Transforming the world to more sustainable feedstocks

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DuPont™
Renewably-sourced™
Materials

Overview

Transforming the world to more sustainable feedstocks

DuPont's Performance Materials approach to renewable materials

DuPont's growing family of Renewably Sourced (RS) materials

Commercial

- Sorona® EP PolyTrimethylene Terephthalate (PTT)
- Hytrel® RS™ Thermoplastic Elastomers
- Zytel® RS™ Polyamide Resins

Developmental

- PolyTrimethyleneFurandicarboxylate (PTF) Barrier resin
- High performance polyesters based on isoidide – through consortium BPM Hippie project

DuPont's History & Approach to Renewable Materials

Abridged History of DuPont Biomaterials

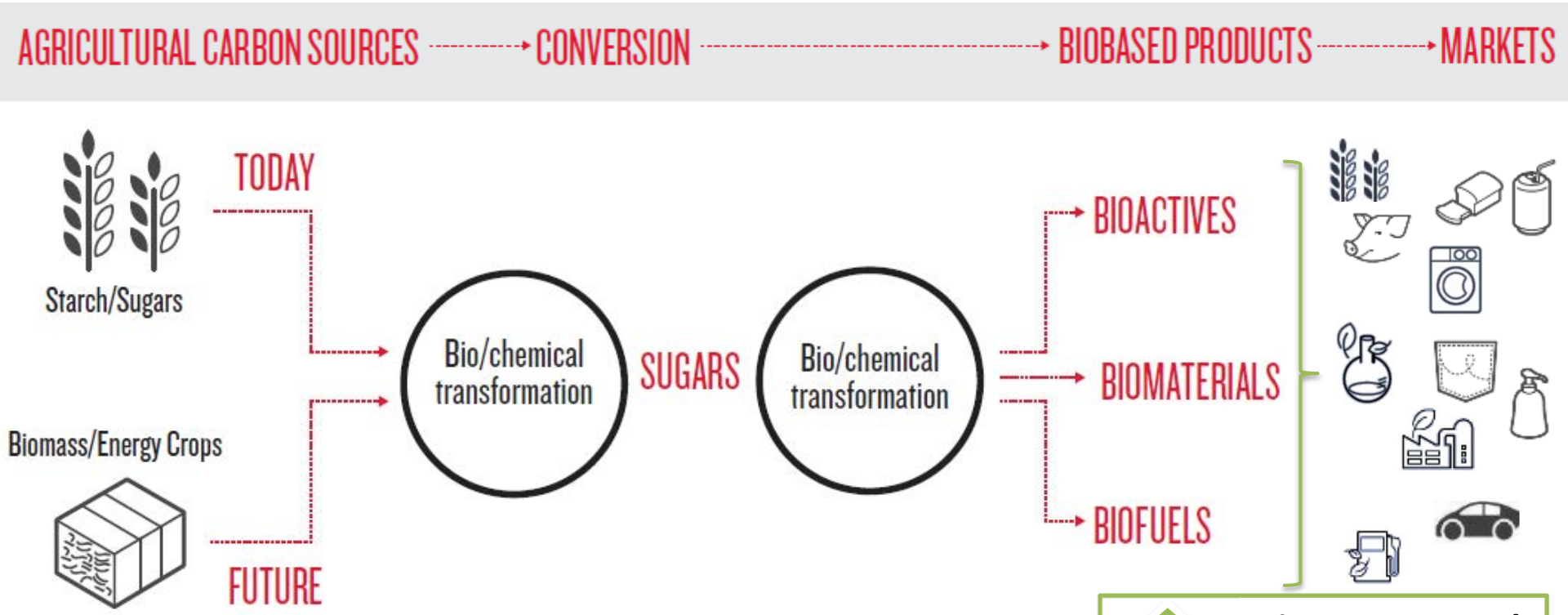
- Founded in 1803 as an explosives company.
- Diversified into cellulose-based materials in early 1900s. Developed first “nylon”, PA510, in 1934. This was a biobased nylon derived from castor beans. PA66 from petroleum sources was later developed to reduce costs.
- Built world-leading petro-based materials businesses during the 20th century through R&D and acquisition.
- Commercialized a portfolio of new biobased engineering polymers in the last 10+ years.

Wallace Carothers
Invented Neoprene® and Nylon

- In addition to biobased materials/polymers, DuPont biotechnology is leading the world in biofuels with cellulosic ethanol and biobutanol. DuPont enzymes are used across a wide range of industries to improve products and make processes more sustainable.

