# A Success Story; TPO Made From PureFive®

**PureCycle**

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# AGENDA

1. Introduction
2. PureCycle Process
3. TPO from recycled PP (rPP) in:
    1. Bumper Fascia (TPO 2025)
    2. Interior Automotive Applications (New Development)
4. Summary

# Introduction

# The Automotive Industry Needs Performance

## Interior and Exterior applications have tight requirements:

- **Impact Resistance**
  - Repeated recycling ↓ impact strength and other important mechanical properties
- **Aesthetics**
  - Unmelted particles → surface defects
  - Contaminants → inconsistent color → difficult color matching
  - Inconsistent PCR feedstock quality ↓ consistency
- **Odor and VOC's** (*specially for interior applications*)
  - Repeated recycling → degradation → unpleasant smells and "fogging"




**Recycled Polypropylene (rPP) and Recycled Thermoplastic Olefins (rTPO) are the keys to sustainability in automotive applications**

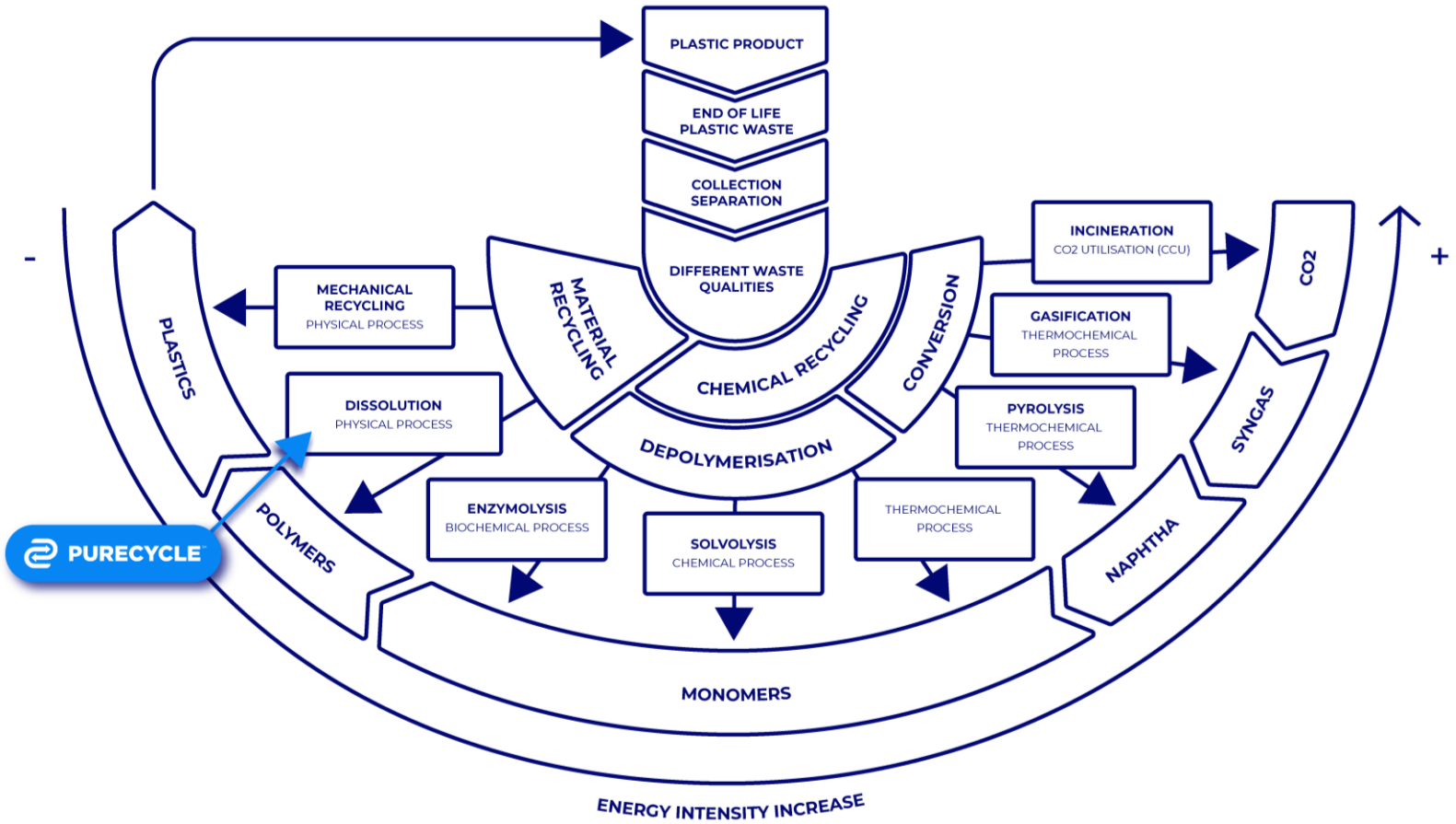
# The Market

| | |
|---|---|
| **Regulatory Mandates** | European End-of-Life Vehicles (ELV) directive targets higher post-consumer recycled (PCR) plastics content in new vehicles |
| **Sustainability Goals** | Major OEMs (e.g., BMW, Volvo, VW) committed to 20–30% recycled plastics by 2030 |
| **Carbon Footprint Reduction** | Using rPP reduces cradle-to-grave lifecycle emissions significantly compared to virgin equivalent[1, 2, 3] |

1. https://plasticsrecycling.org/wp-content/uploads/2024/08/APR-Recycled-vs-Virgin-LCA-May2020.pdf
2. https://langgengjayagroup.co.id/blog/recycled-polypropylene-the-future-of-sustainable-packaging
3. https://www.researchgate.net/publication/377431690_Life_Cycle_Assessment_of_a_Plastic_Part_Injected_with_Recycled_Polypropylene_A_Comparison_with_Alternative_Virgin_Materials

