



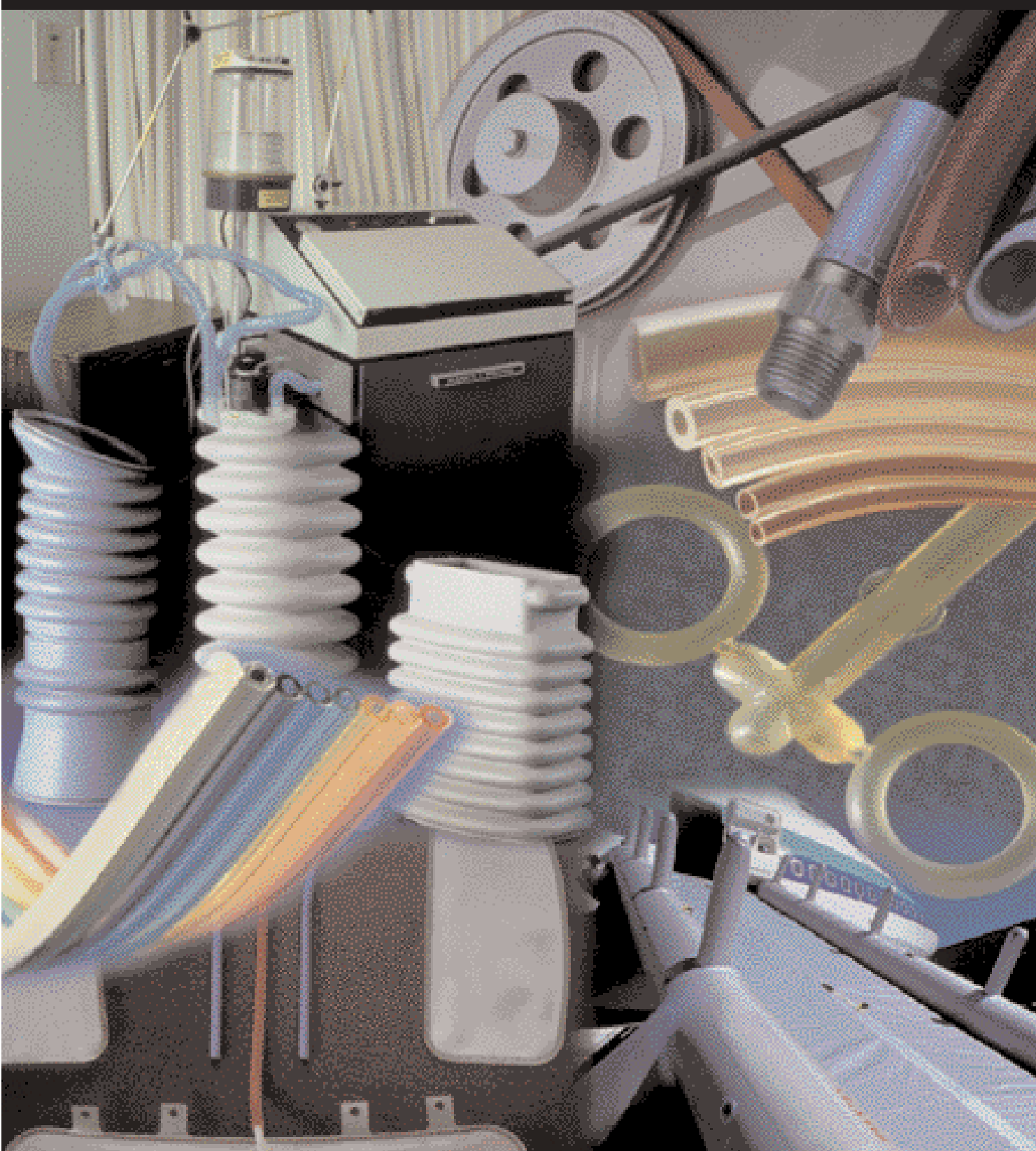
ALLIANCE FOR THE
POLYURETHANES
INDUSTRY

A BUSINESS UNIT OF THE AMERICAN PLASTICS COUNCIL

AX-235

THERMOPLASTIC POLYURETHANES

Bridge the Gap between Rubber and Plastics



thermoplastic

p o l y u r e t h a n e s

Introduction

There are many thermoplastic elastomers (TPE) available in today's marketplace. All are elastic and melt processable. Most can be processed on extrusion or molding equipment, and can be colored and fabricated by a variety of methods.

With more than 30 years of commercial product development, one thermoplastic elastomer clearly stands out for its ability to provide a multitude of physical property combinations for a wide variety of processing applications: thermoplastic polyurethane (TPU).

About TPU

TPU is a polyurethane elastomer that is fully thermoplastic. It is a linear segmented block copolymer composed of hard and soft segments.

