

High-value materials

To make the world a brighter place





Overview - How Can We Help You?

- Review Markets and Applications where TPU can be used
- Identify different ways to process TPU
- Compare TPU against other materials
- Review TPU Chemistry
- Case Study - How to specify Covestro TPU



Here to help

At a glance Structure

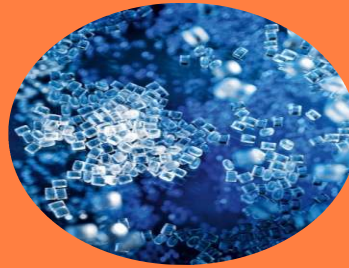


Polyurethanes



Raw materials
for rigid and flexible
foams and TPU

Polycarbonates



Granules and
sheets for a
wide variety of
applications

Coatings



Raw materials
for coatings,
adhesives and
specialties

Products and solutions

Polyurethanes (PUR)



Flexible foam

- Upholstered furniture
- Mattresses
- Car seats

- flexible
- hard-wearing
- lightweight
- readily moldable



Rigid foam

- Insulating materials for buildings and refrigerators

- insulating
- rigid
- lightweight



Thermoplastic Polyurethane (TPU)

- Industrial Mechanical
- Hose, Tubing, Belting & Profile

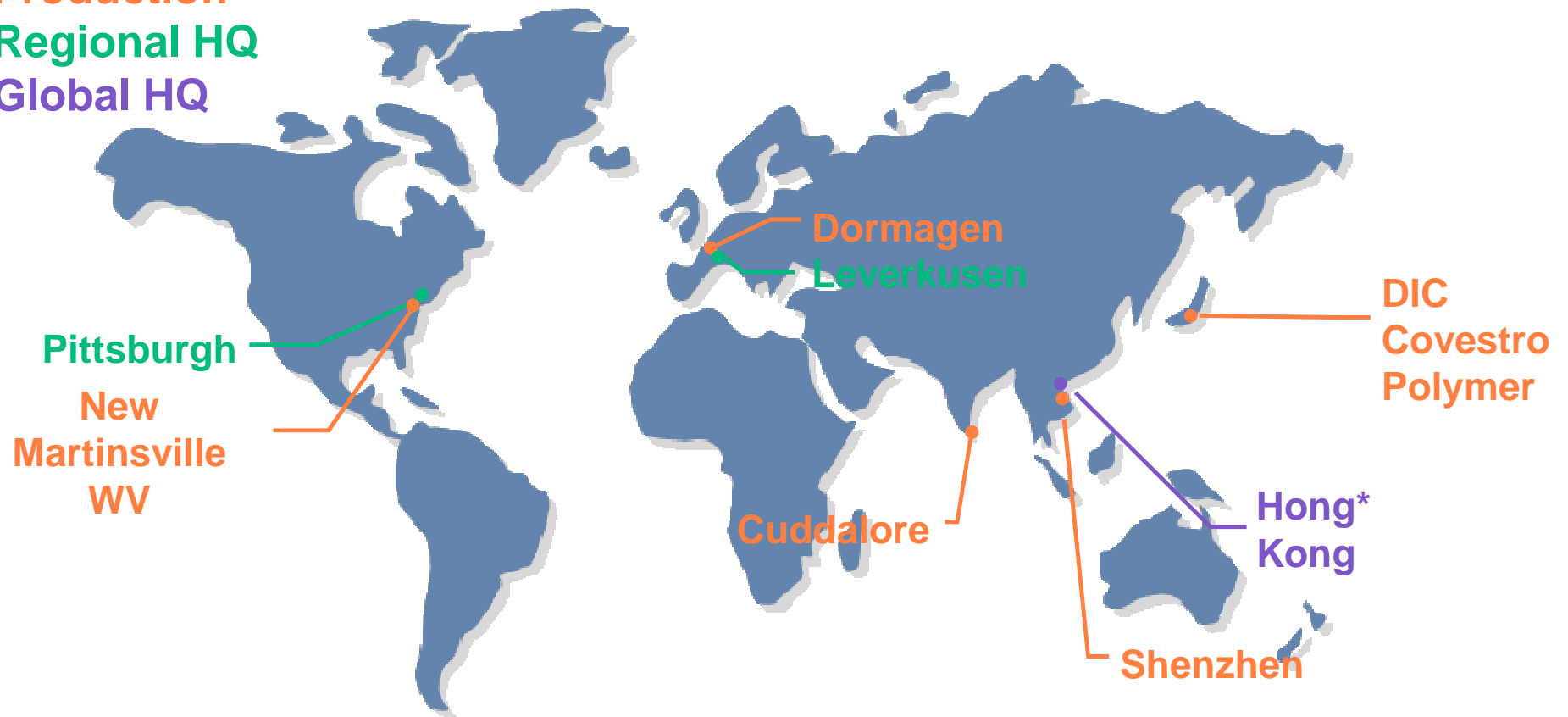
- tough
- flexible
- resistant to cold and heat



Global Production



- Production
- Regional HQ
- Global HQ





Markets for Covestro TPU in NAFTA

Hose, Tube, Belting & Profile (HTBP)

Industrial Mechanical

Large Market Segments for Covestro TPU

Film & Cable Bundling



Automotive

Footwear

Coatings

Healthcare

Cable

Adhesives

Specialized Market Segments for Covestro TPU



What Can You Make with TPU?

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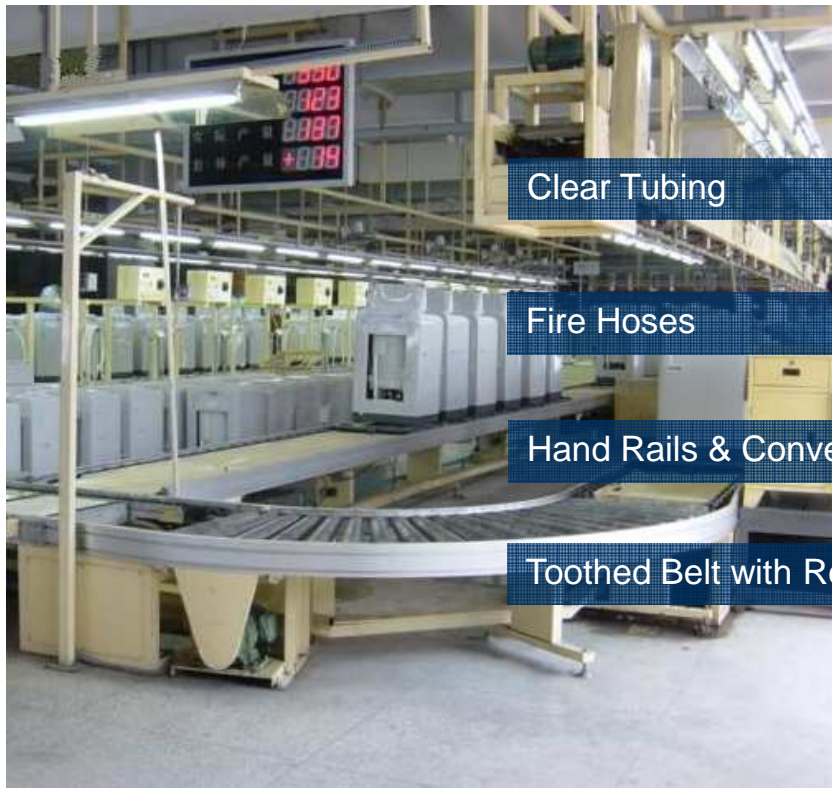
Hose, Tubing, Belting, & Profile

What can be made with TPU?



