Carbon®

Challenging The Expectations of Additive Material Properties.

Colton Sampson
Director of Consumer Products & Technology

A Presentation at the 2020 Outdoor Retailer Snow Show
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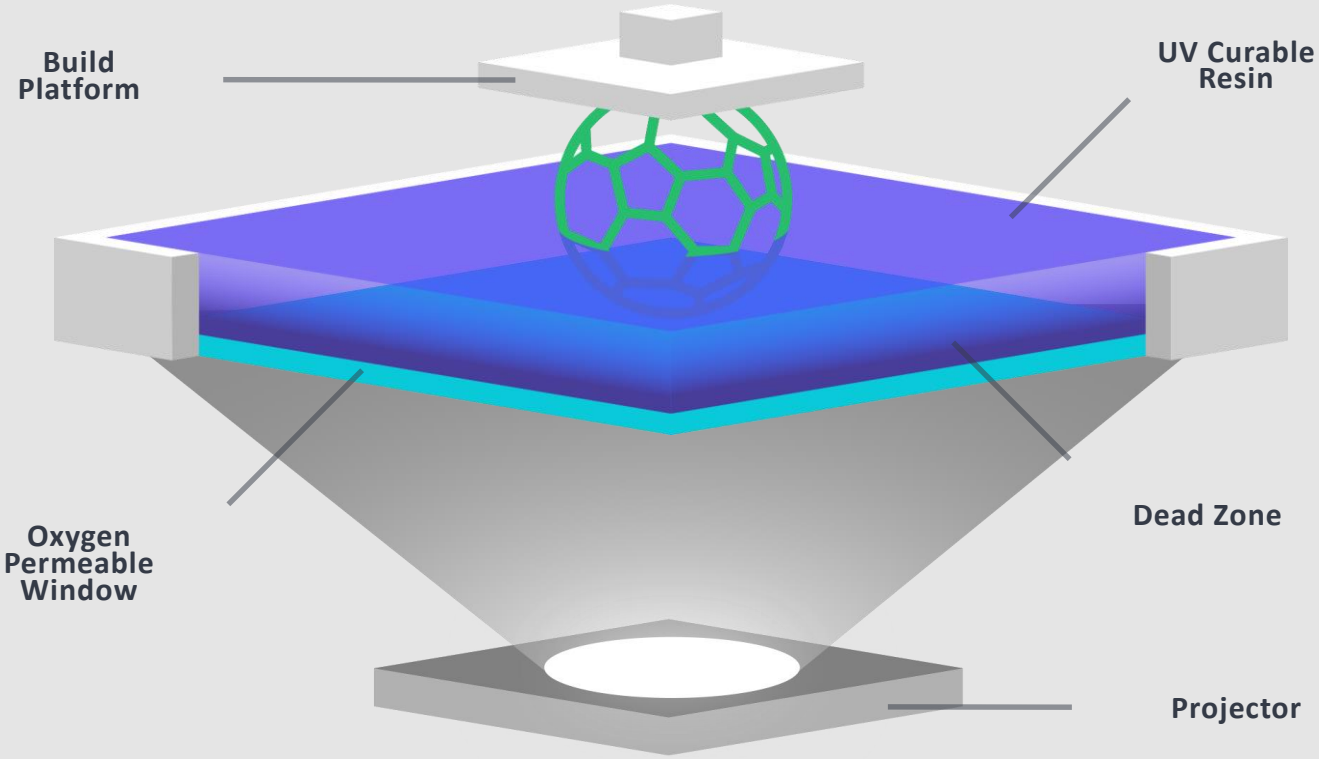
Colorado Convention Center, Denver, Colorado

TED

IDEASWORTHSPREADING



CARBON DIGITAL MANUFACTURING PLATFORM:

Production at Scale

M2

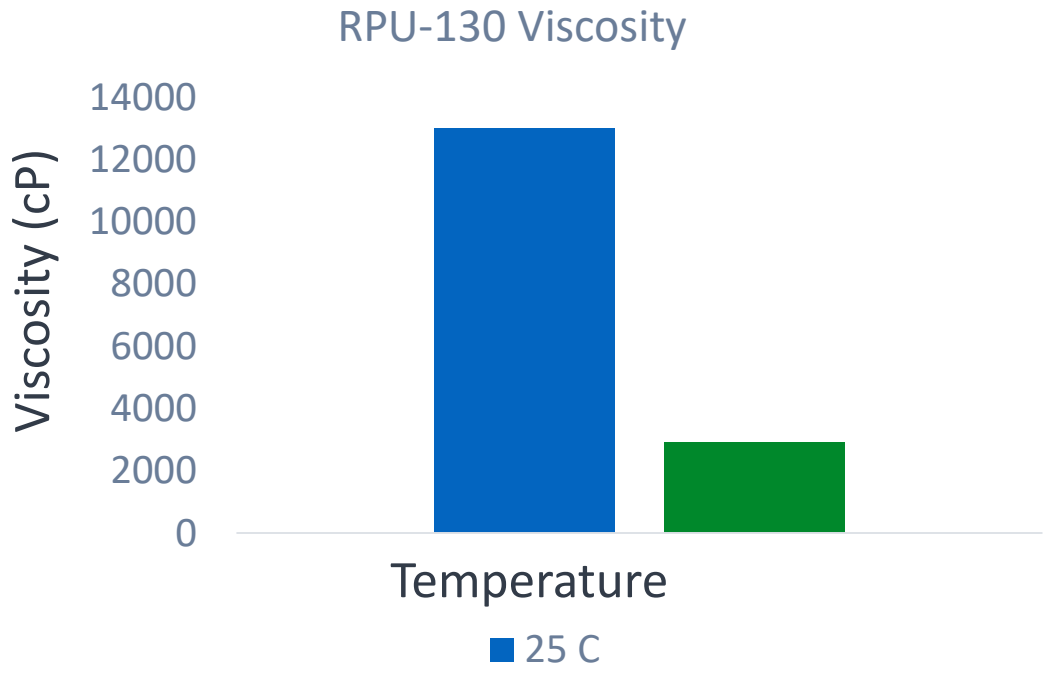
SMART PART WASHER

L1

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



DUAL-CURE RESINS

1

Liquid Programmable Resin

CLIP

2

UV Light Cured Green Part

GREEN YOUNG'S MODULUS
250-280 MPa

BAKE

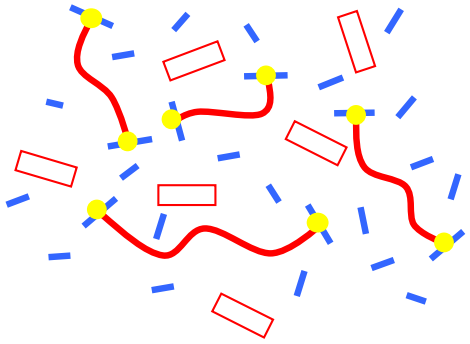
3

Thermally Cured Strong Part

CURED YOUNG'S MODULUS
3800-4000 MPa

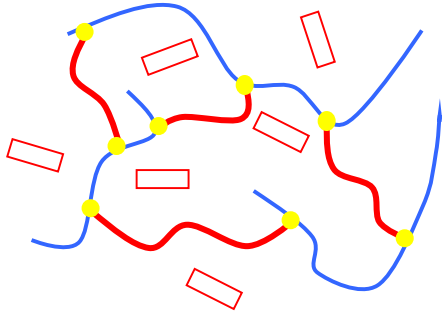
Continuous Liquid Interface Production shapes the part