Sugar Becomes our New Oil

Alternative, Low Cost Sources of Carbon: the Foundation for a Biobased Economy



Availability: Increasing ag productivity; geographic diversity

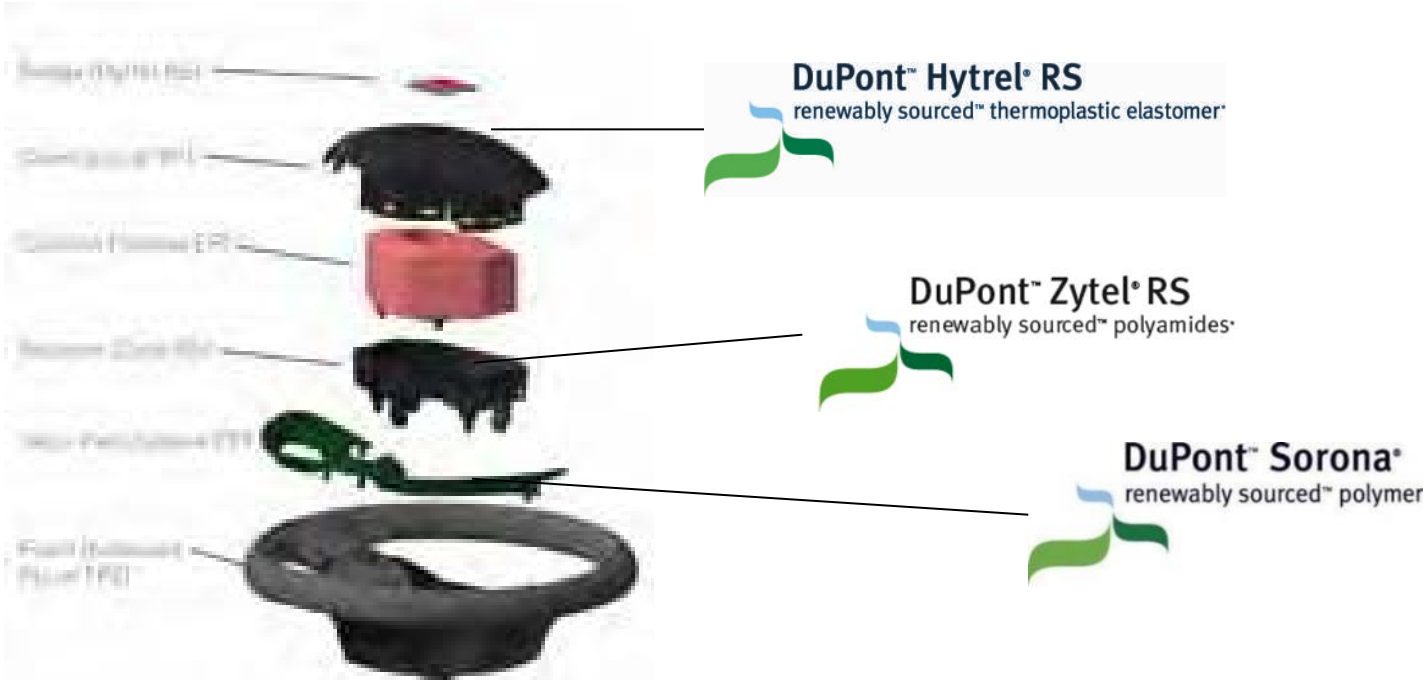
Manufacturing costs: Technology breakthroughs; New enzymes and bioprocesses