Hose, Tubing, Belting, & Profile

What can be made with TPU?



Clear Tubing

Fire Hoses

Hand Rails & Conveyor Belts (FDA approved)

Toothed Belt with Reinforcement

Flexible

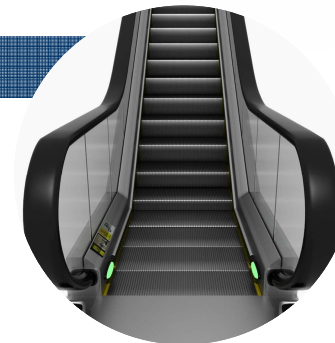


Tubing



Fire Hoses

Rigid



Escalator Handrails

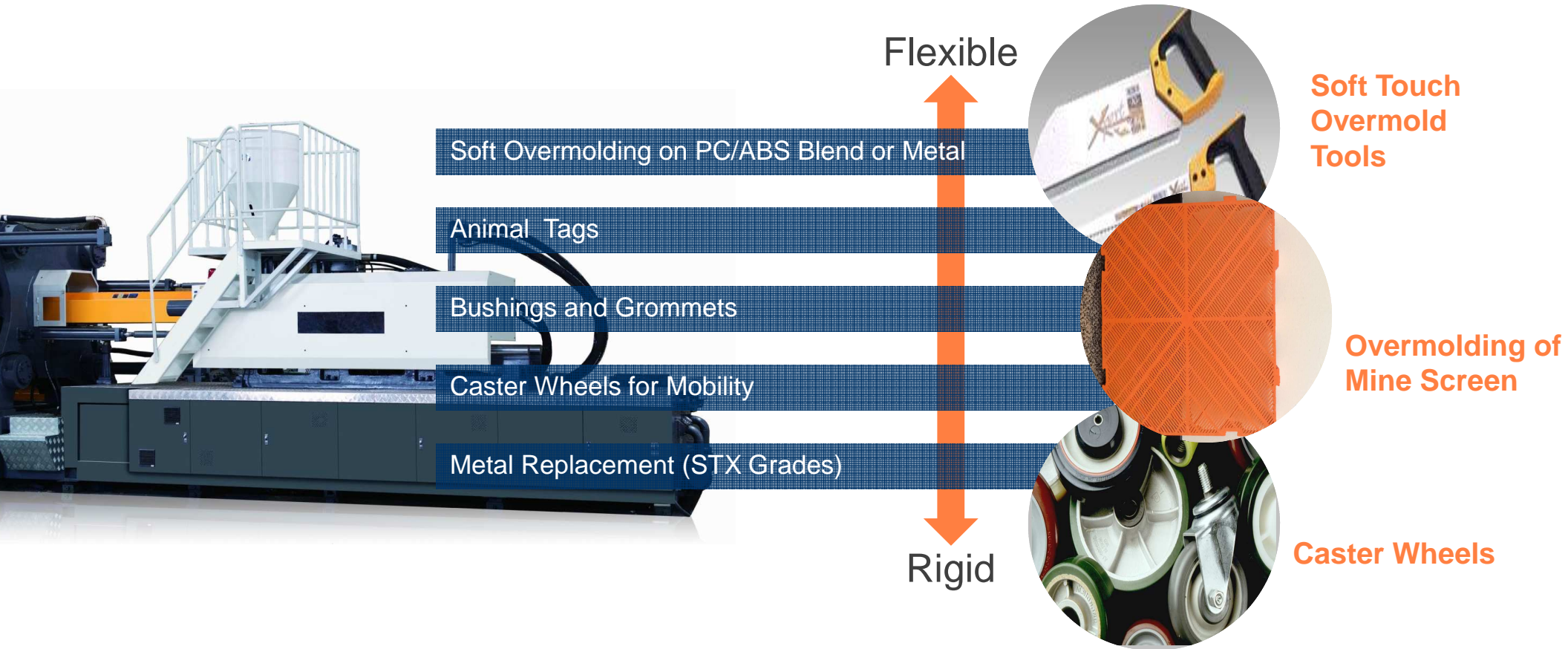
Industrial Mechanical

What can be made with TPU?



Industrial Mechanical

What can be made with TPU?