Thermal curing locks mechanical properties



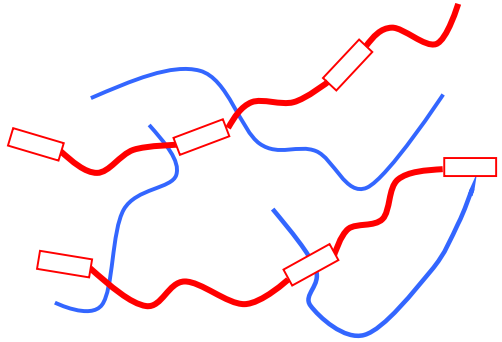
Liquid resin with no cross-links

CLIP



Cross-Linked UV system with an unreacted thermal system

BAKE



Post-bake an interpenetrating network of UV System and thermal system forms

US Patent 9,676,963

Carbon Has Resins To Fit Your Unique Design Needs

EPX 82
Automotive

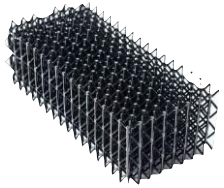
FPU 50
Enclosures

CE 221
Fluidics

RPU 70
Nozzles

SIL 30
Padding

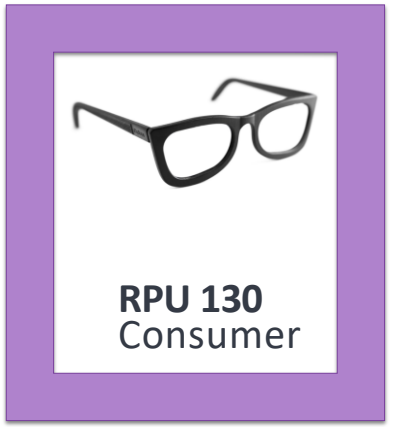
EPU 41
Energy return



EPU 40
Impact absorption

DPR 10
Models

MPU 100
Medical

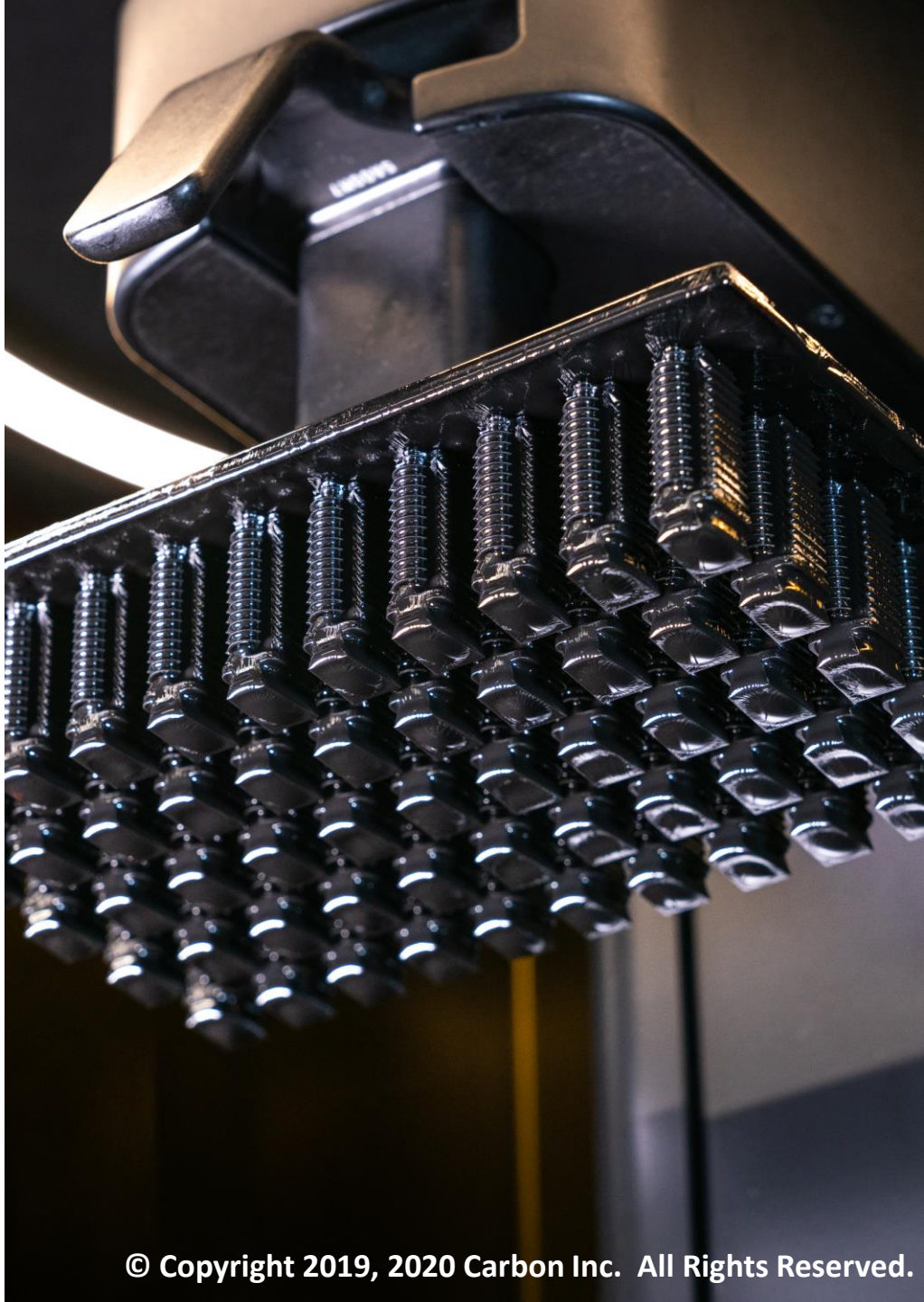


RPU 130
Consumer

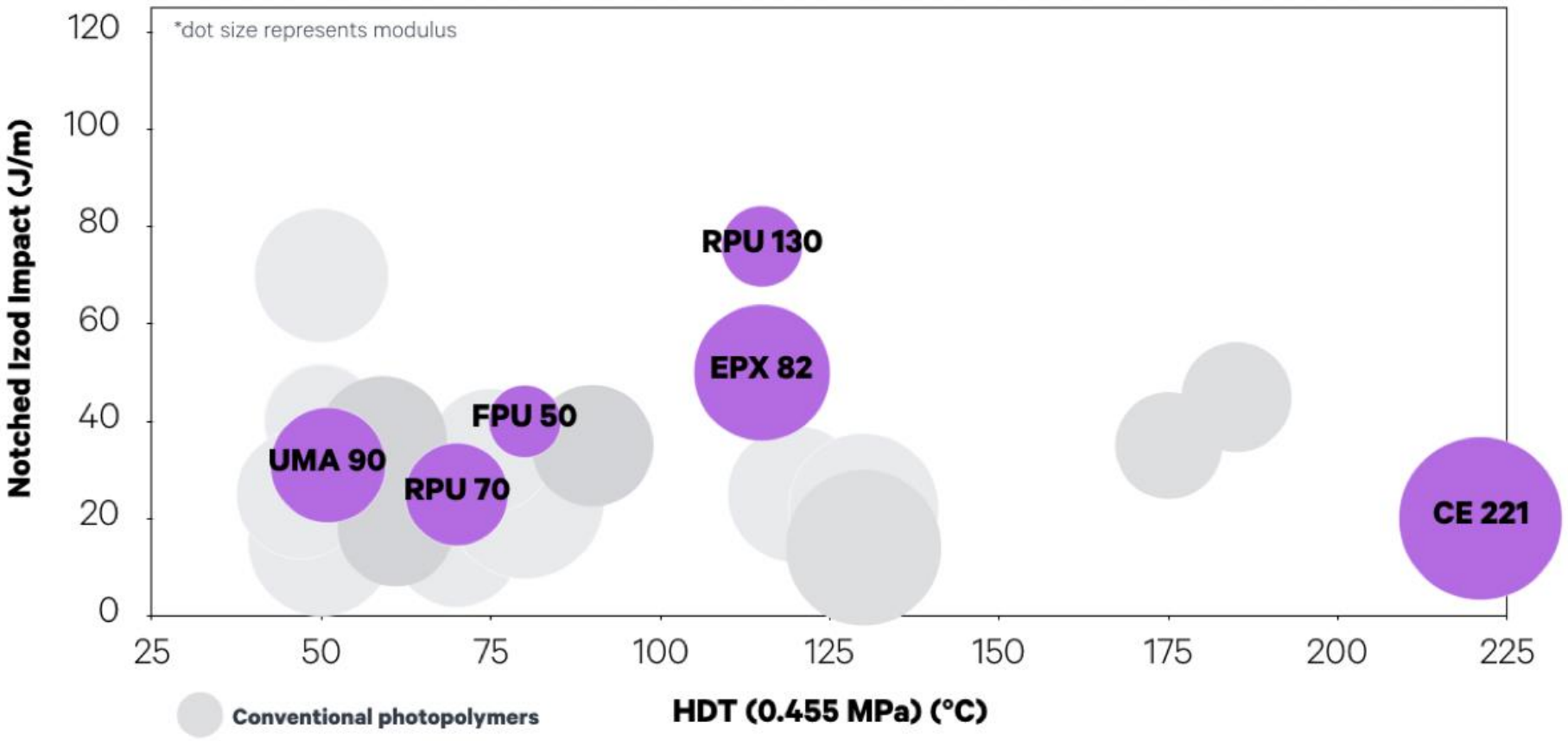
INTRODUCING: RPU 130

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.