# PureCycle's Dissolution Recycling Process

# Diversity of Plastics Recycling Technologies




*Graphic via nova-institute.eu

PureCycle's dissolution recycling process is NOT chemical recycling.

Dissolution is a physical process and does not break the polymer chain.

**Key Benefits**

- High product quality
- High plastic recovery rate for reuse
- Low energy usage and low carbon footprint

*Nova-institute.eu 2023 ; https://renewable-carbon.eu/publications/product/mapping-of-advanced-plastic-waste-recycling-technologies-and-their-global-capacities-short-version-pdf/*

# From PCR to 100% PureFive® rPP

## Feedstock

Film



Fiber



Flakes (mixed rigids)



## Extraction

- Add Solvent

## Mixing & Settling

## Filtering

## Solvent Recovery

## PureFive®

**Purified Recycled Pellets**



**Removes:**

**Co-Product 1**

- Odor, Residuals & Oligomers

**Co-Product 2**

- Polyethylene
- Solids/Non-melts
- Non-polyolefin Polymers

- Pigments/Colors, Contaminants & Small Particles

- Solvent: Recovered & Reused

# PureFive® Purified Post-Consumer Resins in Interior TPO Automotive Applications

# **Prior Work (TPO'25):** External Bumper Fascia Cover - VW Atlas




Source: VWGoA - Innovation Hub Knoxville

**Bumper Fascia tests** [1]

| Test name | Results |
|---|---|
| 50 cycles (environmental testing), *internal test* | 🟢 |
| Temperature Resistance: - 30°C, *internal test* | 🟢 |
| Florida Weathering (2 cycles), *internal test* | 🟢 |
| Impact testing, *internal test / ISO 6603* | 🟢 |
| Flexural Strength Method A, *ISO 178* | 🟢 |
| Cross-cut testing, *internal test / ISO 2409* | 🟢 |

🟢 **OK**

*1, Sustainable Post Consumer Recycled PP for Class A Automotive Applications, S. Blackson, TPO 2025*

# Current Focus: TPO for Interior Trim Applications

## Requirements:

- ✓ High impact resistance
- ✓ High heat resistance
- ✓ High rigidity
- ✓ Moldability
- ✓ **Low VOC**