Diverse Demand: Regulatory; Product and Process; Performance; Green claims

DuPont's Portfolio of Bio-Based Polymers

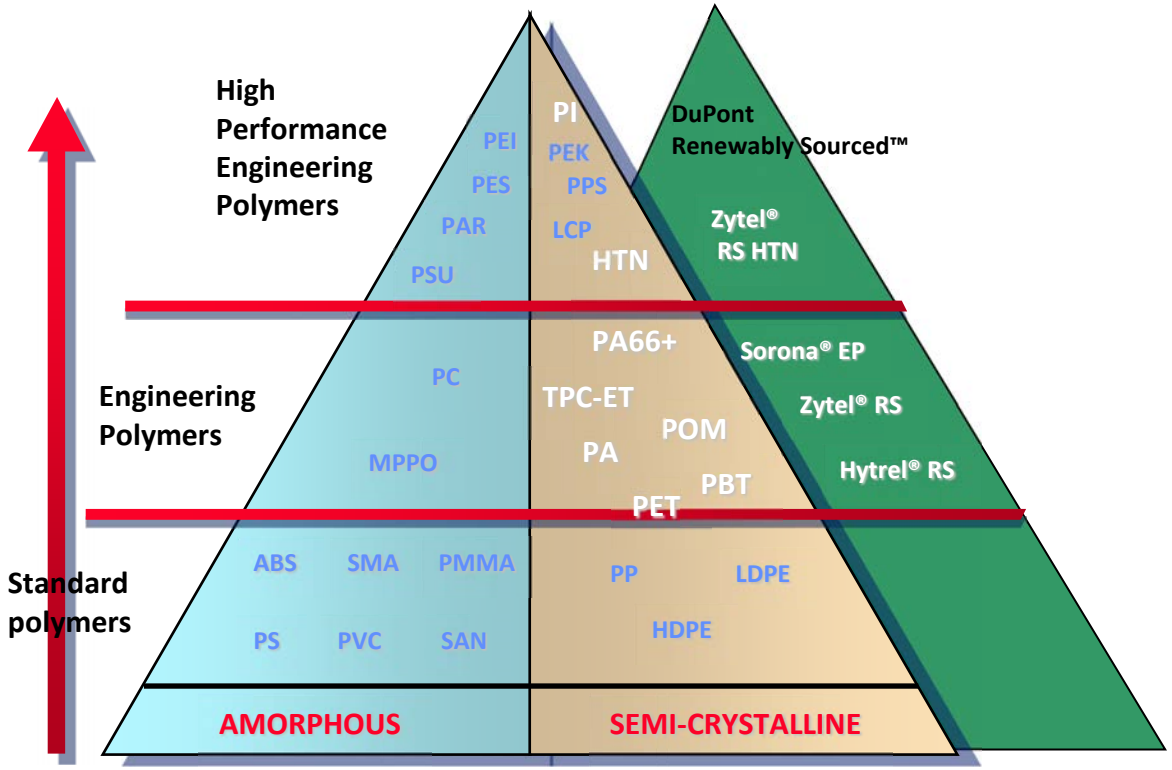
TAKATA wins 2012 Bioplastics award with DuPont RS products

2012 Bioplastics Award



DPM Renewably Sourced Engineering Polymers

- Zytel® Nylon and Zytel® HTN
- **Zytel® RS Renewably Sourced Polyamides**
- Delrin® Acetal
- Vespel® Polyimide
- Tynex® Filaments
- Rynite® PET
- Crastin® PBT
- **Sorona ® EP Renewably Sourced**
- Hytrel® TPC-ET
- **Hytrel ® RS Renewably Sourced**



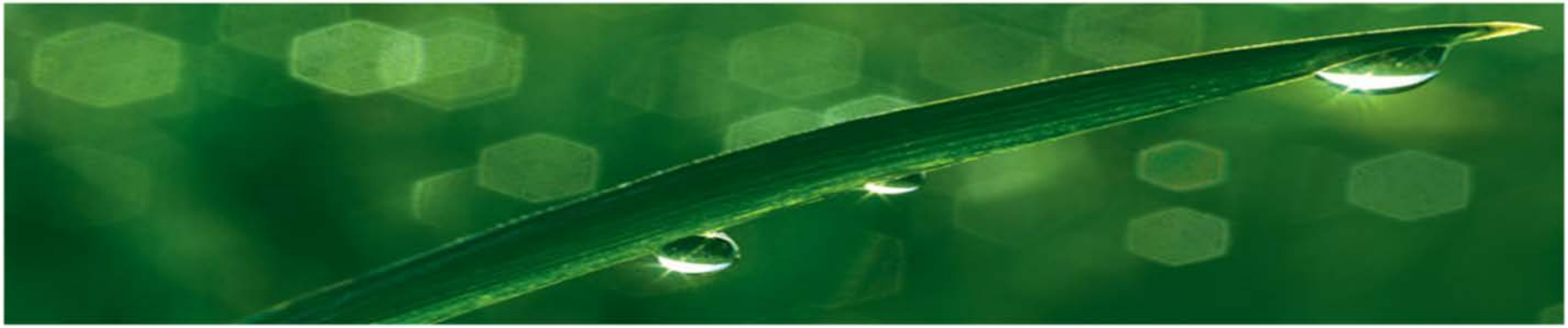
- Products in green are commercial today and competitive with petroleum based equivalents.
- Technology exists to convert half our product line to biobased today but further improvements to improve cost efficiencies are still required.