The hard segment can be either aromatic or aliphatic in nature. Aromatic TPUs are based on isocyanates such as MDI. Aliphatic TPUs are based on isocyanates such as H₁₂ MDI. When these isocyanates are combined with various short chain diols they become the hard block. Normally it is aromatic, but where color and clarity retention during exposure to sunlight is a priority, an aliphatic hard segment is typically recommended.

The soft segment can be either polyether or polyester type. The choice affects the relative suitability for a given application. For use in wet environments, for example, a polyether-based TPU is preferred. When oil and hydrocarbon resistance are primary factors, a polyester-based TPU is the material of choice. Another polyester type, polycaprolactone, also provides oil and hydrocarbon resistance with improved hydrolytic stability.

A wide variety of property combinations can be achieved by varying the molecular weight of the hard and soft segments, their ratio and chemical type. For example, shore hardness ranges from 60A to 80D can be achieved. TPU also offers high tensile strength, elongation and tear resistance as compared to other TPEs.

TPU Product Information

TPU excels in offering a wide and effective combination of physical properties and attributes over a range of hardnesses.

TPUs offer:

- High elasticity
- High resiliency

- Low temperature performance
- Good compression set
- Flexibility without plasticizers
- Abrasion resistance

PLUS:

- Impact resistance (toughness)
- Tear resistance
- Weather resistance
- Hydrocarbon resistance (polyester-type)
- Hydrolytic resistance (polyether-type)
- Optical clarity (aliphatic type)

TPUs are easily processable and colorable and can undergo a wide variety of post processing steps such as:

- Welding
- Painting
- Printing
- Die cutting
- Slitting

TPU Applications

Recognizing the value of these performance characteristics, manufacturers of a broad assortment of products specify TPU to increase overall product durability and to streamline production processes.

Applications highlighting the attributes of TPU are:

| Market | Applications | Benefit TPU provides |
|----------------|---|--|
| Sporting Goods | In-line skates Ski boots | Abrasion resistance Low temperature flexibility Resiliency |
| Automotive | Side moldings Lumbar support Constant velocity boots | Processability Colorability Impact resistance |
| Industrial | Gaskets and seals Hoses and tubing Film and sheet Wire and cable coatings Caster wheels | Compressive set Chemical resistance Tear resistance Flame retardancy Wear resistance |
| Coated Fabrics | Inflatable rafts Life vests Protective clothing | Weather resistance Toughness Adhesive strength |
| Consumer Goods | Footwear Weather-proof clothing | Durability Flexibility Finish Comfort |

Specialty Grades

Flame retardant

Flame retarded grades of TPU are available and provide tear resistance and toughness for cable jacketing.

Antistatic

Some TPU grades can be produced with an antistatic behavior for special applications such as safety or industrial footwear.

Reinforced

When mixed with glass fiber or mineral fillers, TPU becomes a structural engineering material that retains the desirable properties of abrasion resistance, paintability, high impact strength, good low temperature properties, good fuel resistance and high flow characteristics.

Blending

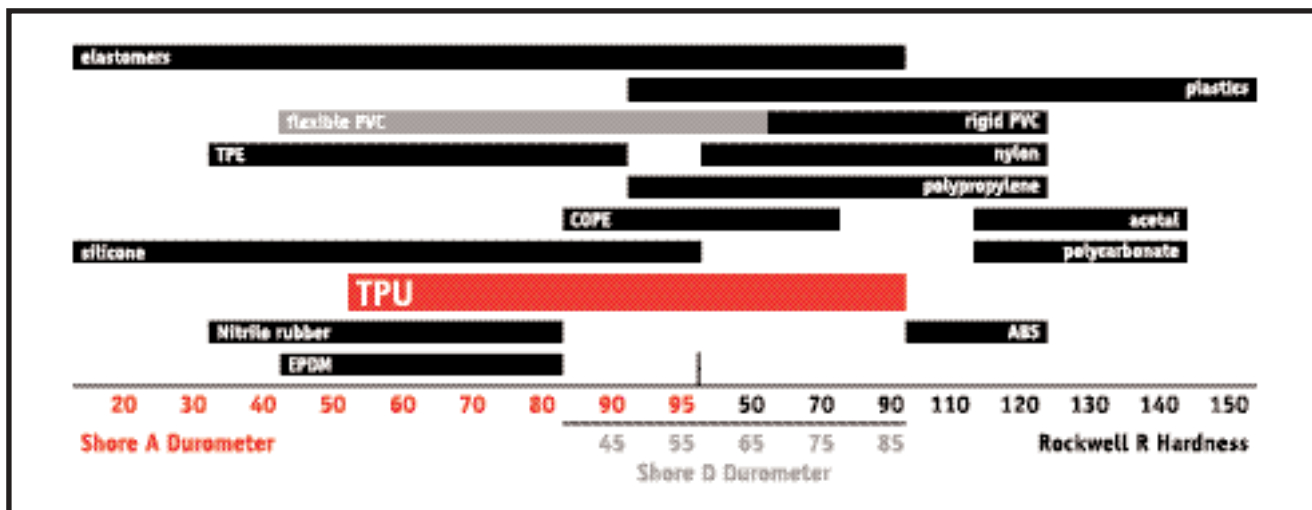
TPU is an outstanding contributor of properties in polymer blends. When added to polymers such as PVC, TPU helps improve toughness, abrasion resistance, low temperature flexibility and compression set.