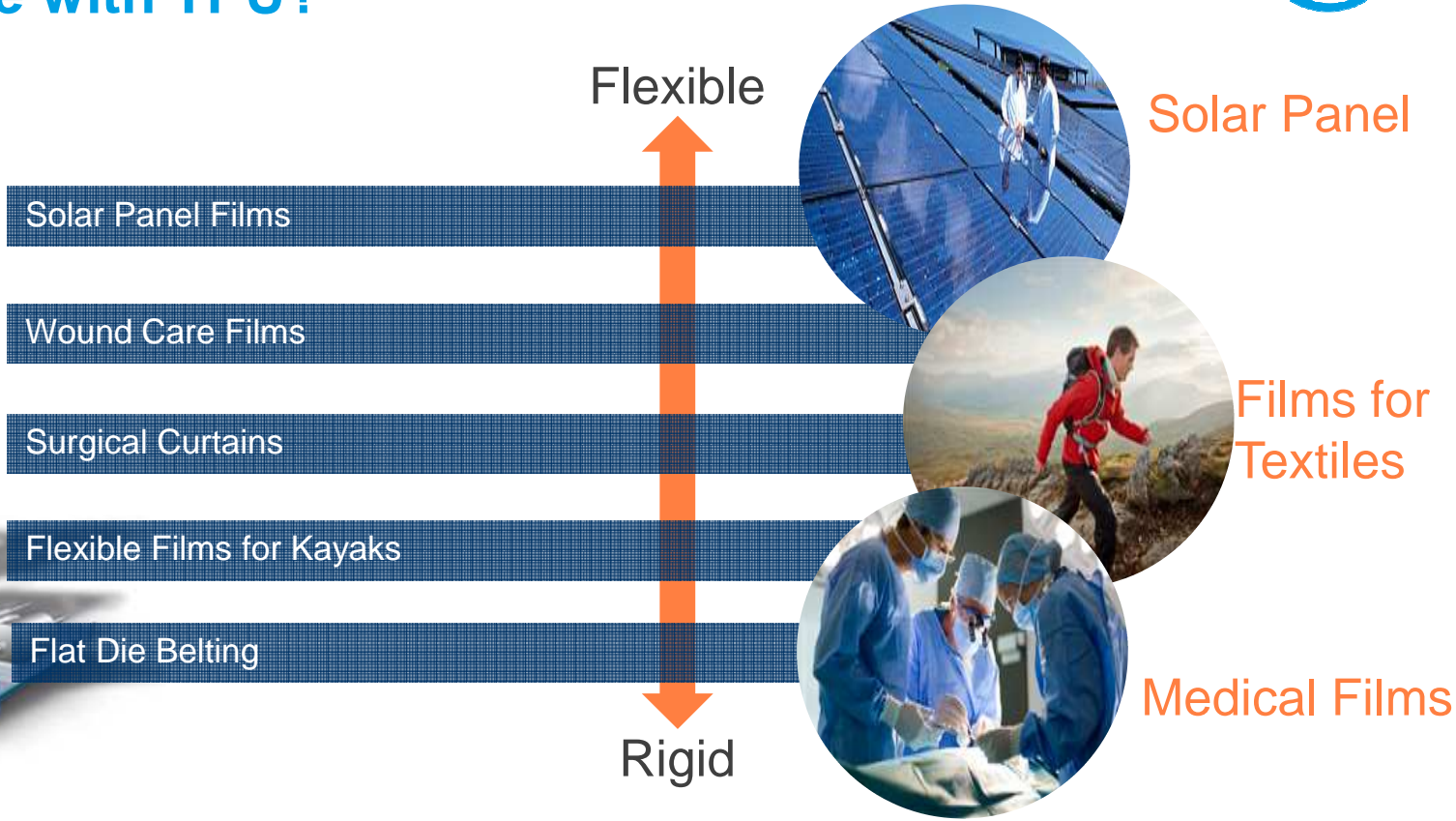
Film and Sheet

What can be made with TPU?



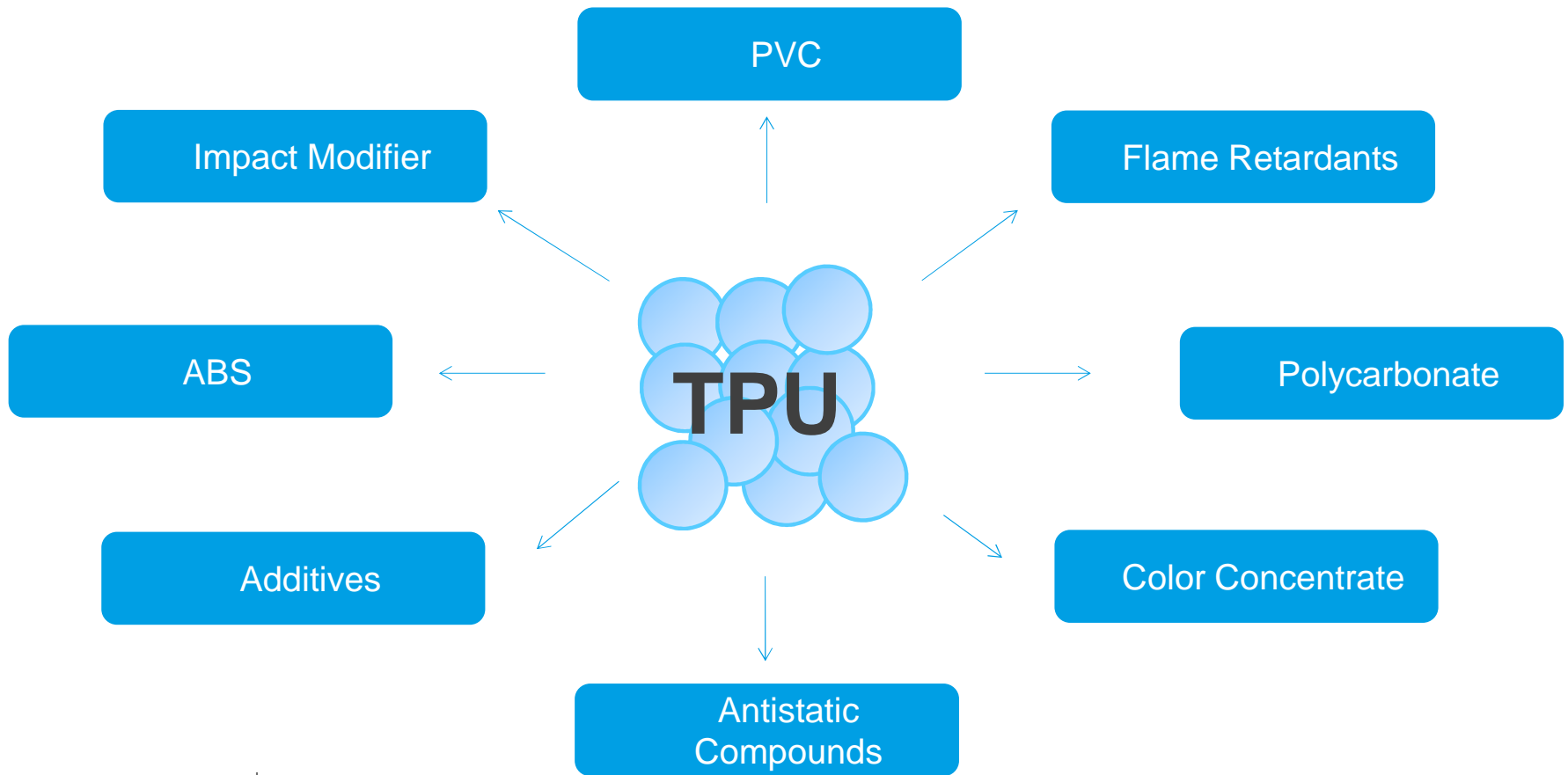
Film and Sheet

What can be made with TPU?



Compounding

What can be made with TPU?



These
technologies are
found in other
markets



Sports & Leisure

What can be made with TPU?



Sports & Leisure

What can be made with TPU?



- Breathable Coated Textiles
- Flexible Frames for Ski Goggles
- Surfaces for Skis
- Ski Bindings

Flexible



Rigid



Foldable Kayak



Putter Insert



Frisbee Disc

Automotive What can be made with TPU?





Automotive

What can be made with TPU?



- Instrument panel skins
- Airbag Coatings
- Interior Trim
- Overmold (gear shifts, soft touch interior)
- Tambour doors (center consol)

Flexible



Rigid



Instrument Panel Skin



Tambour Door



Bushings & Grommets

Extrusion

TPU is commonly use for applications that require excellent tear strength, abrasion resistance and flexibility



Belting



- ✓ Tear Strength
- ✓ Chemical Resistance

Cabling



- ✓ Hydrolytic Stability
- ✓ Abrasion Resistance

Hoses



- ✓ Flexibility
- ✓ Abrasion Resistance

Injection Molding

TPU is commonly use for applications that require excellent tear strength, abrasion resistance and flexibility



Bushings



- ✓ Sound absorption
- ✓ Oil & Grease Resistant

Caster Wheels



- ✓ Cost Performance
- ✓ Abrasion Resistance
- ✓ Non Marking

Overmolding



- ✓ Soft Touch
- ✓ Good adhesion to substrate
- ✓ Life cycle performance

In addition to Standard Grades of TPU for common applications, there are Specialty Grades for unique applications