Terminology

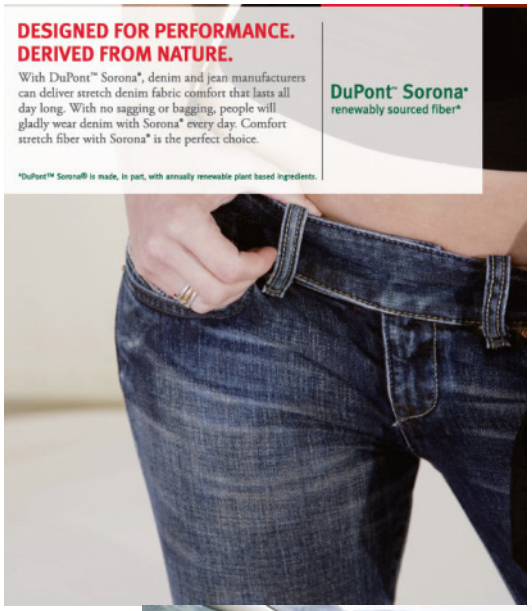
- **RENEWABLY SOURCED** and **BIO-BASED** define the same thing. It refers to a material that contains carbon originating from a renewable plant source. DuPont™ Renewably Sourced™ materials contain a minimum of 20% renewably sourced ingredients by weight.

- **RENEWABLY SOURCED** can include **BIODEGRADABLE** products that can be broken down by living organisms like bacteria. It also includes durable goods that are designed for long life.

- Products discussed in this presentation are for durable good type applications.



Sorona® Polymer and Bio-PDO™

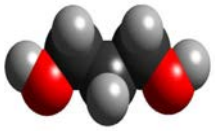


Sorona® Polymer

Basic product properties

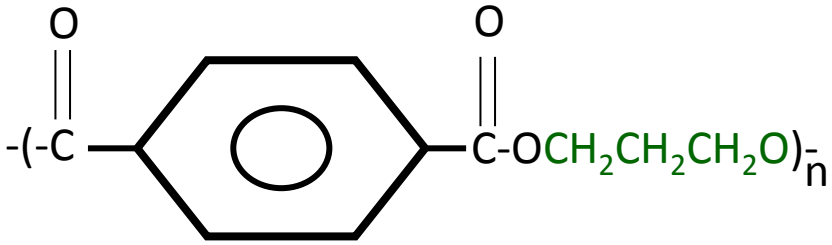
	Sorona®	PET	PBT	Nylon 6	Nylon 6,6	PP	PLA
Melt Temperature, Tm (^{0}C)	228	260	225	222	262	160	130-175
Glass Transition, Tg (^{0}C)	50-70	70 - 80	25 - 35	40 - 60	45 - 65	-30	55 - 65
Density	1.33	1.38	1.32	1.14	1.14	0.91	1.25

