

October 15, 2020



Seeking sustainable solutions?
Create smarter with
Bio TPU™ by Lubrizol

Mantreh Nournia – NA Market Manager
Mike Ramsay – Applications Engineer

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ADVANCING MATERIALS.
ELEVATING PERFORMANCE.

Presenters

Mantreh Nournia

North America Marketing Manager, Lubrizol Engineered Polymers

Mantreh Nournia is based in California, and her focus is Electronics and Consumer Electronics applications for Lubrizol's Engineered Polymers business. With an electrical engineering background and more than 20 years in the electronics and consumer electronics market, Mantreh brings unique value to the company's solution-based approach through her practical experience, understanding of the market and applications expertise.



Mike Ramsay

Applications Engineer, Lubrizol Engineered Polymers

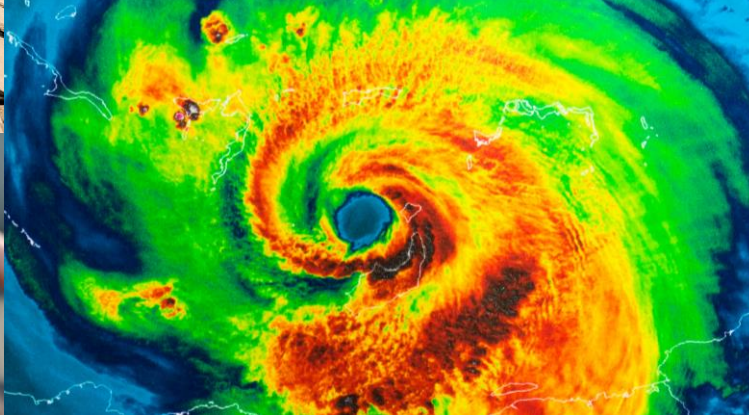
Mike Ramsay, based in our Cleveland, Ohio headquarters, has extensive experience developing applications for thermoplastic films across a wide variety of industrial, automotive, and consumer-facing applications. Mike holds a master's degree in Chemical Engineering. Before joining Lubrizol, Mike worked at Avery Dennison developing films and adhesives for the Graphics market, as well as new technology scouting.

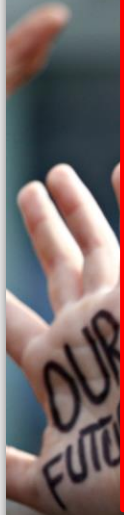
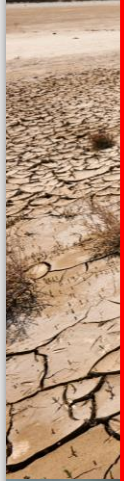


Topics Covered

- Sustainability – Why It's Important
- Introduction to Lubrizol
- Sustainability at Lubrizol
- Eco Solutions & Consumer Electronics
- Collaborative Development Partner and Expert Support

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We need
better solutions,
for a better world



“Transform to Net Zero”

- **Microsoft, Nike, Unilever, Starbucks, Danone, Mercedes-Benz, Maersk, Wipro, Natura & Co.**
- Transformational, Science and Data Driven
- Robust Reduction / Removal **across the Extended Enterprise**
 - Spans full value chain, including impact of products, services and supply chain
- Transparency & Accountability
 - Public disclosure to key stakeholders
 - Just and sustainable solutions for all

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Locally Present, Globally Networked



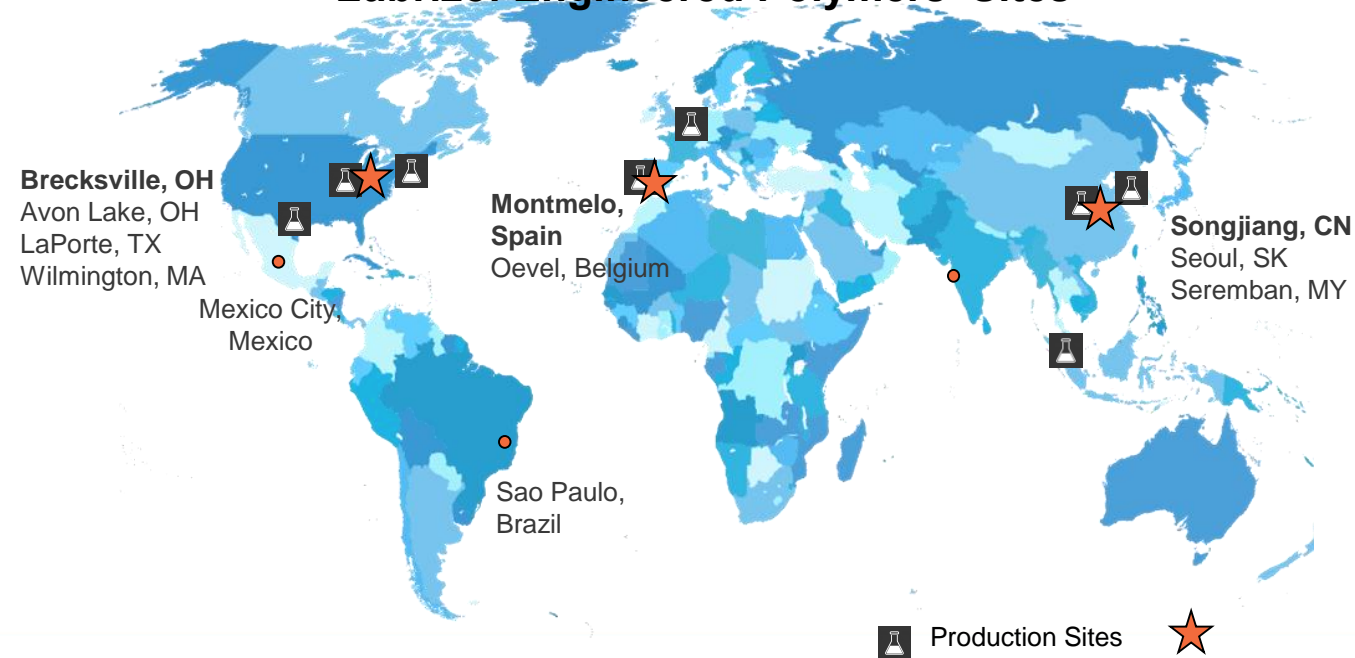
A Berkshire Hathaway company

- Chairman & CEO Warren E. Buffett
- Portfolio of more than 60 businesses

The Lubrizol Corporation, established 1928

- A global specialty chemical company
- Headquartered in Cleveland, OH
- Serves customers in over 100 countries from a well-networked global structure