TENSILE MODULUS	990 MPa
ULTIMATE TENSILE STRENGTH	34 MPa
ELONGATION AT BREAK	>50%
GARDNER IMPACT STRENGTH	>30 J
NOTCHED IZOD IMPACT STRENGTH	>76 J/m
HEAT DEFLECTION TEMPERATURE	119 °C

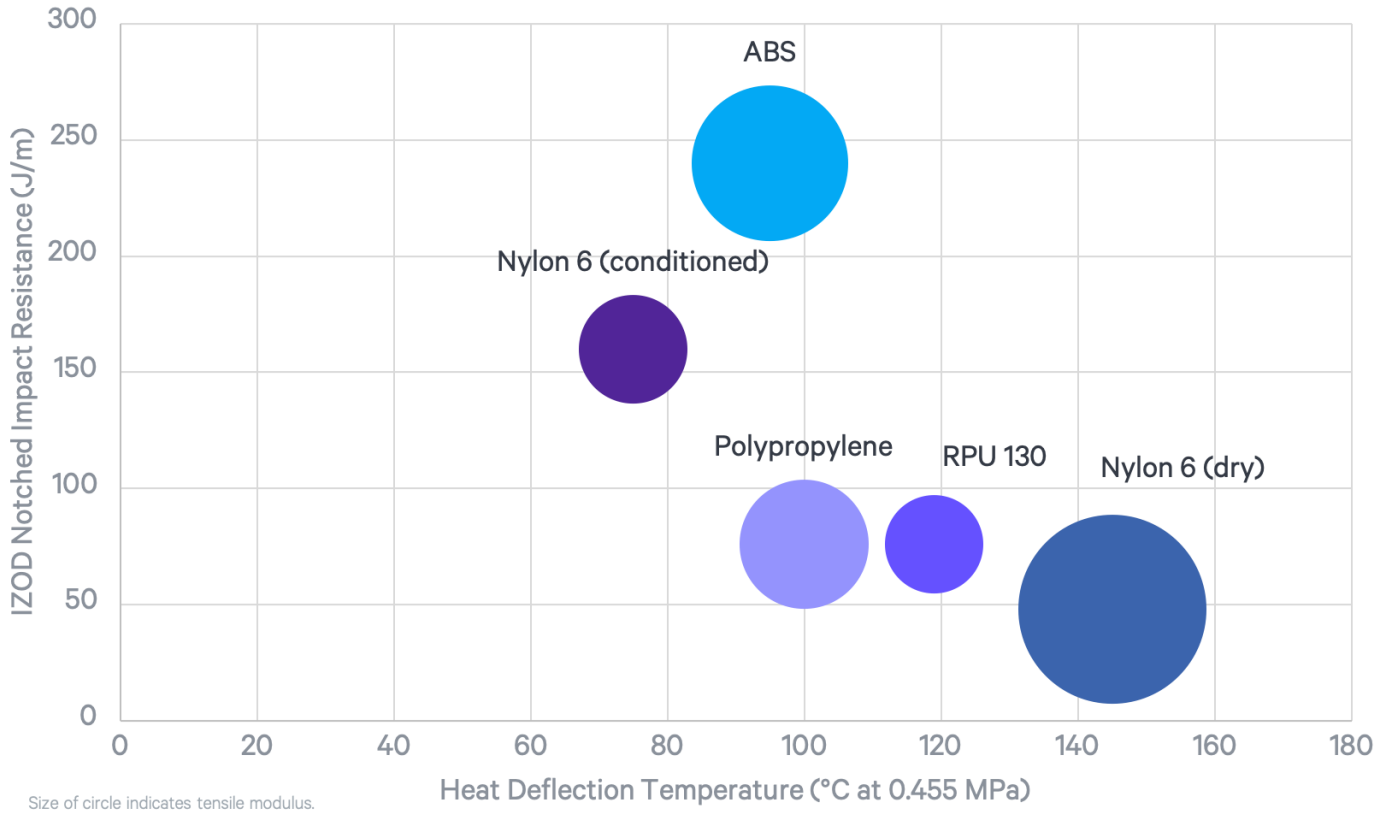


TEMPERATURE + TOUGHNESS FOR RIGID PLASTICS



RPU 130 vs. Traditional Materials

RPU 130's combination of performance attributes is similar to injection-molded materials.