Standard Grades



Specialty Grades

Aliphatics



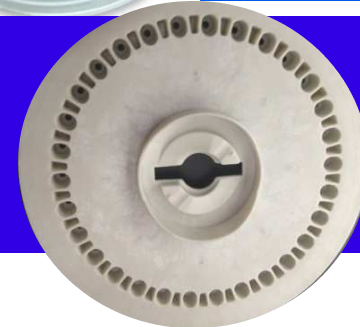
Clear
UV Resistant

Medical Grades



Biocompatibility

Rigid Grades



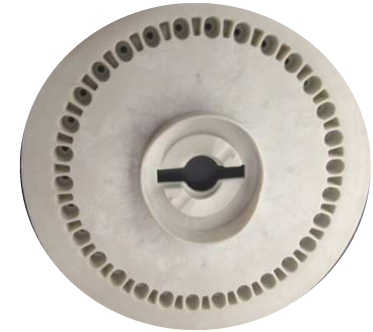
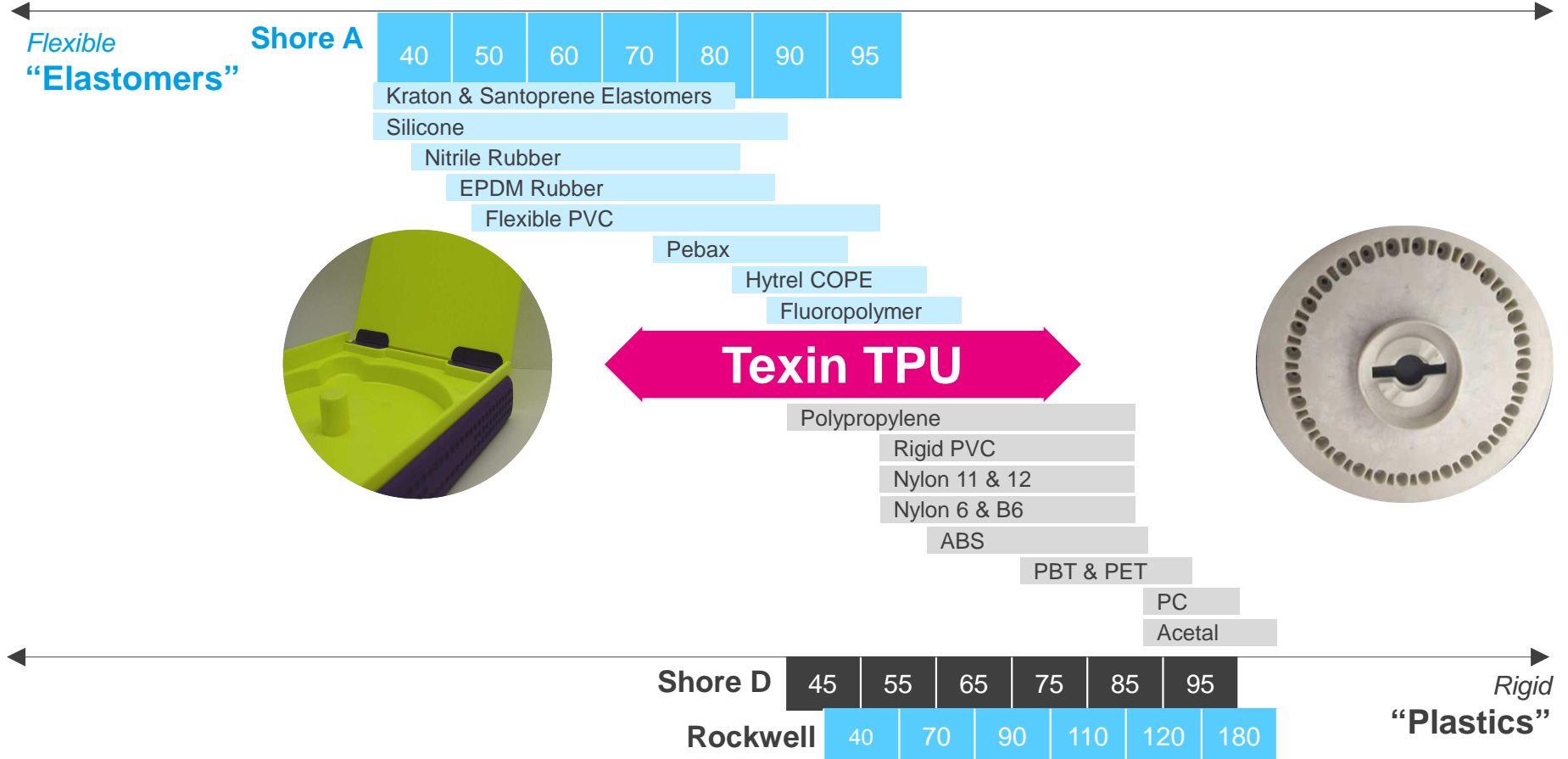
Dimensional
Stability

TPU vs Other Material



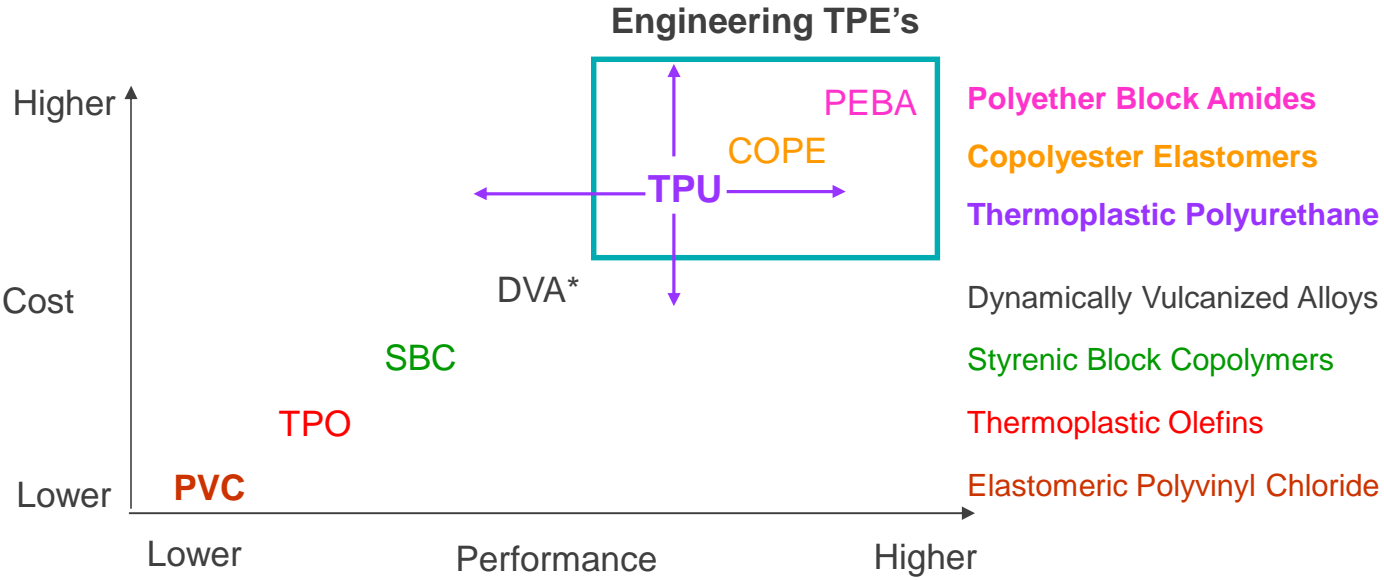


Texin spans the range between flexible Elastomers and more rigid Plastics





Cost to Performance : Comparison of varied TPE's



*DVAs are also known as TPV and TPR

TPU is stronger, more weather-resistant and more chemical-resistant than PVC, Rubber and TPO