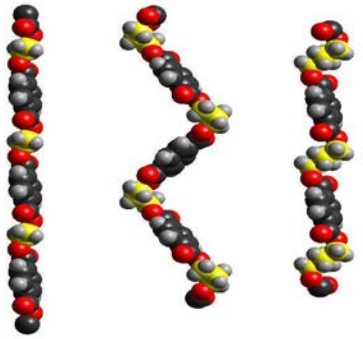
1,3-propanediol + **DMT / TPA**



Bio-PDO™

Catalyst

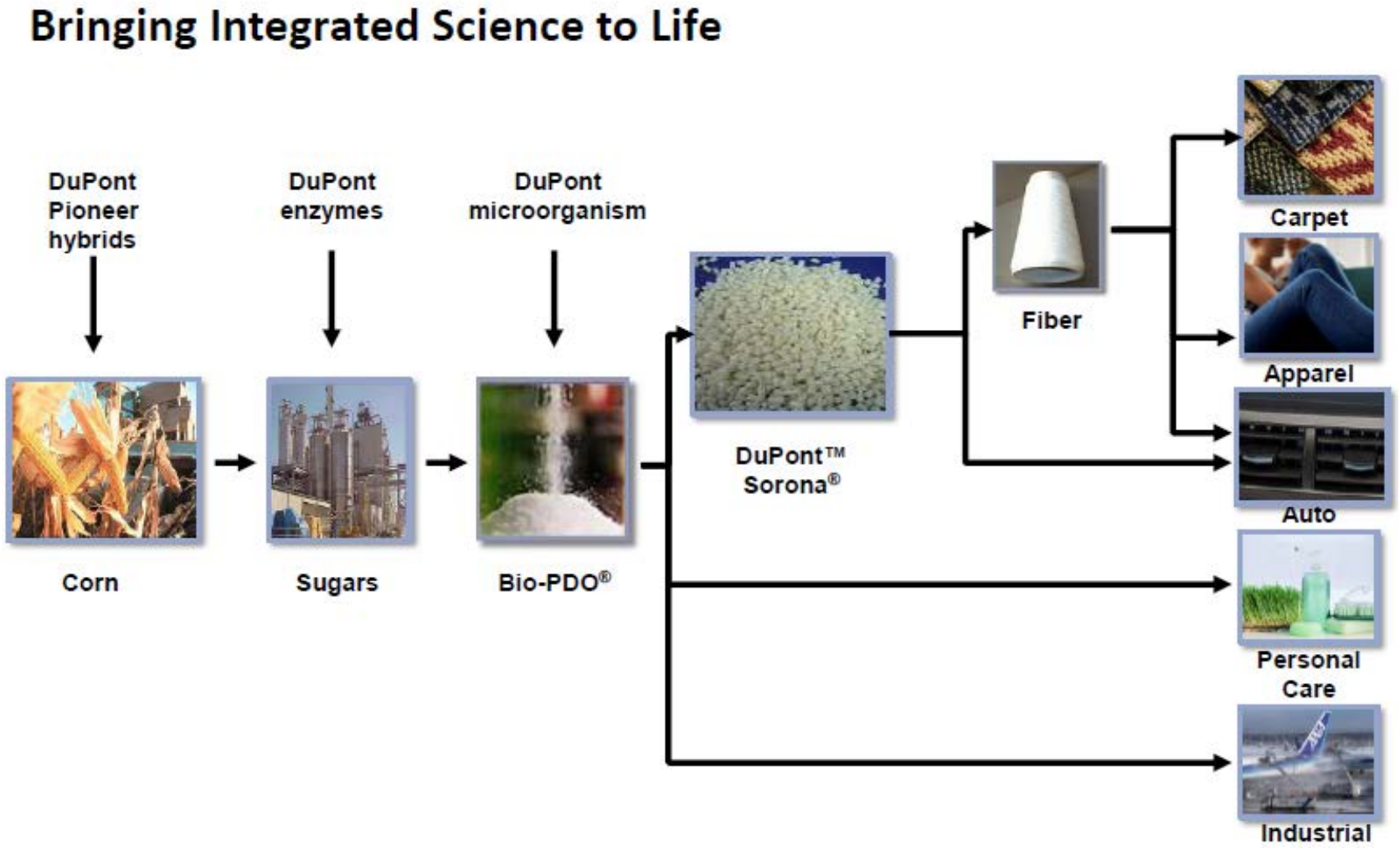




2GT PET **3GT PTT** **4GT PBT**

DuPont™ Sorona® Polymer Platform for Multiple Markets

Combination of Bio-PDO® with polymer, engineering and fiber competencies

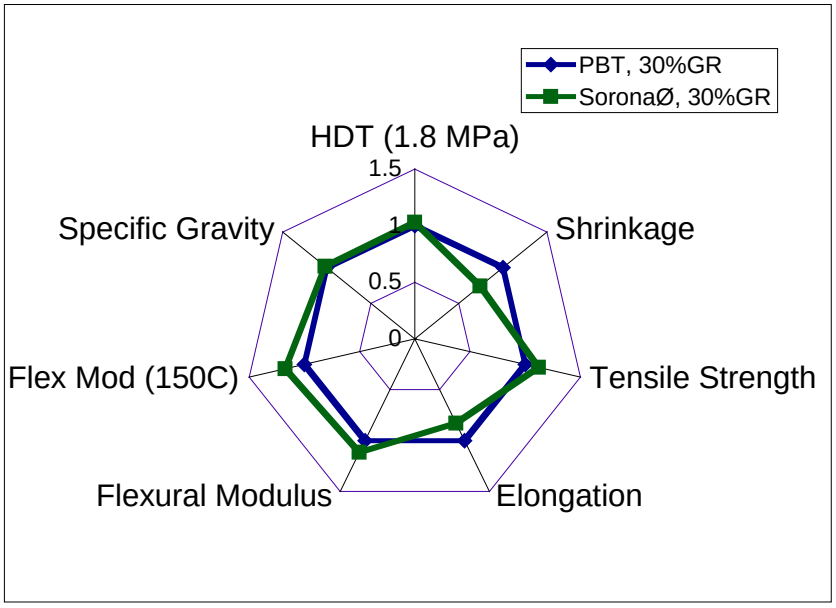


BioMaterials: 1,3-Propanediol from Glucose

Bio-PDO®: A Case Study in Platform Molecules

Sorona® EP Thermoplastic Polyester

- **PTT polyester similar to PBT in performance and price.**
- **Better surface appearance, UV resistance.**
- **Stronger and stiffer than PBT.**
- **Lower shrink vs PBT, less warpage.**
- **Improved hydrolysis resistance and laser weldability. Slightly better electrical properties**