Lubrizol Engineered Polymers' Sites



Employees Globally

8,800

Labs/Technical Facilities

39

Manufacturing Sites

58

Sales Offices

48

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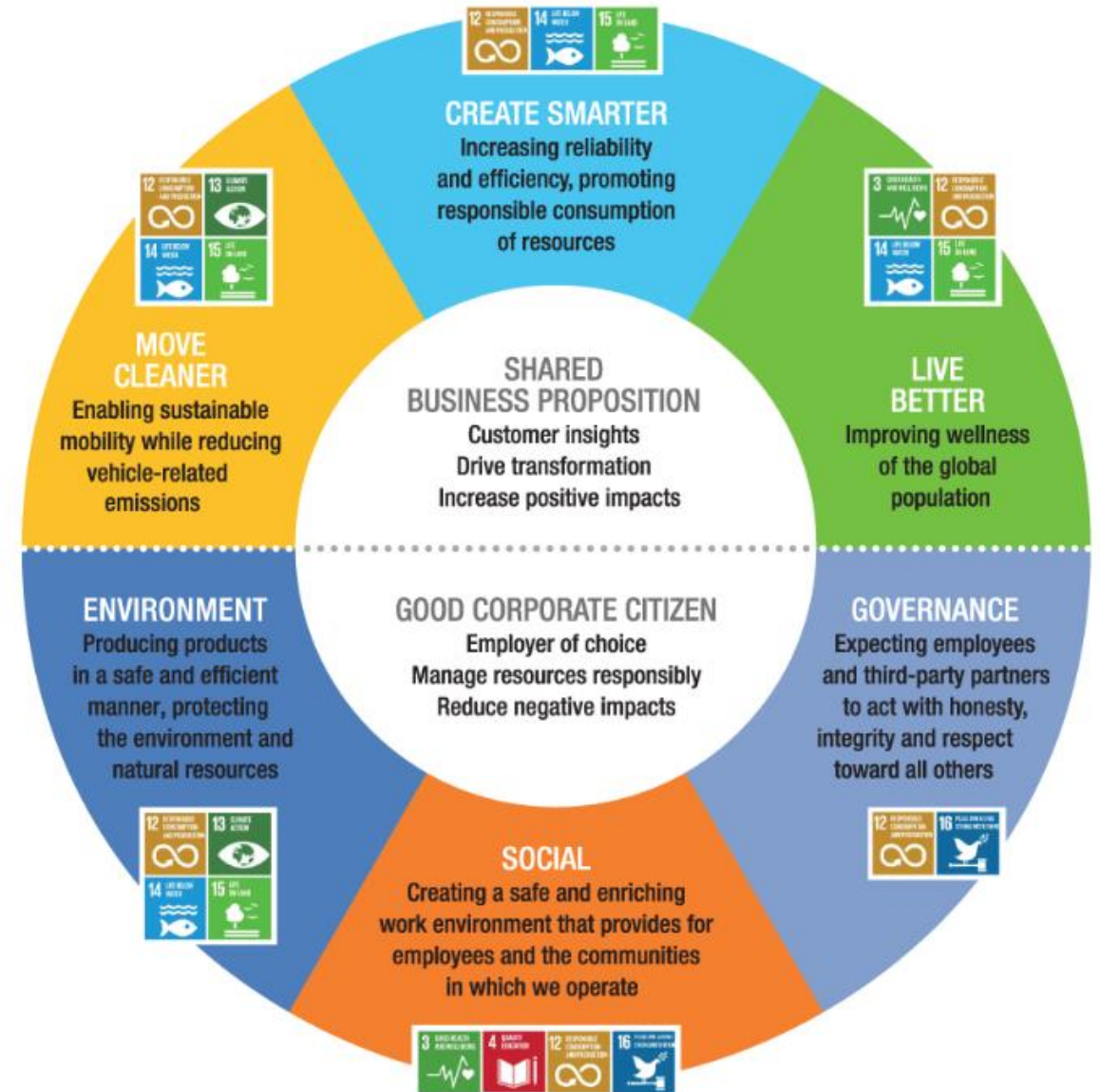
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Sustainability at Lubrizol

- We supply products that address some of the world's toughest challenges, helping the world **move cleaner, create smarter** and **live better**.
- Aligned to UN SDG goals where we believe we can have the greatest impact.
- Committed to operating responsibly, maximizing environmental, social, governance and ethics performance while minimizing our impact on the environment.



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Life Cycle Thinking

- Our opportunity to bring about change is immense.