When compounded with polycarbonate, ABS or acetal, a TPU resin with a nominal 18,000 flexural modulus can produce resins with a flexural modulus value of up to 150,000 psi. Specialized resins can be made that blend the properties of engineering plastics with the features and benefits of TPU.

Whether for its outstanding abrasion resistance, improved product durability, or ease of manufacturing, TPU is a versatile performer in today's TPE marketplace.

TPU bridges the gap between rubber and plastics. Its range of physical properties enables TPU to be used as both a hard rubber and as a soft engineering thermoplastic.

TPU Bridges the Gap between Rubber and Plastics!



| Property | Units | ASTM | polyester | | polycaprolactone | polyether | |
|-----------------------|-----------|------|-------------|-------|------------------|-----------|--------|
| | | | 80A | 65D | 80A | 80A | 65D |
| Tensile Strength | psi | D412 | 5400 | 6000 | 5000 | 5000 | 6400 |
| Elongation | % | D412 | 575 | 400 | 500 | 600 | 390 |
| Tear Strength | Die C pli | D624 | 600 | 1300 | 650 | 500 | 1500 |
| Taber Abrasion | H-22 | | range 10-20 | 50-80 | 20-30 | 20-30 | 80-100 |
| aliphatic TPUs | | | polyester | | | polyether | |
| | | | 80A | 55D | | 75A | 60D |
| Tensile Strength | psi | D412 | 3000 | 5000 | | 3000 | 4500 |
| Elongation | % | D412 | 430 | 350 | | 350 | 360 |
| Tear Strength | Die C pli | D624 | 400 | 550 | | 300 | 700 |

thermoplastic

p o l y u r e t h a n e s

For more information contact any of the TPU suppliers listed below:

BASF Corporation

ELASTOLLAN®
Thermoplastic Polyurethane
1609 Biddle Avenue
Wyandotte, MI 48192
Phone: (800) 892-3111
Fax: (313) 246-6467
www.basf.com/tpu

Bayer MaterialScience LLC

TEXIN®/Desmopan®
Thermoplastic Polyurethane
100 Bayer Road, **Bldg 8**
Pittsburgh, PA 15205-9741
Phone: (800) 662-2927
Fax: (412) 777-7682
www.bayermaterialsciencenafta.com
Email: TPUinfo@bayer.com

The Dow Chemical Company

PELLETHANE®
Thermoplastic Polyurethane Elastomers
P.O. Box 1206
Midland, MI 48641-1206
Phone: (800) 441-4369
Fax: (989) 832-1465
www.dowep.com

Huntsman Polyurethanes

AVALON®
IROGRAN®
IROSTIC®
IROCOAT®
IRODUR®
KRYSTALGRAN®
Huntsman Polyurethanes
2190 Executive Hills Boulevard
Auburn Hills, MI 48326
Phone: (800) 553-8624
Fax: (248) 322-7303
www.huntsman.com/pu

Merquinsa North America, Inc.

PEARLTHANE®
PEARLCOAT®
PEARLBOND®
PEARLSTICK®
34 Folly Mill Road
Seabrook, NH 03874
Phone: (603) 474-0971
Fax: (603) 474-0972
www.merquinsa.com

Noveon, Inc.

ESTANE®/ESTALOC®
Thermoplastic Polyurethanes
9911 Brecksville Road
Cleveland, OH 44141-3247
Phone: (888) 234-2436
Fax: (216) 447-6211
www.noveoninc.com

This brochure was developed by the Alliance for the Polyurethanes Industry (API), a business unit of the American Plastics Council (APC). The brochure briefly summarizes some of the characteristics of thermoplastic polyurethane (TPU). It is not intended to: (1) replace a comprehensive technical review of TPU, (2) define or create legal rights or obligations, or (3) provide specific legal or technical advice. Neither API nor APC (including members, employees, subcontractors, consultants, or other assigns) makes any warranty or guarantee, express or implied, or assumes any liability or responsibility for any use of any information, product, or process disclosed in this document. Persons using TPU should consult with their technical and legal advisors.

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ALLIANCE FOR THE
POLYURETHANES
INDUSTRY

A BUSINESS UNIT OF THE AMERICAN PLASTICS COUNCIL

1300 WILSON BOULEVARD
ARLINGTON, VA 22209

703.741.5656 FAX 703.741.5655

www.polyurethane.org www.plastics.org