Potential Applications

- Electronic control module housings
- Headlamp bezels
- Connectors, electrical, electronic parts
- Handles, seat trim components
- Any painted part (eliminate paint)

DuPont's internal cradle-to-gate LCA study, based on design data and peer reviewed

	Sorona PTT	PTT Propylene Route	Polyamide 6
Greenhouse gas emissions in kg CO_2 equivalent/kg	3.38 [1, 2]	4.42 [1]	9.1 [4]
Non-renewable energy consumption in MJ/kg	83.8 [1, 5]	101.2 [1, 5]	120.5 [4, 5]

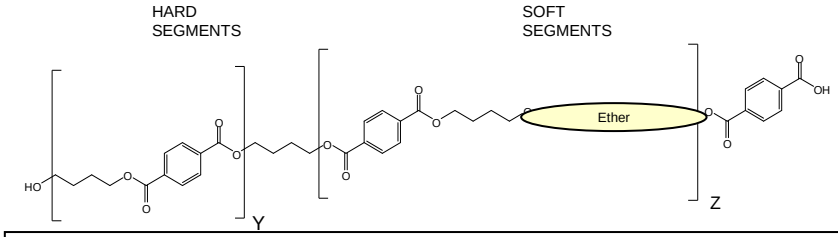
1 - peer reviewed Bio-PDO / Sorona LCA (Prof. Konrad Saur, Five Winds International, based on design data)
2 – includes carbon sequestered in the product
4 – Plastics Europe (March 05) A. Boustead
5 – heating value (top value) basis

Hytrel® RS Thermoplastic Elastomer

Hytrel® RS Thermoplastic Elastomer

Drop-in commercial replacement for all Hytrel® grades

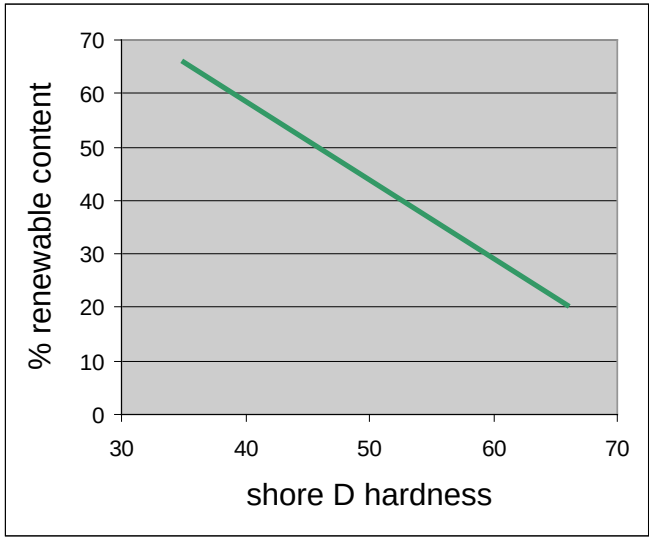
- **Excellent elasticity & low temperature flexibility**
- **Good chemical & oil resistance**
- **Uses waste biomass foodsource.**
- **Specialized grades for air bag doors and blow molded air ducts**
- **Applicable for next-generation jounce bumpers**



In Hytrel® RS, petroleum sourced polyether glycols in the soft segments are replaced by Renewably Sourced polyether glycols made from non-food biomass.

Air bag door cover

Jounce bumper



The renewably sourced content of Hytrel® RS varies with the hardness of the grade