**Shrinking
Our Footprint**



**Extending
Our Handprint**





MOVE CLEANER
CREATE SMARTER
LIVE BETTER

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Lubrizol's Mission

MOVE CLEANER

Enable a **>50%**
reduction in vehicle emissions by 2040.*

CREATE SMARTER

Improve the circularity of our products **25%**
by 2028.**

LIVE BETTER

Improve at least **2B** lives by 2028.***

***For More Information, Visit:**
<https://www.lubrizol.com/sustainability/>

Driving Circularity

Lubrizol's **Create Smarter** goal is aligned with principles of circular design



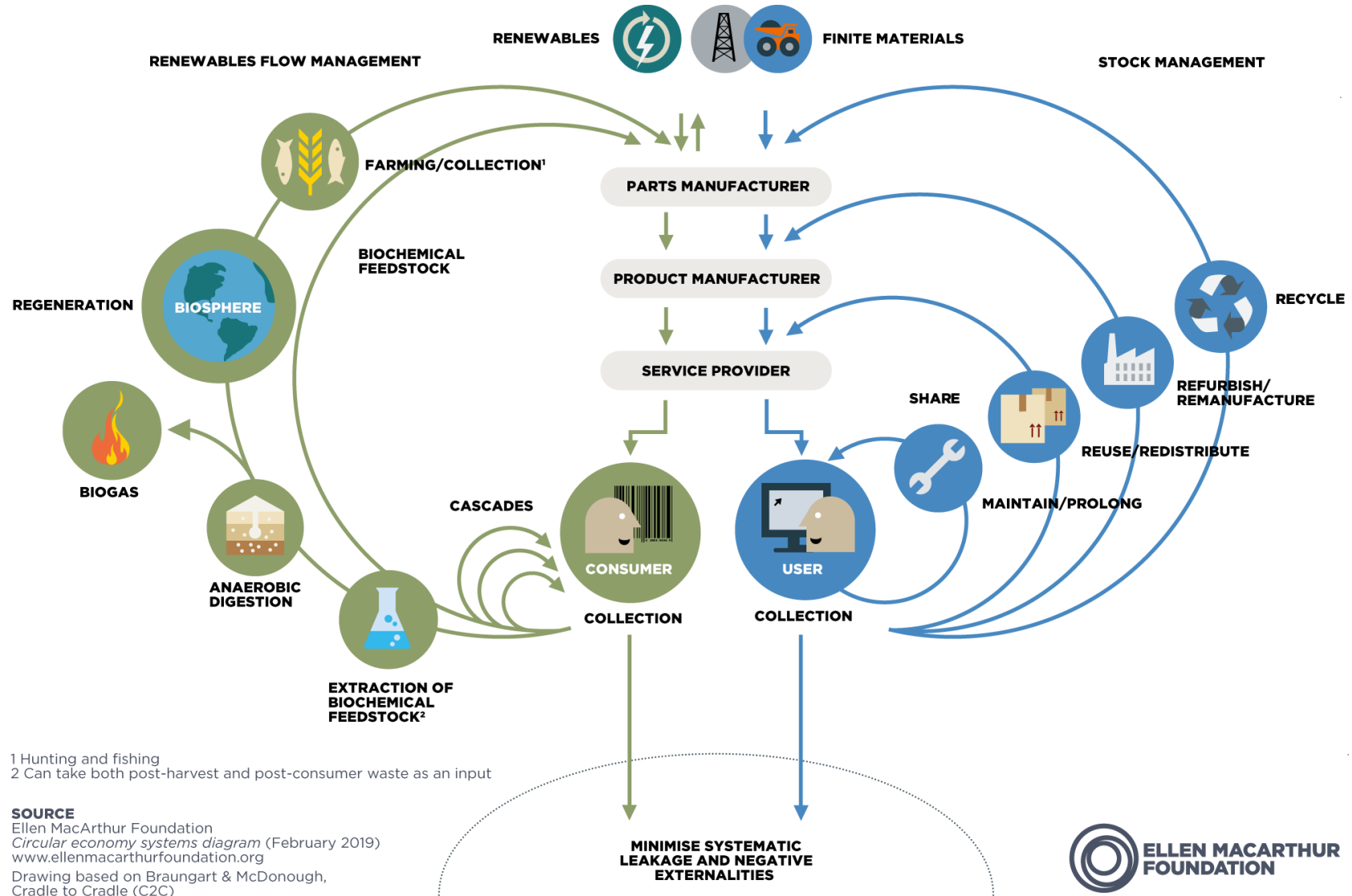
DESIGNING OUT WASTE AND POLLUTION



KEEPING PRODUCTS AND MATERIALS IN USE



REGENERATING NATURAL SYSTEMS



1 Hunting and fishing
2 Can take both post-harvest and post-consumer waste as an input

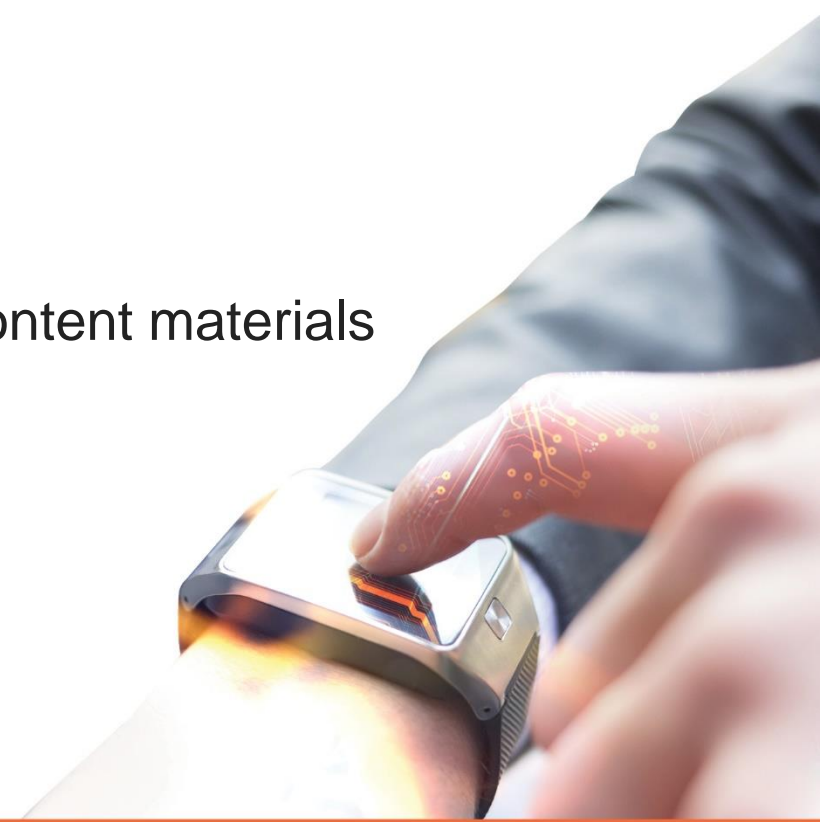
SOURCE
Ellen MacArthur Foundation
Circular economy systems diagram (February 2019)
www.ellenmacarthurfoundation.org
Drawing based on Braungart & McDonough,
Cradle to Cradle (C2C)



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Sustainability Trends in Consumer Electronics