Properties		TPU Polyester	TPU Polyether	PVC	Rubber	TPO
Strength	Tensile strength	Very Good	Very Good	Poor	Poor	Poor
	Tear Strength	Very Good	Very Good	Good	Poor	Poor
	Elongation	Very Good	Very Good	Poor	Very Good	Poor
Abrasion	Abrasion Resistance	Very Good	Very Good	Poor	Poor	Poor
Weather	Low Temperature Applications	Good	Very Good	Poor	Good	Very Good
	High Temperature Applications	Very Good	Very Good	Good	Poor	Good
Chemicals	Oil & Greases	Very Good	Good	Good	Poor	Poor
	Solvents	Very Good	Good	Good	Poor	Poor
	Ozone	Very Good	Good	Very Good	Poor	Poor
	Weathering	Good	Very Good	Very Good	Poor	Poor
	Hydrolysis	Poor	Very Good	Very Good	Very Good	Good

Very Good

Good

Poor

TPU is stronger, more weather-resistant and more chemical-resistant than PVC, Rubber and TPO



TPU

Strong/Flexible
Low Temperature
Flexibility
Abrasion Resistance
Chemical Resistance



PVC

Abrasion Resistance
Chemical Resistance



Rubber

Strong/Flexible



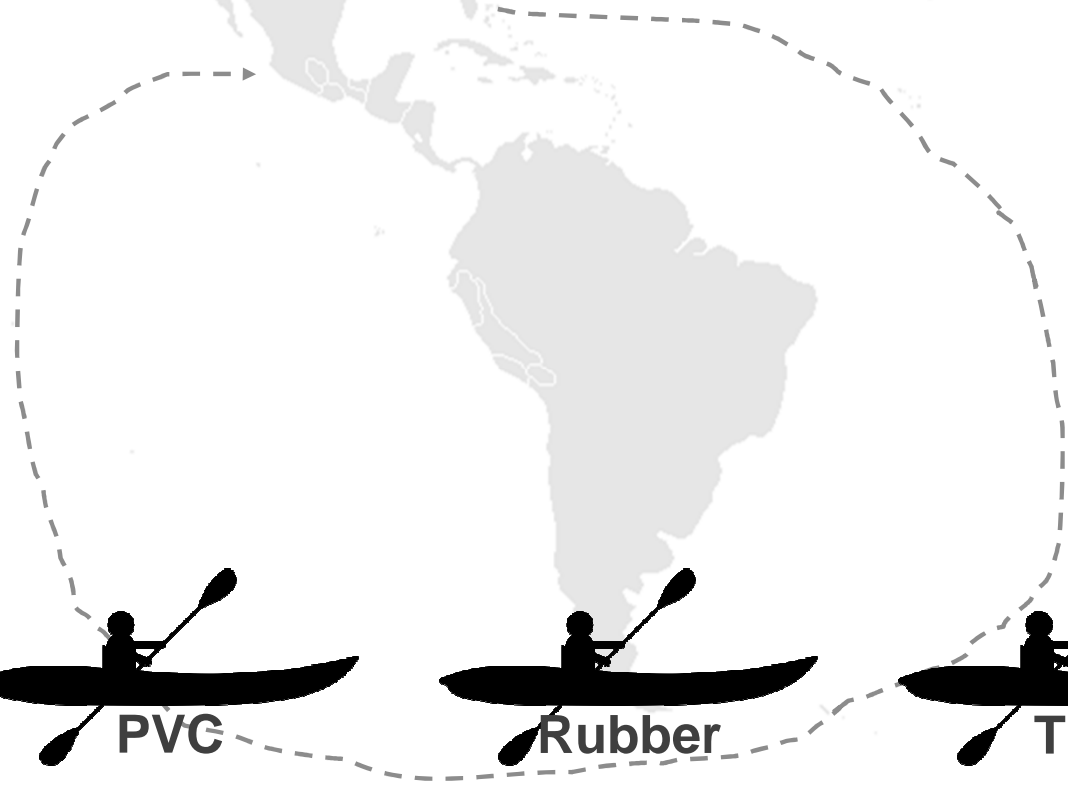
TPO

Low Temperature
Flexibility

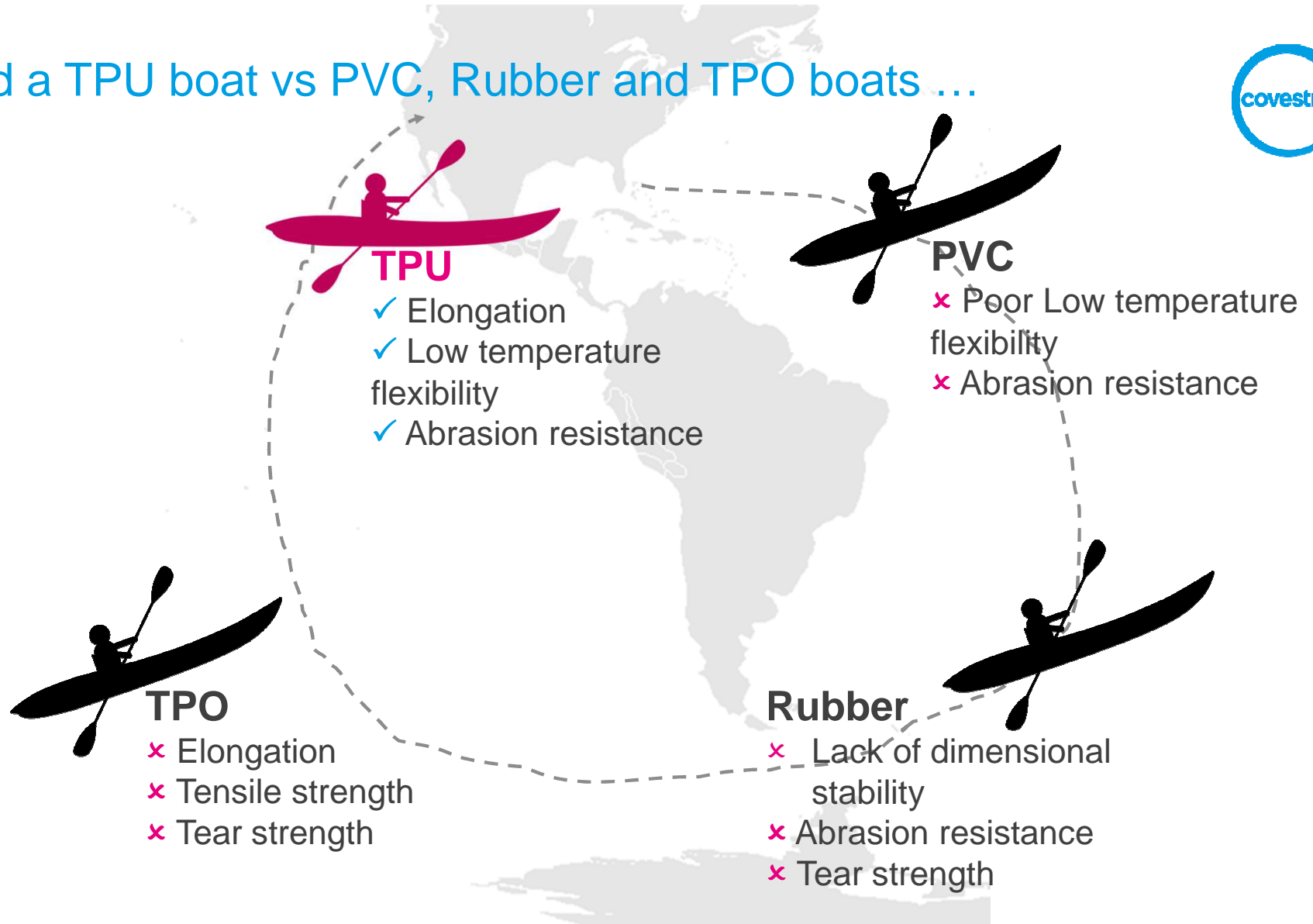




If you raced a TPU boat vs PVC, Rubber and TPO...



If you raced a TPU boat vs PVC, Rubber and TPO boats ...



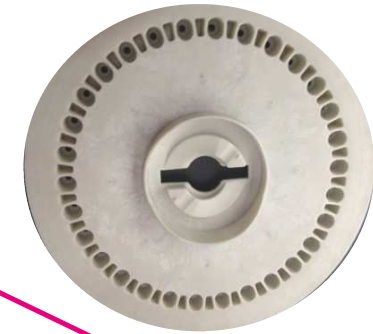
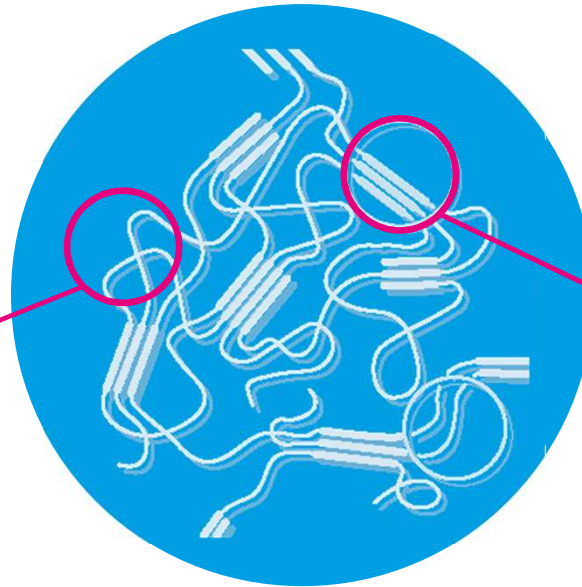
TPU Chemistries



TPU is made up of a mix of “hard” and “soft” segments in different ratios to make TPU’s with different properties



More SOFT Segments
Wavy lines



More HARD Segments
Straight lines

Properties

Properties