Bio based carbon content

BETA

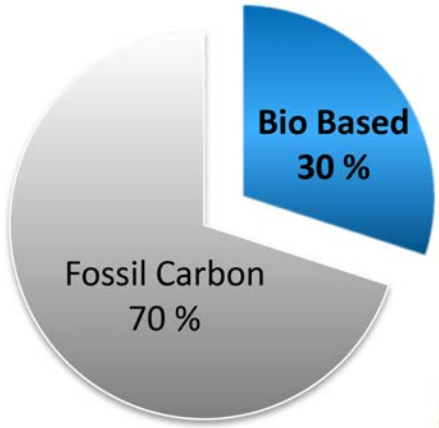
ISO-17025 Accredited Testing Laboratory

PJLA ISO/IEC 17025:2005 Testing Accreditation# 59423

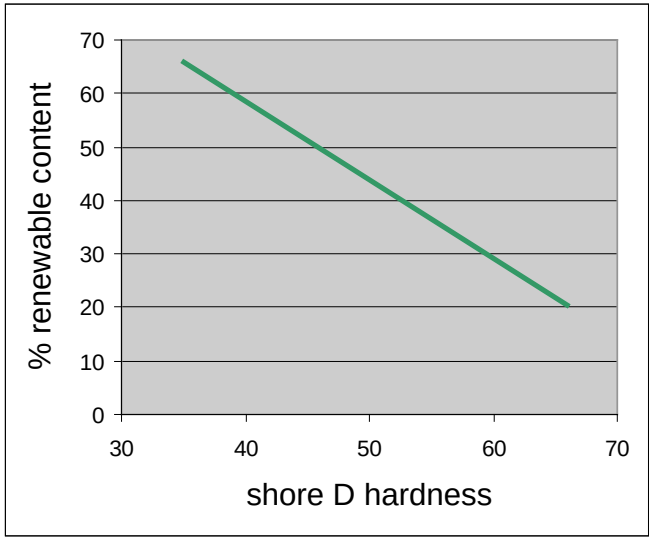
Beta Analytic Inc.
4985 SW 74 Court
Miami, Florida 33155 USA
Tel: 305-667-5167
Fax: 305-663-0964
info@betalabservices.com
www.betalabservices.com

Report of Biobased Content Analysis using ASTM-D6866-11

Bio based content



The percentage of carbon in Hytrel® RS R4275 BK316 that is derived from renewable sources is determined by C14 measurements according to ASTM D6866.



The renewably sourced content of Hytrel® RS varies with the hardness of the grade

Zytel®-RS Engineering Resins

DuPont™ Zytel® RS
renewably sourced™ polyamides

Trekking pole handle

Current Uses for Long Chain Nylons

Improved balance of higher temperature performance, Flexibility, low moisture absorption & salt resistance

PA610	PA612	Melt Blends*	PA1010
• Paper machine clothing • Radiator end tank, • Industrial hoses & tubing • Connectors • Gas fuel lines	• Sensors & solenoids • Paper machine clothing • Radiator end tank • Batteries • Water management • Oil & gas lines	• Sensors • paper machine clothing • Truck air brake • Oil & gas lines • Auto fuel vapor lines	• Diesel fuel lines • Hand held devices • Truck air brake

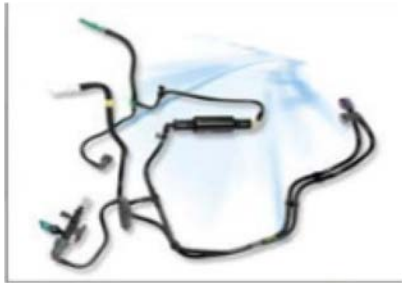
*Melt blend of semi-aromatic copolymer and homopolymer
Compounded extrusion grade formulations containing impact modifier/plasticizer/heat stabilizers

Zytel® RS Long Chain Polyamides

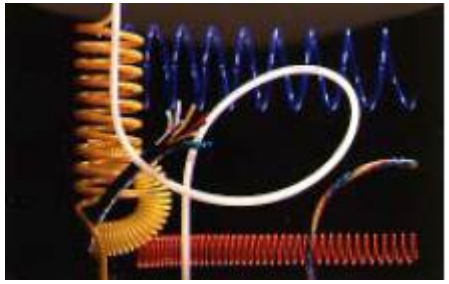
Important products in DuPont's LCPA line

- Current products based on bio-feedstock derived from castor plant. Includes various grades of PA10,10 (100% biobased) and PA6,10 (60% biobased).
- Commercial in radiator end-tanks, fuel lines, air brake tubing, coolant pipes, consumer products, sporting goods, hand held devices.
- Provides competitive cost options vs nylon 11 and 12.