- **Change in consumer purchase behavior**
 - Driven by awareness of human impact on environment
- **OEMs seeking a carbon neutral supply chain**
 - Extended responsibility across value chain
- **Product life cycle considerations...**
 - Increased interest in use of renewable and recycled-content materials
- **... including end of life**
 - Increased recyclability of products
- **Product longevity**
 - Durability, reuse, repair, replace



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Introducing Bio TPU™ by Lubrizol



- First Bio TPU™ solution to market, anticipating market trends
- Revolutionary line of bio-based* TPU made with renewable-sourced material
 - Content ranging from 29% to 67%*
- Provides comparable performance and benefits as traditional petroleum-based TPU
 - Hardness from 82 Shore A to 55 Shore D

**Bio-based content: per ASTM D6866*

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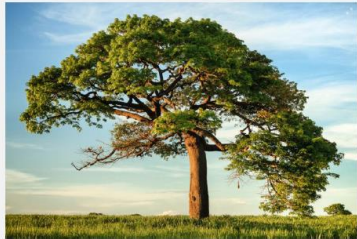
Technical Benefits of Pearlthane™ ECO Family

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Reducing Product Carbon Footprint by Using Bio-Based

Bio-Based content, as measured by ASTM D6866-20 (C14 analysis)

- Biobased content is how much “new” or recent organic carbon is in an object or substance, compared to the amount of “old” organic carbon it contains.

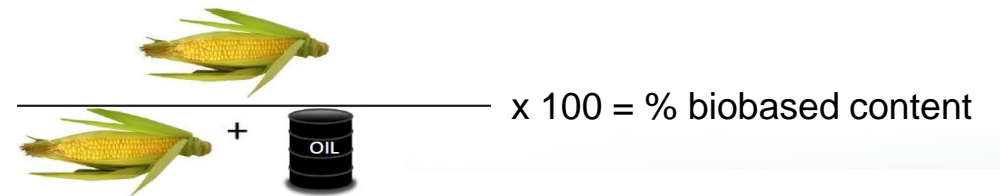


A tree is 100% Biobased



Coal is 0% Biobased

$$\frac{\text{"new" organic carbon}}{\text{"new" organic carbon} + \text{"old" carbon}} \times 100 = \% \text{ biobased content}$$

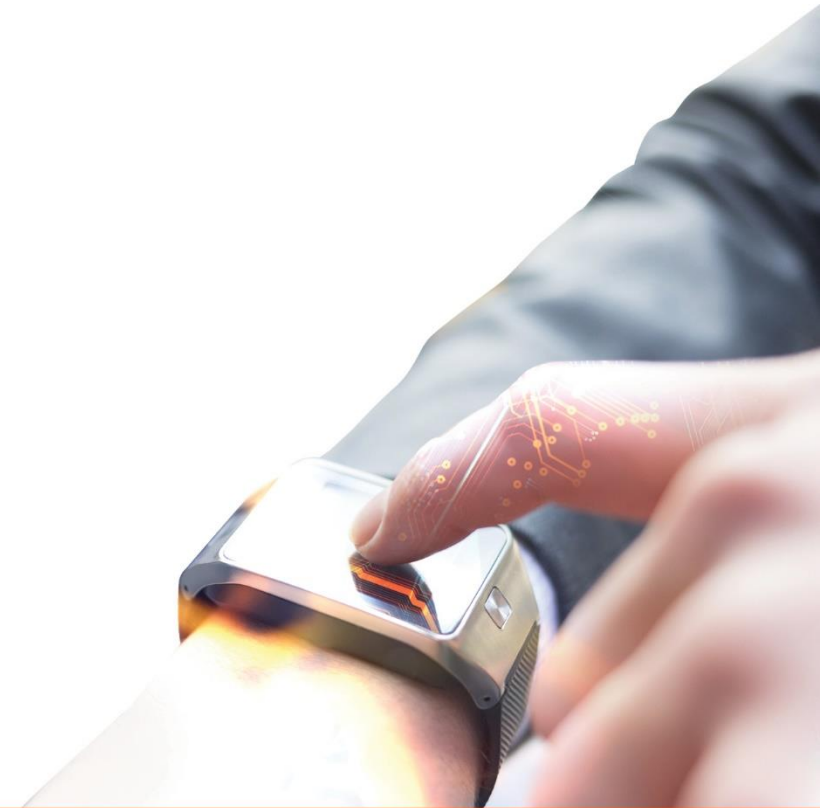


$$\frac{\text{Corn} + \text{Oil}}{\text{Corn} + \text{Oil}} \times 100 = \% \text{ biobased content}$$

Source: https://www.biopreferred.gov/BPResources/files/UnderstandingBiobasedContent_2017.pdf
<https://www.betalabservices.com/biobased/astm-d6866.html>
<https://www.astm.org/Standards/D6866.htm>

Performance Benefits

- Processed via injection molding or extrusion
- Superior **abrasion resistance**
- Very good **chemical resistance**
- **Low temperature flexibility**
- UV and **hydrolysis resistance**
- **Transparency**
- Good **bonding** to Nylon and other substrates
- Outstanding **mechanical properties**
- **Low density**
- **High temperature resistance**



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Pearlthane™ ECO TPU & Pearlbond™ ECO TPU for HMA

- Up to 67% bio-based* content
- Non-GMO
- Non-food source based
- Non-animal feed based
- Better bonding
- Lower density
- More flexible

ECO Grades	Shore hardness	% Bio-based content
Pearlthane™ ECO D12T80E**	82 A	43
Pearlthane™ ECO D12T85	85 A	46
Pearlthane™ ECO DevGrade***	~85A	51
Pearlthane™ ECO D12T90E**	91 A	37
Pearlthane™ ECO 12T95	95 A	32
Pearlthane™ ECO D12T55D	55 D	29
Pearlbond™ ECO 590 HMA	52 D	67