**Hard TPOS**
Interior roof pillar molding

**Hard & soft TPOS**
Instrument panel components, plus soft touch controls

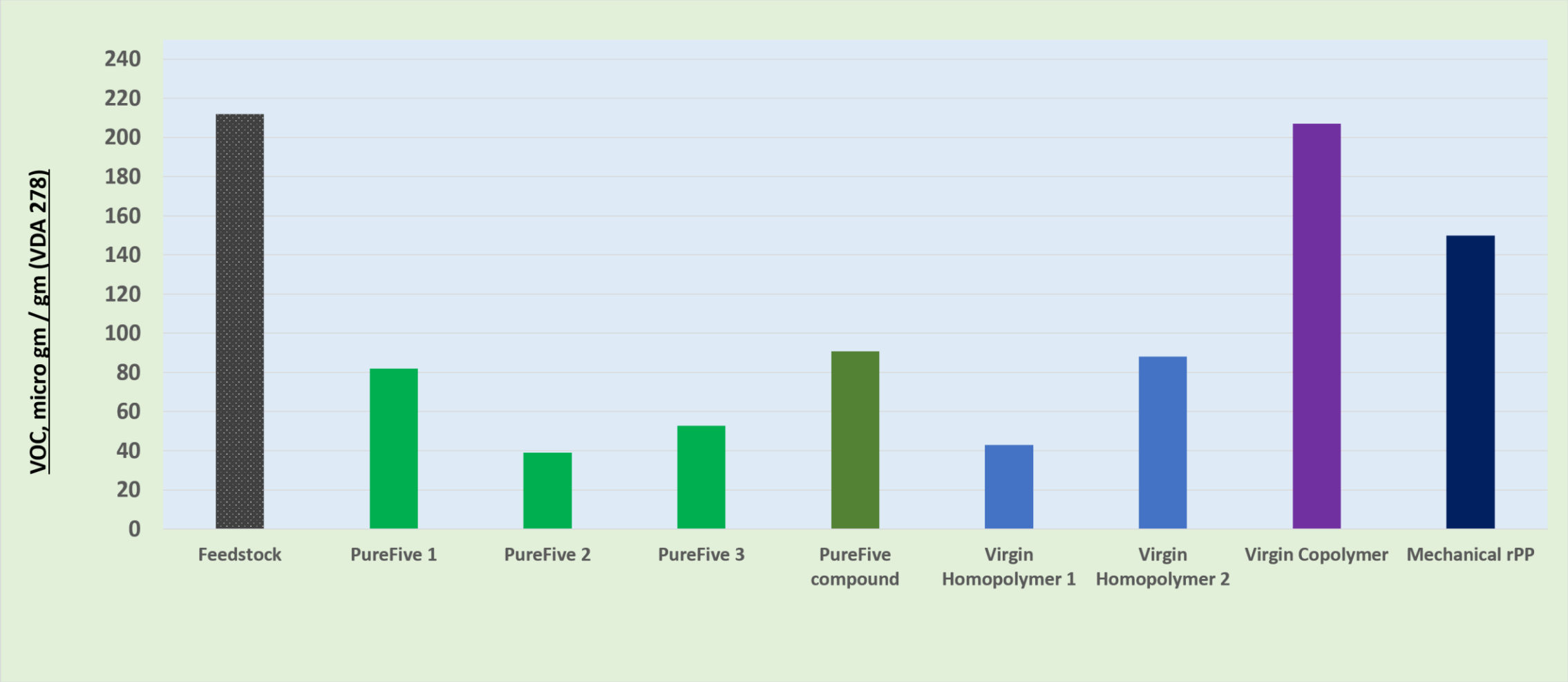
**Soft TPOS**
Simulated leather in interior door panel



**Soft TPO skin**
Simulated leather console covering

**Hard TPOS**
Knee bolsters

# **Volatile Organic Compounds (VOC),** VDA 278




A lower-temperature extraction (typically **90°C**) to release highly volatile organic compounds (**VOC**) up to $C_{25}$. The thermally extracted vapors are transferred to a gas chromatography-mass spectrometry (**GC-MS**) system where they are separated, identified, and quantified against chemical standards