Radiator end-tanks – Comm'l

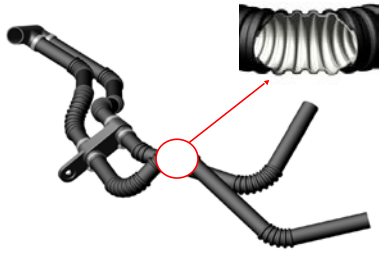


Fuel lines – Comm'l



Pneumatic/air brake tubing Comm'l

Fuel Connectors

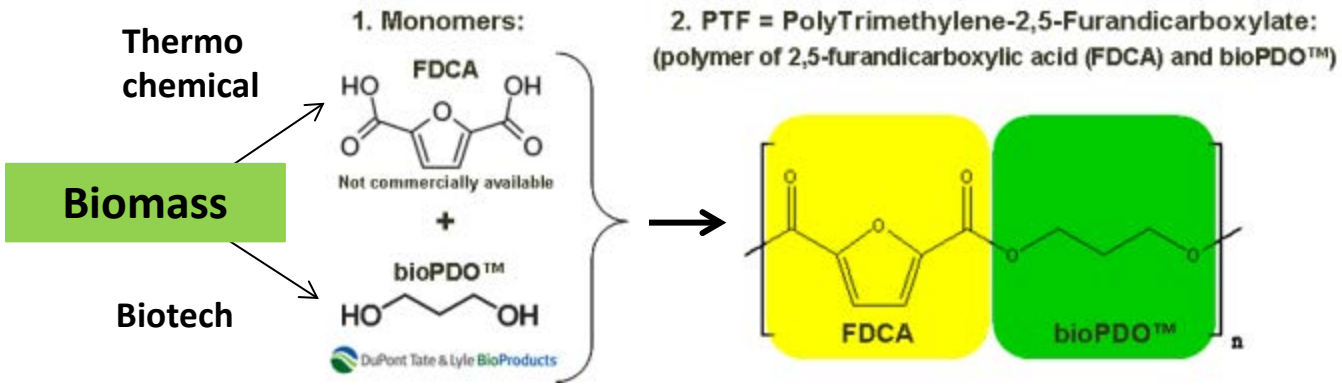


Coolant pipes

Polytrimethylene Furanoate (PTF)

Polytrimethylene Furandicarboxylate (PTF)

Synthesis and basic properties

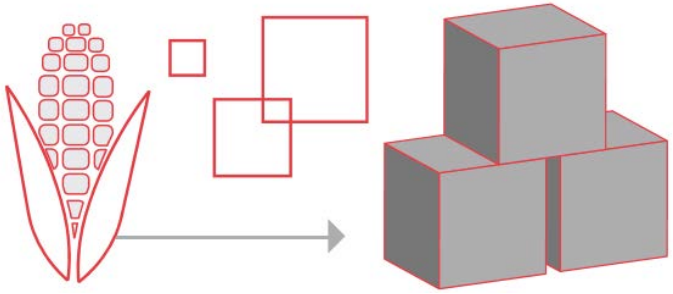


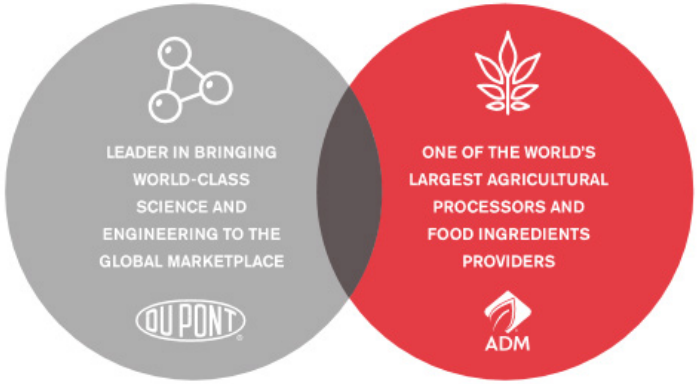
Basic Properties	PTF
Density (g/cc)	1.41
Tg (°C)	54-55
Tm(°C)	178-179

Polytrimethylenefurandicarboxylate (PTF)

Summary and status

- **Substantially better gas barrier properties**
- **100% Sustainably sourced**
- **Higher yields and lower operating cost**
- **Partnership** with Archer Daniels Midland (ADM) on FDME synthesis -> turning fructose into biomaterial
- **Possible applications:**
  - Thin wall and light beverage bottling
  - Food packaging with extended shelf-life





Expanding Renewably Sourced Engineering Polymers

A committed partner for sustainable product development

Within 15 years, DuPont expects a significant percentage of our performance polymer offering to be renewably sourced (RS grades).

We are investing heavily in R&D and are committed to developing bio-based alternatives to petro products whenever technically and economically feasible.

Commercial RS Engineering Polymers Today:

- **Sorona® PTT (injection molding grades and fibers)**
- **Hytrel® RS TPE**
- **Zytel® RS PA610**
- **Zytel® RS PA1010**
- **Zytel® RS HTN**
- **Bynel® and Fusabond® PE based tie-layers and modifiers**

Four additional polymer platforms are currently in scale-up this year for compound development and customer sampling

The miracles of science

plastics.dupont.com

Thank you!