*Bio-based content: per ASTM D6866

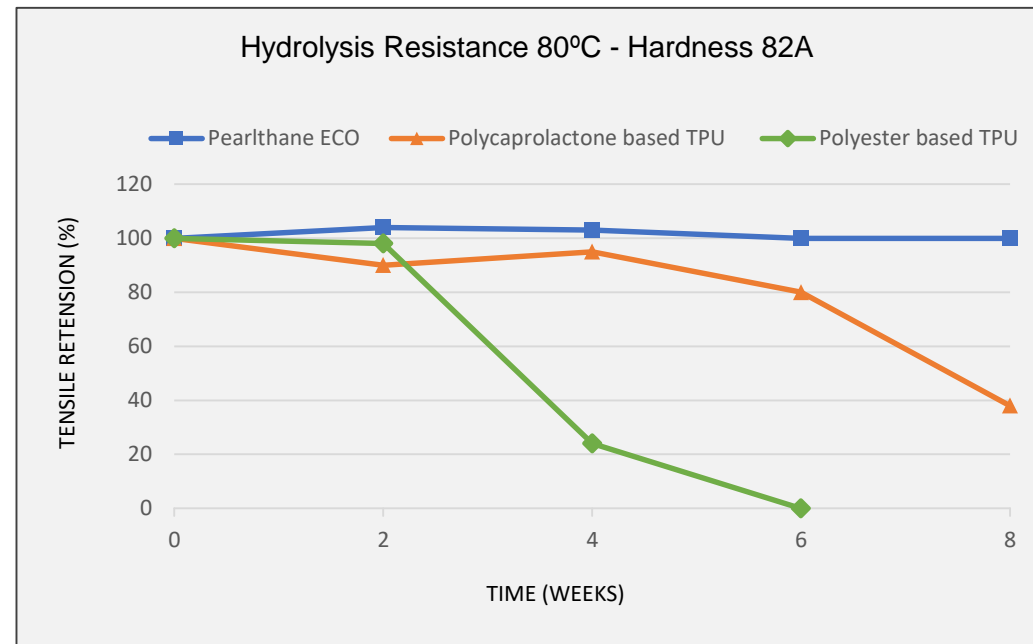
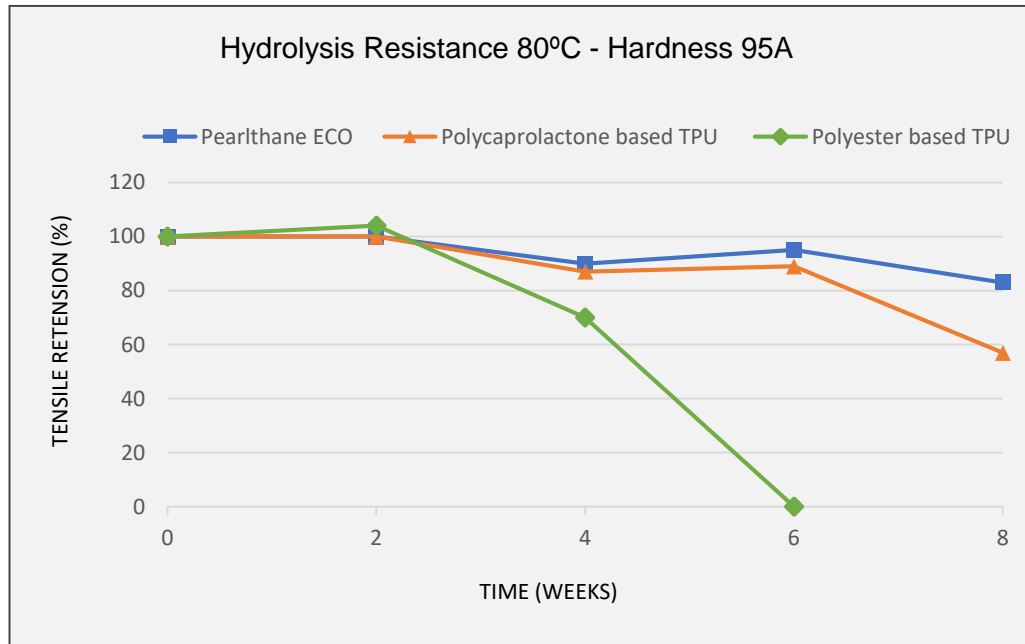
**Food contact grades

***Commercializing in 2021

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Pearlthane™ ECO Grades – Hydrolysis Resistance

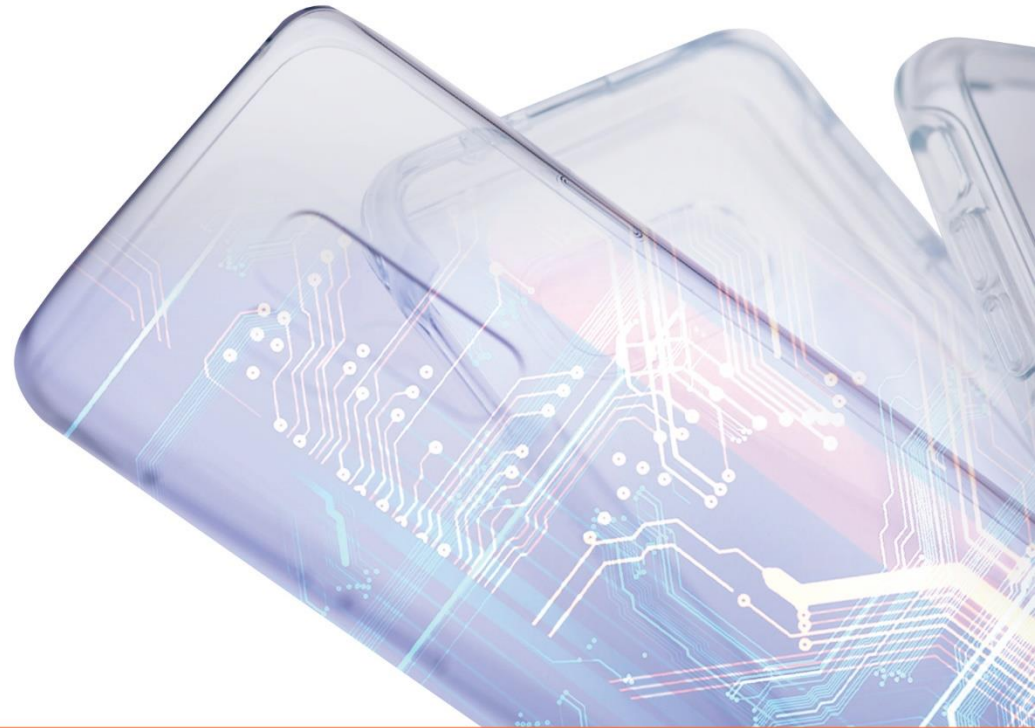
Pearlthane™ ECO maintains 100% tensile strength at 8 weeks