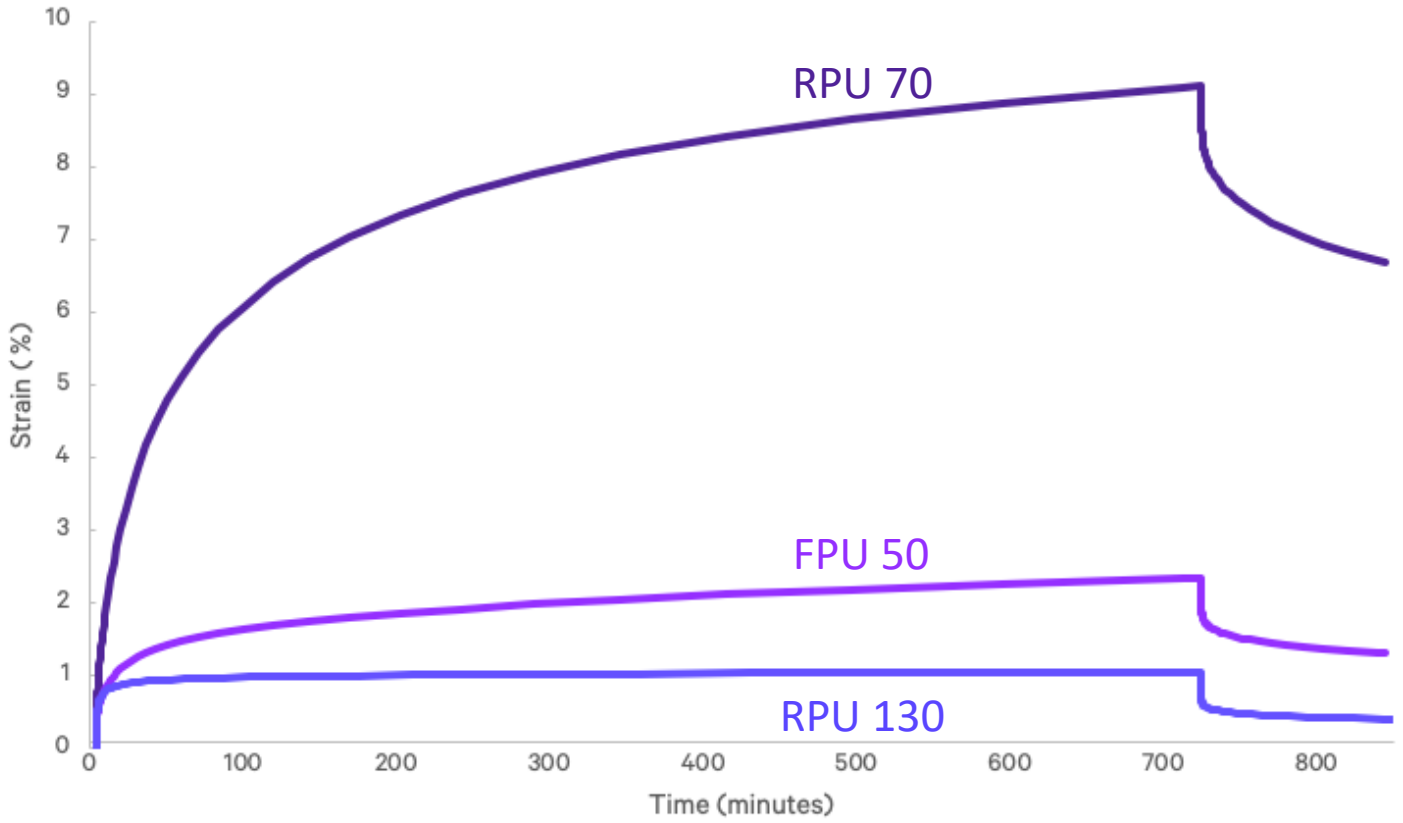
Gardner Impact Test

RPU 130 (ductile at 30J)