Elasticity \longleftrightarrow Rigidity

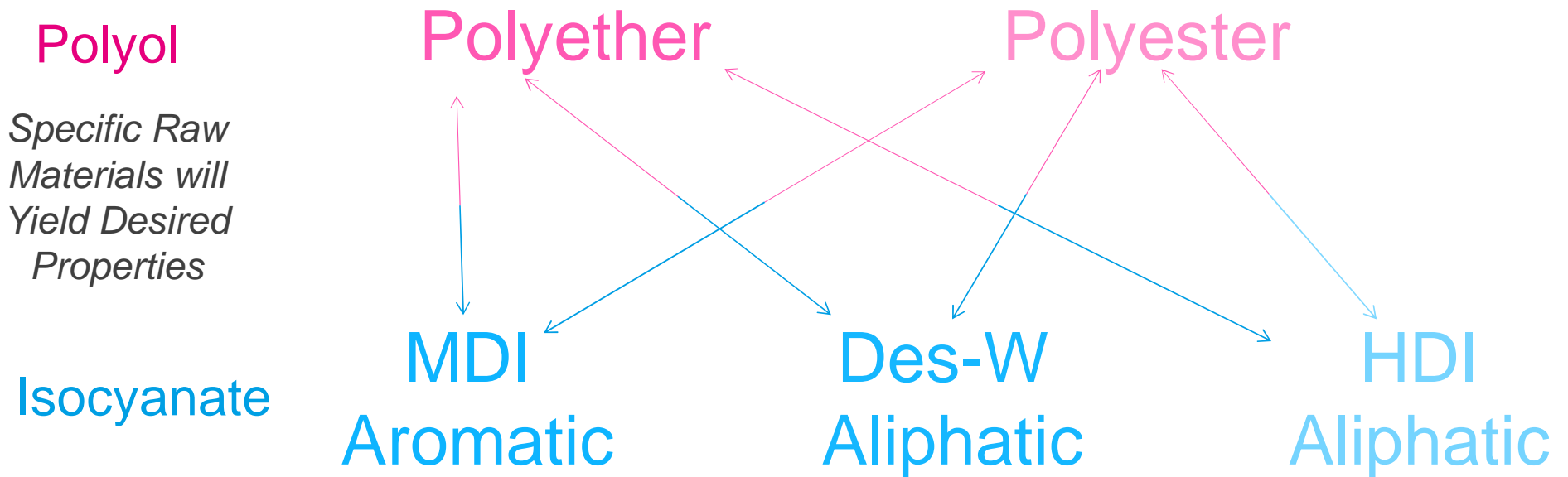
Flexibility \longleftrightarrow Hardness

Resilience \longleftrightarrow Flexural Modulus Characteristics

Low temperature performance \longleftrightarrow Upper use of temperature

Texin[®] / Desmopan[®] Product Line

Base Material Combinations



Majority of NAFTA Sales are Ether & Ester Aromatic

Ester & Ether Attributes



Ester

- Cut & Scratch Resistance
- Superior Wear Resistance
- Higher Mechanical Properties
- Fuel & Oil Resistance
- Heat Stability
- Good Transparency Depending on Grade

Ether

- Hydrolysis Resistance
- Fungus & Moisture Resistance
- Cold Temperature Flexibility
- Resistant to Salt Water Cracking
- Ozone Resistance
- Excellent Transparency
- Better Inherent UV Stability

Note: Several type ether and ester raw materials available and can offer various performance levels

Covestro TPU Brand Names



Covestro – TPU – NAFTA Trade Names



 **Texin[®]**

 **Desmopan[®]**

Nomenclature



Texin xxx(x) = Commercial grade

First Digit	Meaning
2	Standard Polyester
3	Polyester with better hydrolytic stability
4	TPU/PC Blend (4 Digit)
9	Standard Polyether

Suffixes	Meaning
U	UV Stabilizers Added
R	Better Mold Release
LW	Low Wax

Texin DP7-xxxx or xxxx = Developmental grade
DP7 products do not follow this logic

Last Digits	Meaning
>75	Shore Hardness A
<75	Shore Hardness D

Q: What type of TPU is Texin 250?

A: Ester TPU. Shore Hardness of 50D

Q: What type of TPU is Texin 987U?