Climate chamber: 80°C, 95% humidity

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Pearlthane™ ECO TPU Grades – Transparency



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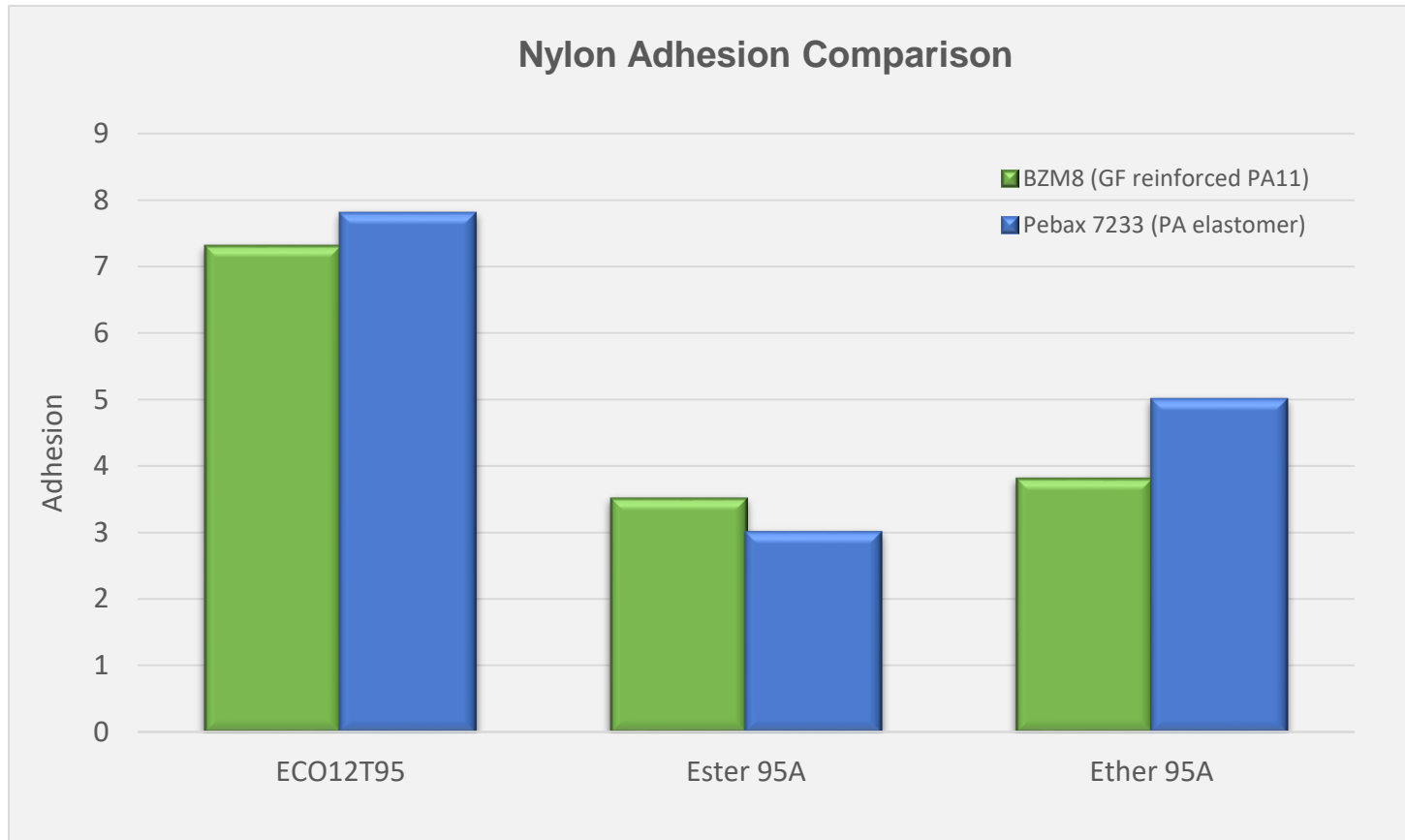
Pearlthane™ ECO TPU Grades – Excellent Adhesion

	Standard Polyester TPU	Pearlthane™ ECO TPU
Rigid polymer	PA11	25
	COPA	104
	ABS	8
	PC/ABS	7
	PC	134

ESTANE® GP 95AB TPU vs. Pearlthane™ ECO 12T95 TPU

5-15 N/cm: low to average degree of adhesion
 15-30 N/cm: good adhesion
 > 30 N/cm: excellent adhesion

