Challenging The Expectations of Additive Material Properties.

Colton Sampson
Director of Consumer Products & Technology

A Presentation at the 2020 Outdoor Retailer Snow Show
January 30, 2020
Colorado Convention Center, Denver, Colorado
CARBON DIGITAL MANUFACTURING PLATFORM:
Production at Scale

M2

SMART PART WASHER

L1

© Copyright 2019, 2020 Carbon Inc. All Rights Reserved.
C5 Heated Cassette

Thermally conductive window that interfaces with the M2

- Heats resins up to 65 °C
- Reduces viscosity of resins for better flow, allowing access to new formulation space
- Uniform heat distribution across the print for improved part accuracy
- Greater extent of polymerization conversion during printing

© Copyright 2019, 2020 Carbon Inc. All Rights Reserved.
DUAL-CURE RESINS

1. Liquid Programmable Resin
   - Liquid resin with no cross-links
   - Cross-Linked UV system with an unreacted thermal system

2. UV Light Cured Green Part
   - Continuous Liquid Interface Production shapes the part

3. Thermally Cured Strong Part
   - Thermal curing locks mechanical properties
   - Post-bake an interpenetrating network of UV System and thermal system forms

US Patent #: 9,676,963

© Copyright 2019, 2020 Carbon Inc. All Rights Reserved.
Carbon Has Resins To Fit Your Unique Design Needs

- EPX 82 Automotive
- FPU 50 Enclosures
- CE 221 Fluidics
- RPU 70 Nozzles
- SIL 30 Padding
- EPU 41 Energy return
- EPU 40 Impact absorption
- DPR 10 Models
- MPU 100 Medical
- RPU 130 Consumer
INTRODUCING: RPU 130

RPU 130 is a strong and tough engineering polyurethane offering a unique combination of durability, impact resistance, and dimensional stability at elevated temperatures (i.e. heat resistance). These properties make it ideal for many consumer and automotive applications requiring rigid parts. Its performance compares to an unfilled thermoplastic e.g. nylon and polypropylene.

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>TENSILE MODULUS</td>
<td>990 MPa</td>
</tr>
<tr>
<td>ULTIMATE TENSILE STRENGTH</td>
<td>34 MPa</td>
</tr>
<tr>
<td>ELONGATION AT BREAK</td>
<td>&gt;50%</td>
</tr>
<tr>
<td>GARDNER IMPACT STRENGTH</td>
<td>&gt;30 J</td>
</tr>
<tr>
<td>NOTCHED IZOD IMPACT STRENGTH</td>
<td>&gt;76 J/m</td>
</tr>
<tr>
<td>HEAT DEFLECTION TEMPERATURE</td>
<td>119 °C</td>
</tr>
</tbody>
</table>

© Copyright 2019, 2020 Carbon Inc. All Rights Reserved.
TEMPERATURE + TOUGHNESS FOR RIGID PLASTICS

*dot size represents modulus

- UMA 90
- FPU 50
- RPU 70
- RPU 130
- EPX 82
- CE 221

Conventional photopolymers

Notched Izod Impact (J/m)

HDT (0.455 MPa) (°C)
RPU 130 vs. Traditional Materials

RPU 130’s combination of performance attributes is similar to injection-molded materials.
Dimensional Stability at Elevated Temperature

RPU 130 shows improved creep resistance (65°C, 1.8 MPa load)
Applications

• Rigid parts - Stiff but flexible
• Impact resistance
• Durability at elevated temperatures
• High Quality surface finish and aesthetics
• Unique geometries – unmoldable
• Personalization
Environmentally Sustainable

- Made with Susterra® propanediol from DuPont Tate & Lyle Bio Products
  - 100% bio-based building block
  - Produces 48% less greenhouse gas emissions and uses 46% less nonrenewable energy from cradle-to-gate.
- Nearly 30% of RPU 130 is composed of Susterra® propanediol
Key Material Takeaways

- Strong, tough, and heat resistant
- Improves on performance attributes of both RPU 70 and FPU 50
- Mechanical properties comparable to an unfilled thermoplastic
- Unlocks the potential of digital manufacturing for many applications
- Existing traction in consumer, automotive, and industrial markets
- 30% derived from plants
Thank You!