A: Ether TPU. Shore Hardness of 87A
With a UV Additive

Case Study: IT Market



- Customer wants a product for molding to be used in a phone case application
- Aside from TPU, customer is also looking at TPE, TPV

What TPU material would you recommend to support the customer?

Ask these Questions to Help Recommend a TPU



Question to Ask

Answer

Chemistry

-
1. What is the desired hardness range?

 2. Will there be moisture contact?

 3. Is cold temperature flexibility important?

 4. Is UV property stability important?

 5. Will the material have chemical contact?

 6. Is scratch / mar resistance important?

 7. Is there a load on the finished part?

Ask these Questions to Help Recommend a TPU



Question to Ask	Answer	Chemistry
1. What is the desired hardness range?	65A-95A	Ether/Ester
2. Will there be moisture contact?	✓	Ether
3. Is cold temperature flexibility important?	✓	Ester/Ether
4. Is UV property stability important?	✓	Ether/Aliphatic
5. Will the material have chemical contact?	✓	Ester
6. Is scratch / mar resistance important?	✓	Ester
7. Is there a load on a finished part?	✓	Ester

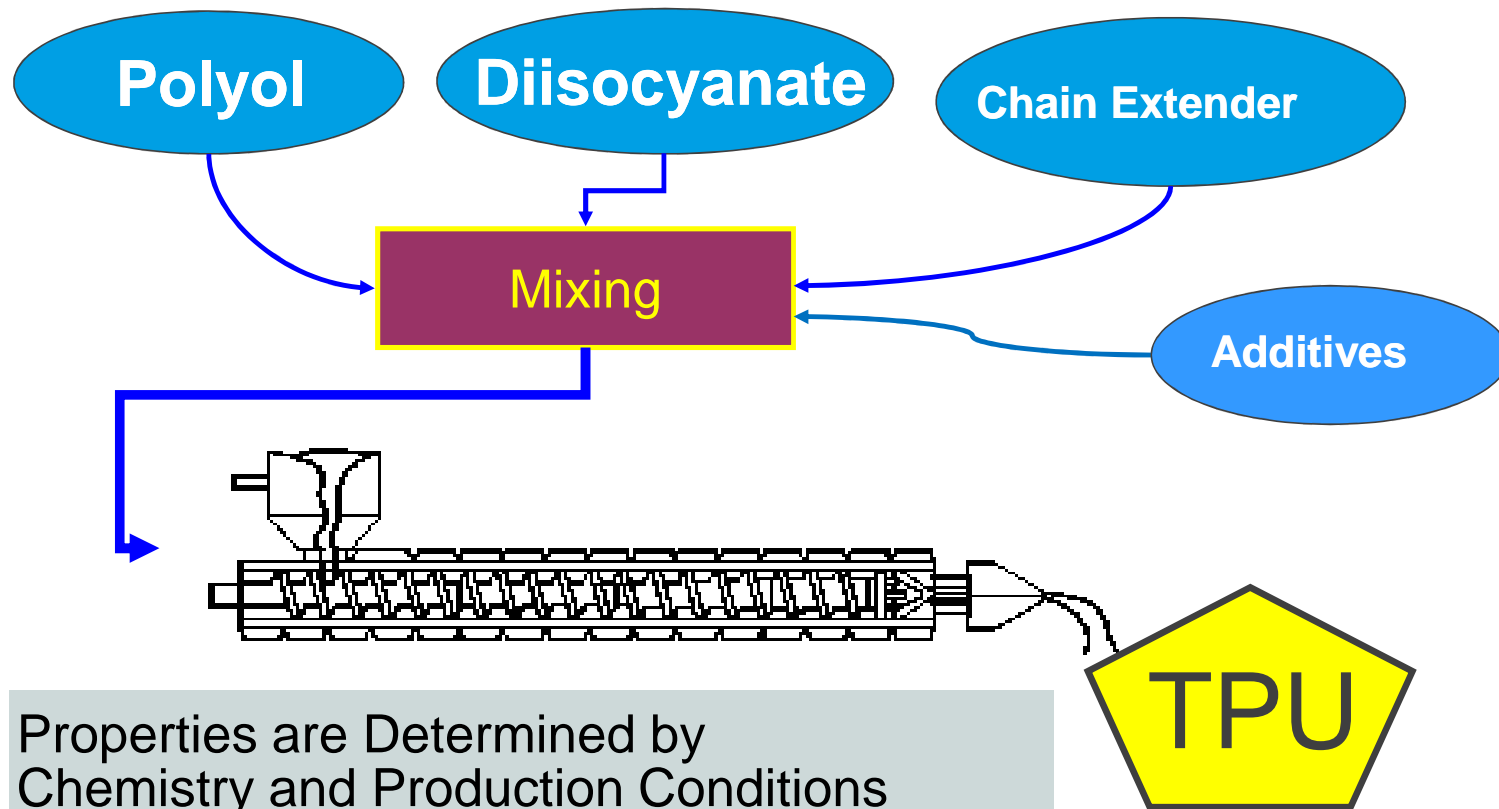
* Typical answers, for material selection for applications can vary

Production

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How is Texin made?



Properties are Determined by Chemistry and Production Conditions



Drying TPU

The majority of technical issues result from improper drying!