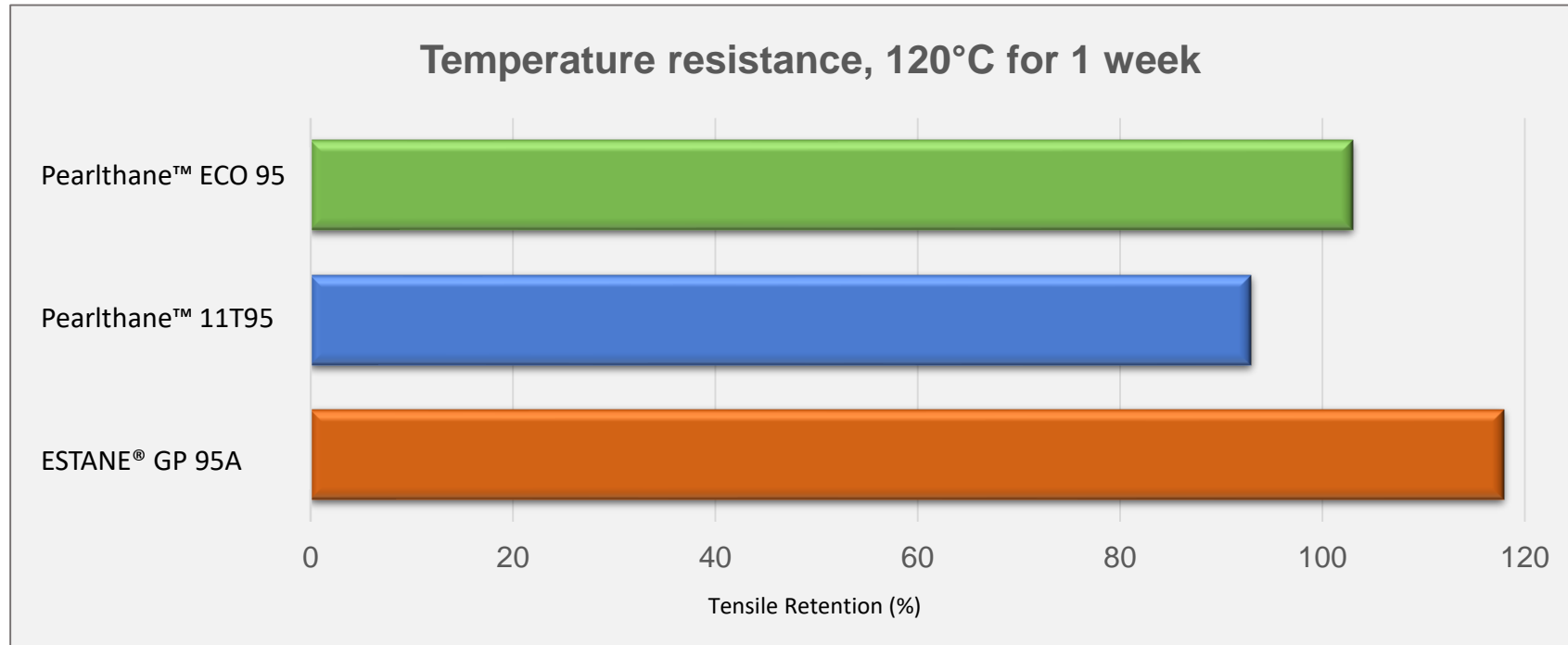
Pearlthane™ ECO TPU Grades – Good Nylon (PA) Adhesion



2K Molding - Peel strength
Mold Temperature : 60°C
1st shot by TPU & 2nd by PA

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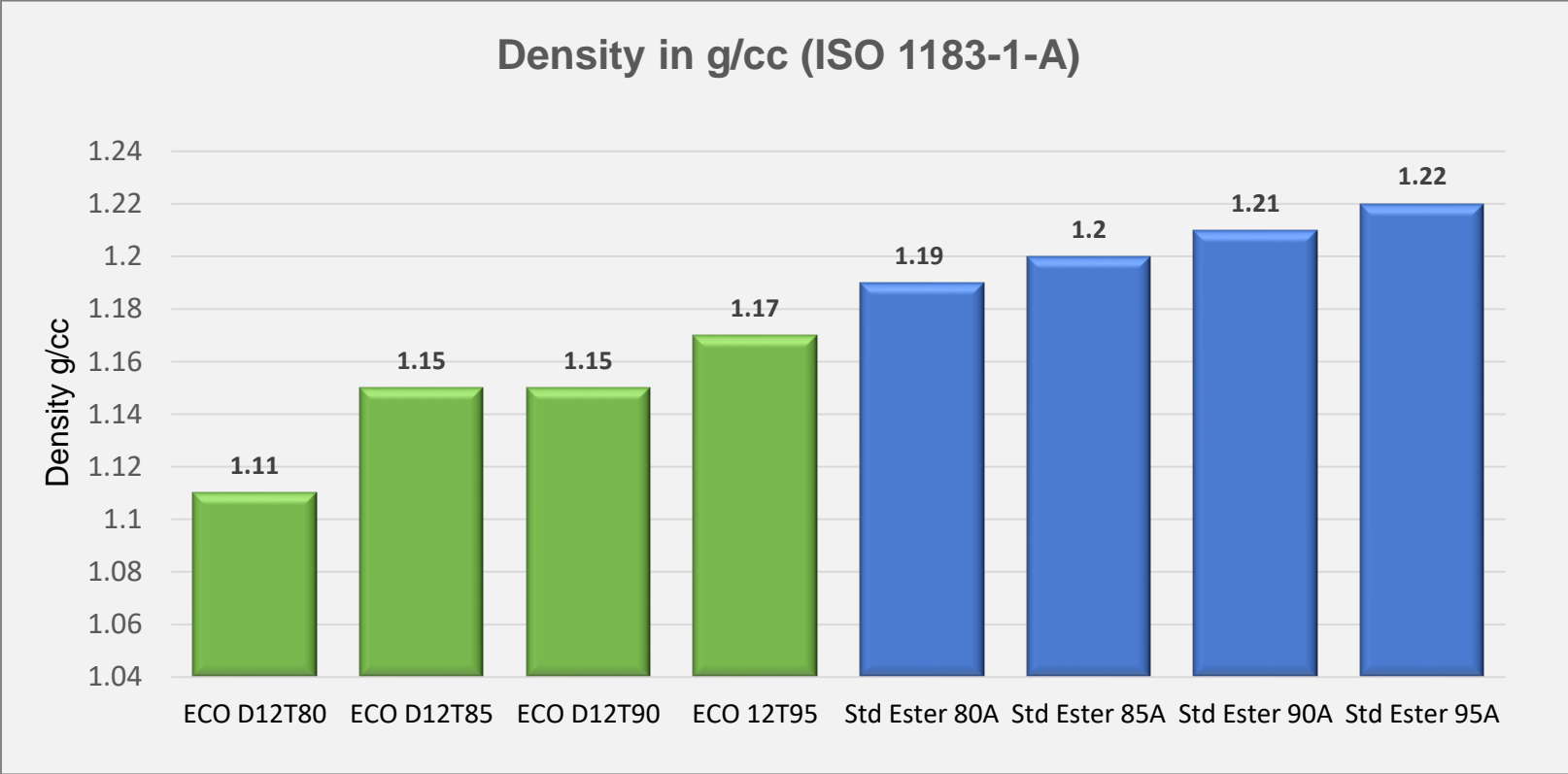
Pearlthane™ ECO TPU Grades – High Temperature Resistance



Hardness 95A

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Pearlthane™ ECO Grades - Low Density



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Pearlthane™ ECO a reflection of our ...