# Formulations

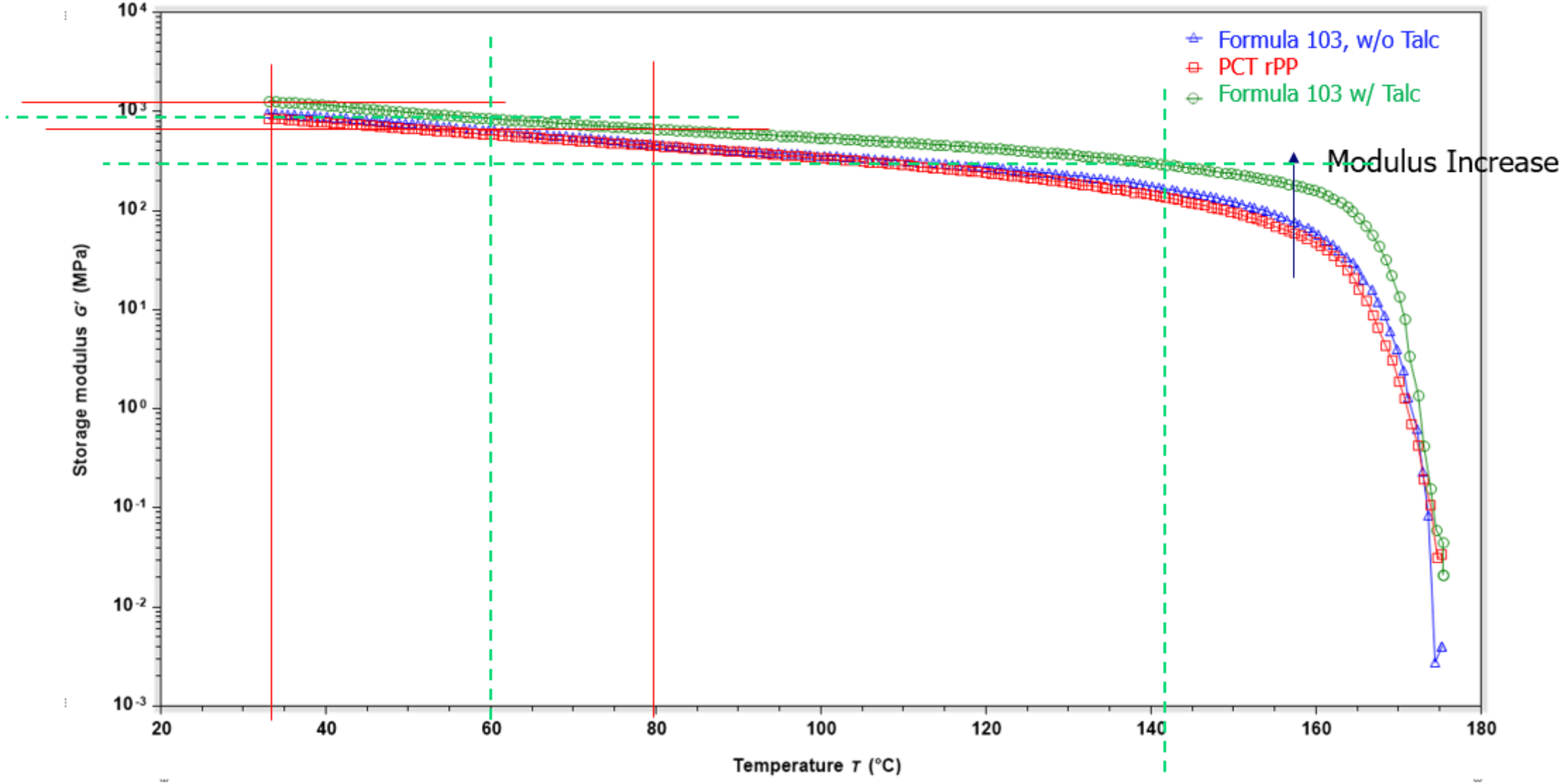
| Formula | 101 | 102 | 103 | 204 | 205 | 206 |
|---|---|---|---|---|---|---|
| **PureCycle hPP, %** | **30** | **30** | **27** | **30** | **28** | **27** |
| Virgin Resin 1 | ✓ | | | ✓ | ✓ | ✓ |
| Virgin Resin 2 | | | ✓ | | ✓ | ✓ |
| Virgin Resin 3 | | ✓ | | ✓ | ✓ | |
| EO 1 | ✓ | | | ✓ | ✓ | |
| EO 2 | | ✓ | ✓ | ✓ | | ✓ |
| Filler 1 | ✓ | | ✓✓ | ✓✓ | ✓✓ | ✓✓ |
| Filler 2 | | ✓ | | | | |

