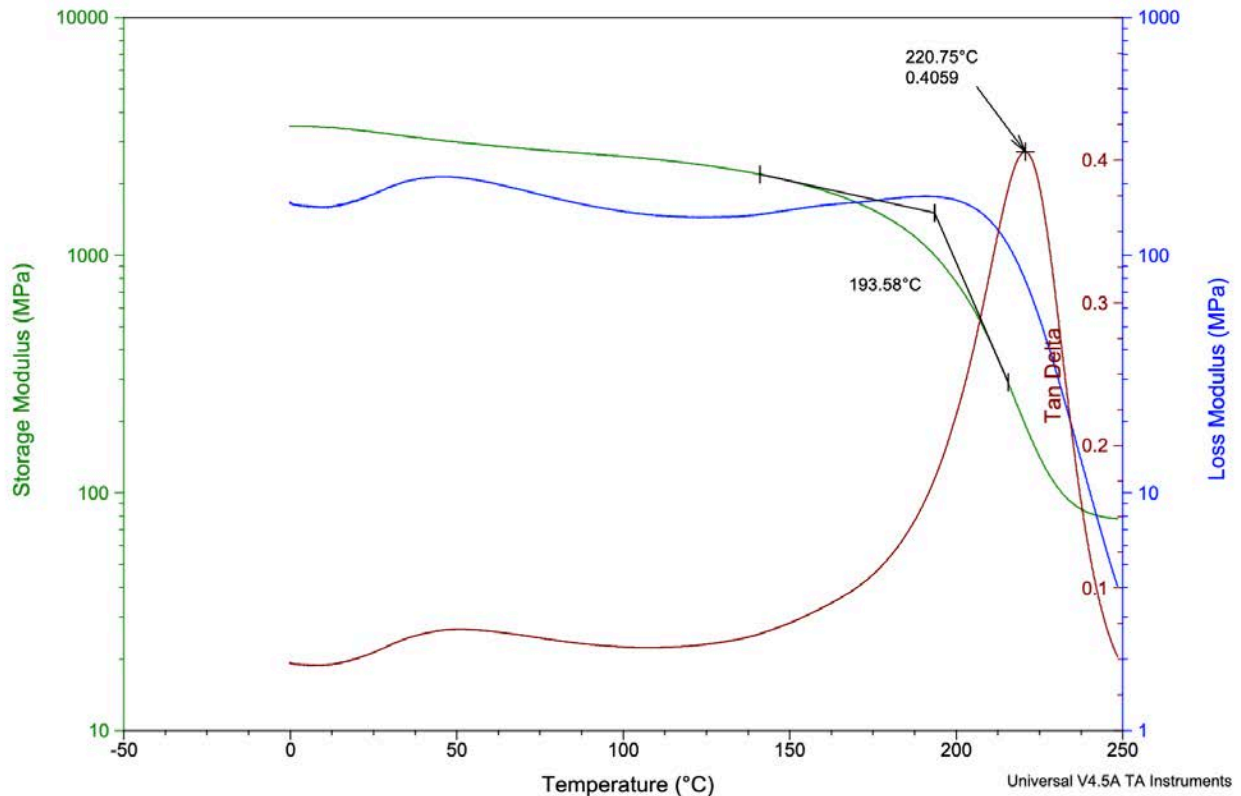
Natural polymer aging can occur in the presence of light, sun, and heat. Carbon evaluated the UV aging performance of CE 221 using ASTM D4459, which is intended to simulate indoor exposure of solar radiation through glass.



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

## CE 221 Dynamic Mechanical Analysis (DMA)

Dynamic mechanical analysis provides insight into the resin's viscoelastic properties across a range of temperatures. The figure below shows a temperature ramp of CE 221. This material exhibits a flat and high storage modulus up to a softening onset temperature of 190 °C, which reflects its rigid and temperature-resistant performance. The peak in the tan( $\delta$ ) curves indicates that the glass transition temperature of CE 221 is approximately 220 °C.



**Standard:** ASTM D4065

**Instrument:** TA DMA Q800

**DMA Mode:** Tension

**Sample Dimensions:** L=20 mm, W=10 mm, t=1 mm (rectangular block)

**Strain Amplitude:** 0.1% (linear regime of viscoelasticity)

**Oscillation frequency:** 1 Hz

**Temperature Range:** 0 °C to 250 °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.



# CE 221 Biocompatibility

## Biocompatibility Testing

Printed parts were provided to NAMSA for evaluation in accordance with ISO 10993-5, *Biological evaluation of medical devices - Part 5: Tests for in vitro cytotoxicity*. Parts were printed using an M series printer and washed in 50:50 (v:v) propylene glycol (PG) and isopropyl alcohol (IPA). The results indicated that CE 221 passed the requirements for biocompatibility according to the above test. **Carbon has not conducted ISO 10993-10, *Biological evaluation of medical devices - Part 10: Tests for irritation and skin sensitization (GPMT)* testing. Carbon makes no representation and is not responsible for the results of any biocompatibility tests other than those specified above.**

## Disclaimer

Biocompatibility results may vary based on printing and/or post-processing procedures.

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Carbon, Inc. | [www.carbon3d.com](http://www.carbon3d.com)  
1089 Mills Way Redwood City, CA 94063  
1 (650) 285-6307