DEDICATED APPLICATIONS EXPERTISE

- R&D staff with expertise processing TPU for major fabrication processes
- Rapid prototyping to **shorten development cycle**
- Development of custom applications and test methods



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OUR BROAD APPLICATION CAPABILITIES



EXTRUSION

- Cast or Blown Film
- Single or Multi Layer
- Capstock
- Interlayer Construction

MOLDING

- Compression Molding
- Injection Molding
- Overmolding

LAMINATION

- Heat Lamination
- Compatible with Film or Sheet

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MATERIAL SCIENCE EXPERTISE

- **Microscopy, X-Ray & Surface Science**
- **Spectroscopy** MS, NMR, IR & UV/VIS
- **Polymer Physics** DSC, DMA, TMA, TGA & Rheology
- **Chromatography** GC, GC/MS, IC, SFC, GPC, HPLC & LC/MS



- Polymer process simulation
- Inorganic & Wet Chemistry ICP, PC
- Physical & Mechanical Properties Testing



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Benefits Recap

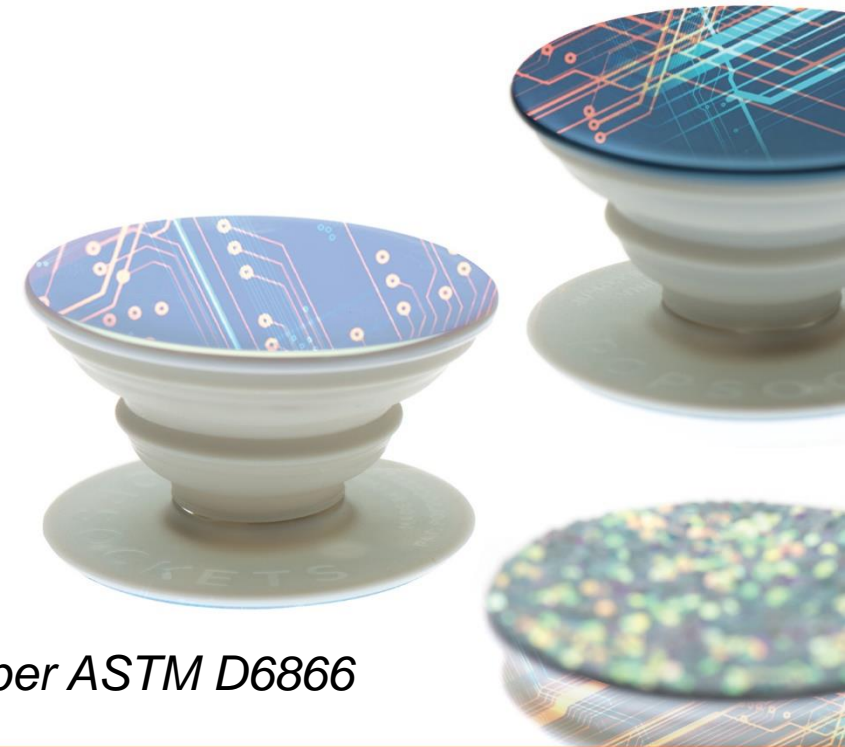
Bio TPU™ is a bio-based* material offering comparable performance to traditional petroleum-based TPU, with the following added benefits:

- Low Density
- Adhesion to PA
- Hydrolysis Resistance vs Ester types
- Low Temperature Flexibility

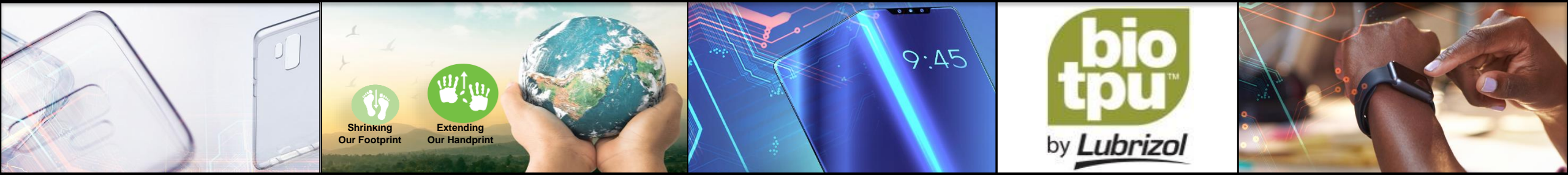
Bio-based content of Pearlthane™ ECO TPU series is from renewable sources non-competing with food chain.

**Bio-based content: per ASTM D6866*

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Summary



Pearlthane™ ECO Family – innovative solutions for a changing world...


- The world around us is going through a mindset of “Reset”
 - We must drive a more sustainable future
- At Lubrizol, we believe in Maximizing our positive impact on people and planet
 - Helping the world move cleaner, create smarter and live better
 - A global organization aligned with local support, with broad capabilities & extensive portfolio
 - Achieving consumer expectations and sustainability
 - Committed to being your partner – even in challenging times!
 - Where you need us, when you need us

Inspiring Sustainability, Improving Lives

For More Information, Visit: <https://www.lubrizol.com/sustainability/>

MOVE CLEANER
CREATE SMARTER
LIVE BETTER

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From the invention of ESTANE® TPU through our newest innovations, we improve lives and deliver success by helping customers solve problems they once thought impossible. We bring together the people, ideas and technologies that can enable new designs, better performing products and more sustainable outcomes. We're proud to be part of The Lubrizol Corporation, a Berkshire Hathaway company. Lubrizol combines market insights, chemistry and application capabilities to deliver efficiency, reliability and wellness in global transportation, industrial and consumer markets.

To learn more, visit www.lubrizol.com

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