# Initial Results

| Formula | | 101 | 102 | 103 | 204 | 205 | 206 |
|---|---|---|---|---|---|---|---|
| **MFR** | *g/10 min* | 20 | **10** | 21 | 23 | 26 | 23 |
| **Density** | *g/cc* | 0.95 | 0.98 | 1.02 | 1.04 | 1.04 | 1.04 |
| **Flexural Modulus, @ 23 °C** | *MPa* | 1100 | 1200 | **2100** | 1900 | 2000 | 2000 |
| **Tensile Strength, @ 23 °C** | *MPa* | 18 | 19 | 30 | 23 | 26 | 24 |
| **Notched Izod @ 23°C** | *ft-lbs/in* | **10.9** | 7.1 | 7.3 | 8.0 | 1.9 | 3.1 |

Results are for one sample, ~5 specimens each.  Typical standard deviation is less than 10%

# **Initial results;** PureFive rPP behaves like virgin PP



# Initial Results, *comparison to other TPO*

| Formula | | 101 | 103 | 204 | TPO-8 | TPO-9 |
|---|---|---|---|---|---|---|
| **MFR** | *g/10 min* | 20 | 21 | 23 | 21 | 20 |
| **Density** | *g/cc* | 0.95 | 1.02 | 1.04 | 1.03 | 1.04 |
| **Flexural Modulus, @ 23 °C** | *MPa* | 1100 | 2100 | 1900 | 1900 | 1600 |
| **Tensile Strength, @ 23 °C** | *MPa* | 18 | 30 | 23 | 19 | 19 |
| **Notched Izod @ 23°C** | *ft-lbs/in* | 10.9 | 7.3 | 8.0 | 9 | 10 |

Results are for one sample, ~5 specimens each. Typical standard deviation is less than 10%

# **Initial results,** Typical requirements compared to Formula 103

| | Average Typical Requirements | Formula 103 |
|---|---|---|
| **MFR,** *g / 10 min* | Between 15 - 35 | 21 |
| **Spec Grav** | Less than 1.1 | 1.02 |
| **Flex Mod,** *GPa* | More than 1.6 | 2.1 |
| **Tensile strength,** *MPa* | More than 20 | 23.3 |
| **HDT** *@ 0.45 MPa* | More than 100°C | 116°C |
| **Flex modulus,** *MPa*, **@** *80°C* | More than 600 | 690 |
| **Notched Charpy** *@23°C, KJ/m²* | More than 10 | 14.5 |
| **Notched Charpy** *@-30°C, KJ/m²* | More than 5 | 5.7 |

Results are for one sample, ~ 5 specimens each. Typical standard deviation is less than 10%

# Summary

# 3 Takeaways

1) Discussed the properties of automotive interior TPO materials made from PCR PP from curbside recycling that was recycled using PureCycle's dissolution recycling process

2) Demonstrated that compounds made from PureFive® met the typical requirements for interior trim compositions at:

   ✓ Room temperature

   ✓ Elevated temperatures (80°C)

   ✓ Sub-ambient temperature (-30°C)

**3) PureFive® presents a real pathway to incorporating PCR PP content in interior automotive applications**