ABS (ductile at 30J)

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

Eyewear

Key Fob

Brake Calipers

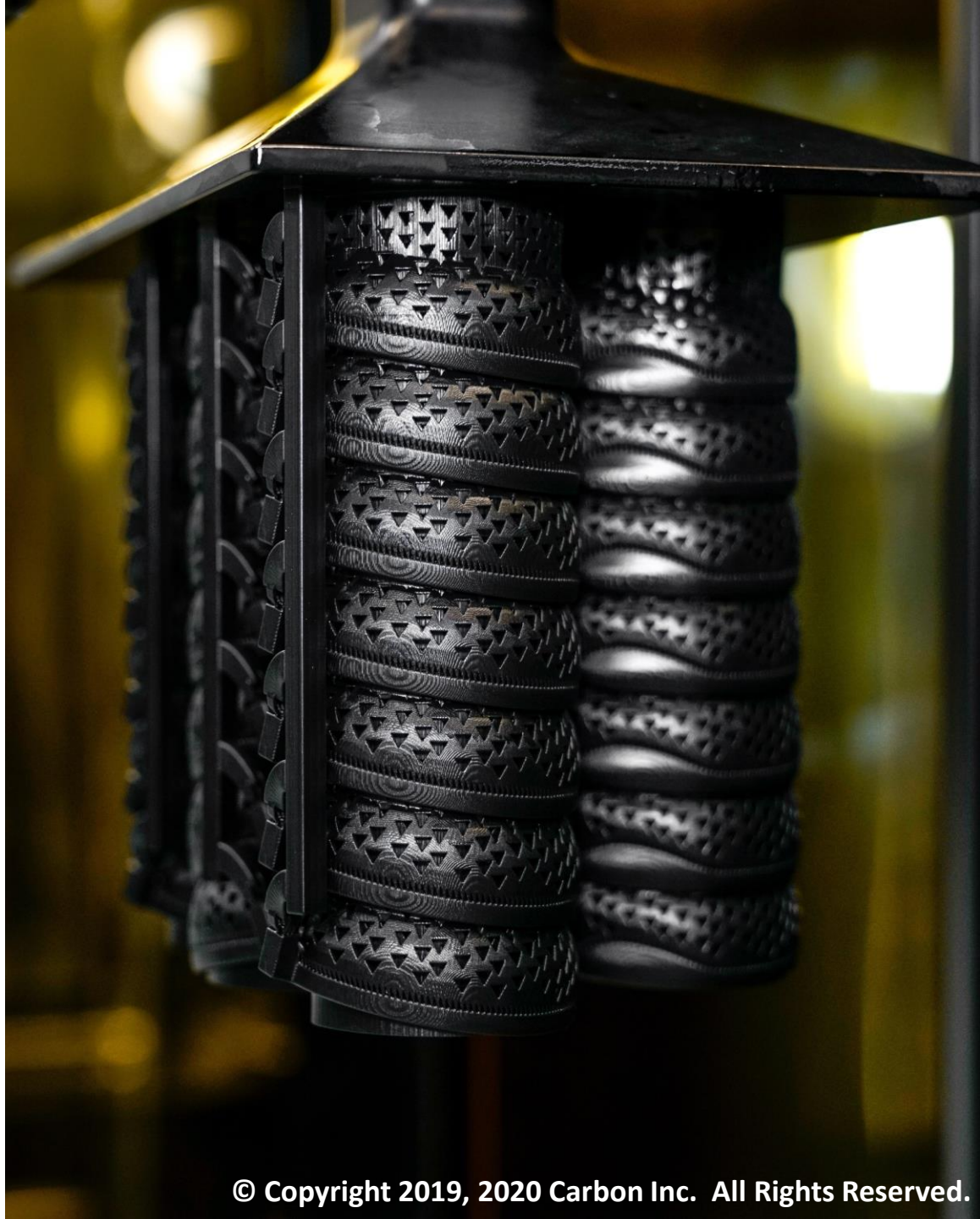
Housing

Push-in Rivet

Environmentally Sustainable

DuPont Tate & Lyle BioProducts™

- 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!