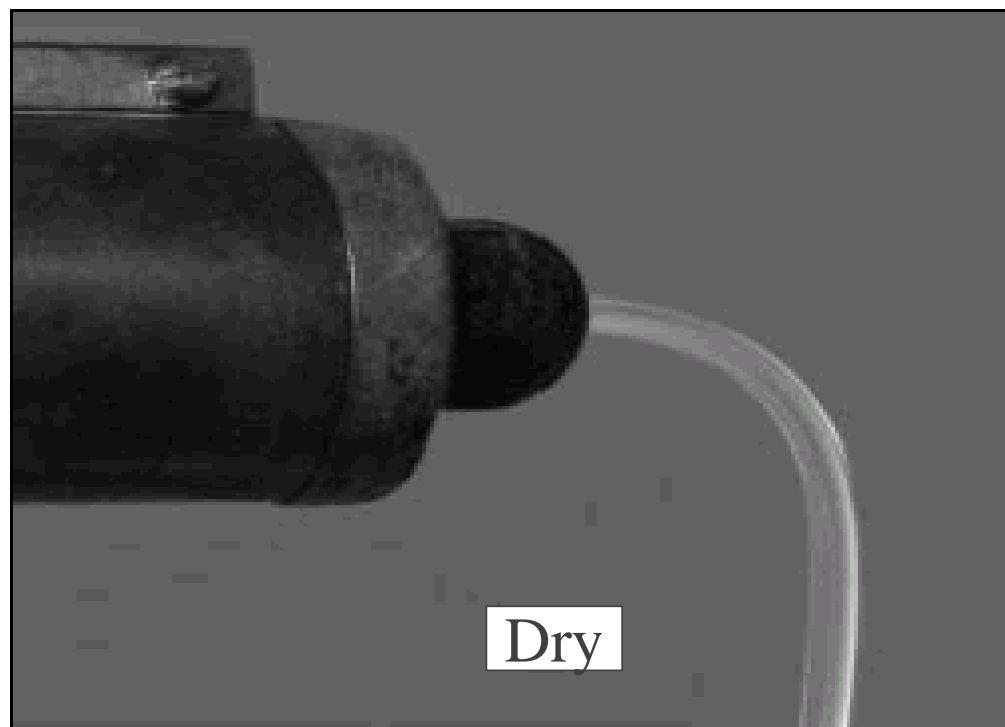
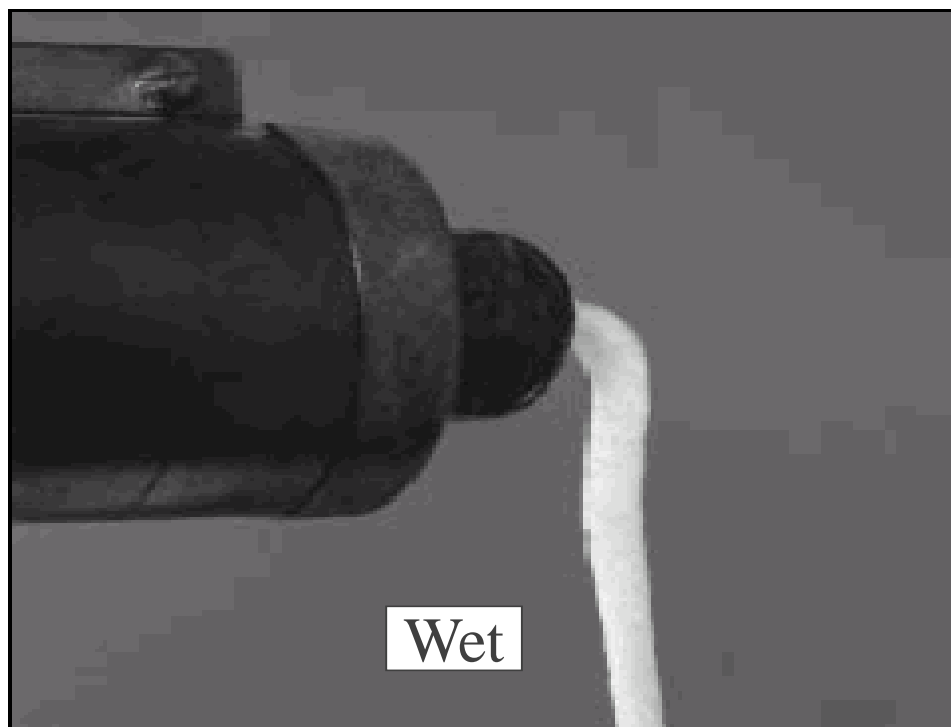


Drying Conditions

- **Dessicant dehumidifying hopper dryer with a dew point $\leq -30^{\circ}\text{C}$**
- **Air inlet temperature of 80-110 $^{\circ}\text{C}$ depending on grade**
- **Dry to $\leq 0.03\%$ moisture**
- **Typical Drying Time: 4 hrs @ 105 $^{\circ}\text{C}$ (~220 $^{\circ}\text{F}$), 6 hrs @ 82 $^{\circ}\text{C}$ (~179 $^{\circ}\text{F}$)**



The Extrudate Can Tell You a Lot





Conclusion

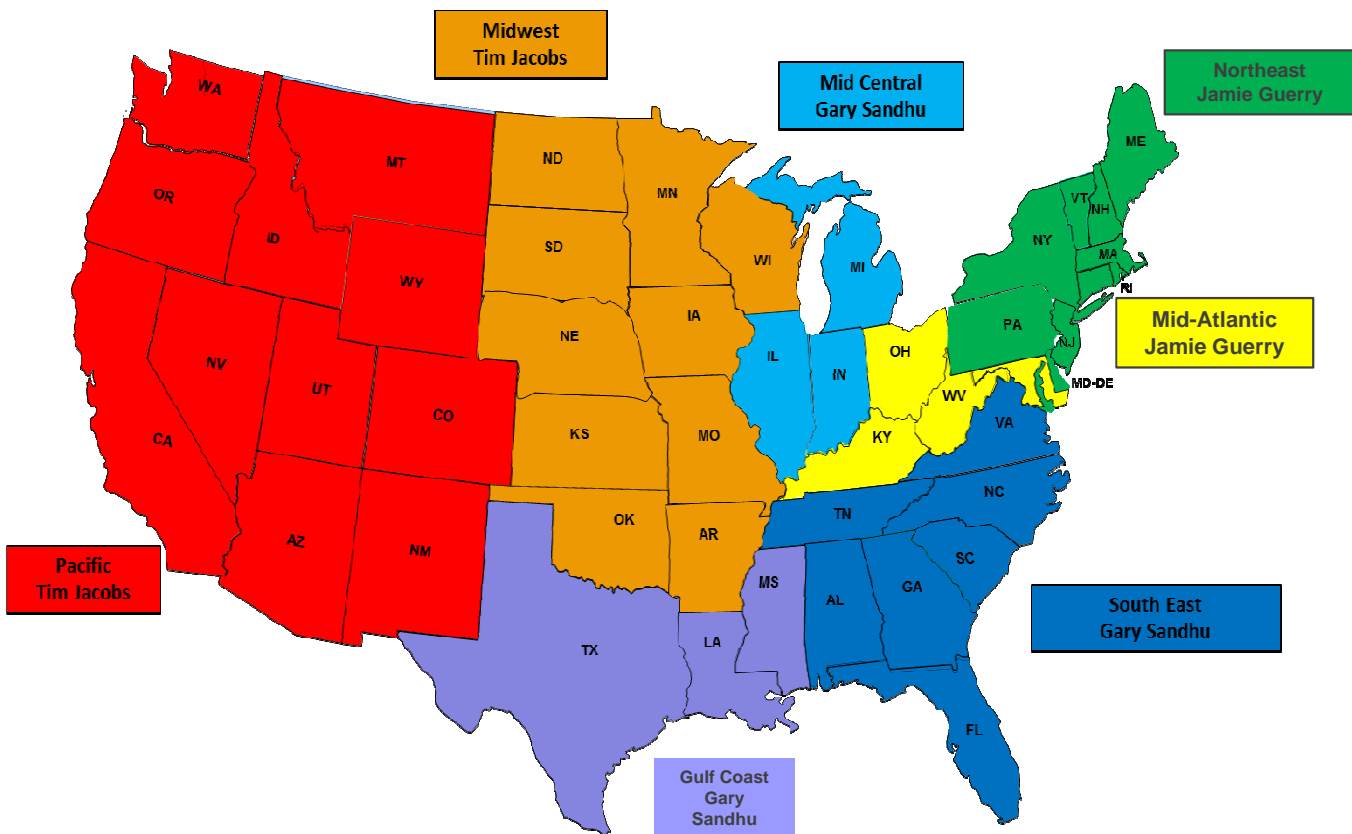
- **Covestro TPUs are used in a variety of markets**
- **TPUs can be processed in different ways for many applications**
- **TPUs bridge the gap between soft elastomers and more rigid plastics**
- **Understanding Covestro TPU properties vs other elastomers can help specify material**
- **Covestro has resources to assist you with your TPU needs**



Texin[®]



Desmopan[®]



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Thank You!

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