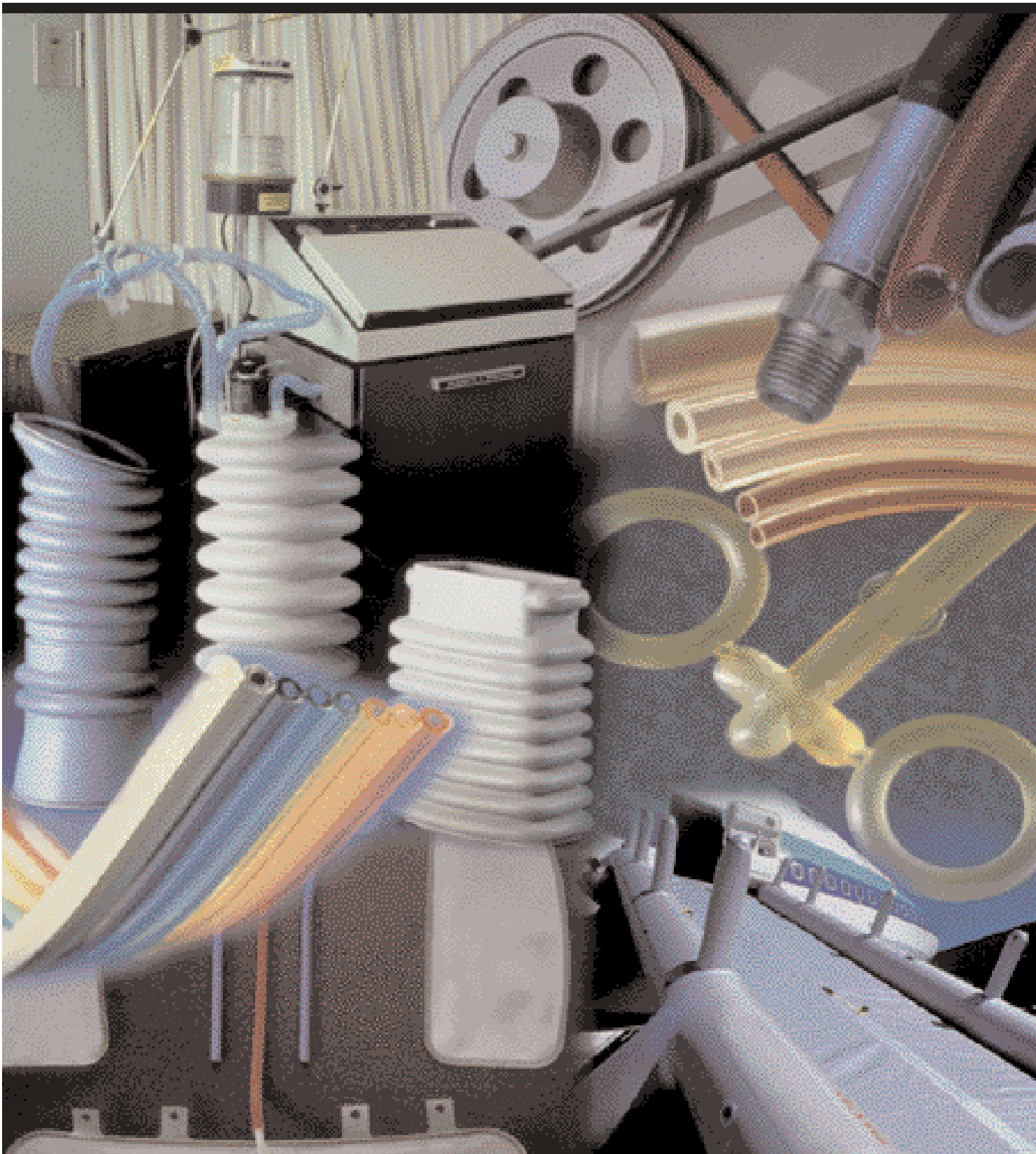
ALLIANCE FOR THE POLYURETHANES INDUSTRY
A BUSINESS UNIT OF THE AMERICAN PLASTICS COUNCIL

AX-235

THERMOPLASTIC POLYURETHANES
Bridge the Gap between Rubber and Plastics



thermoplastic polyurethanes

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 H_{12} 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

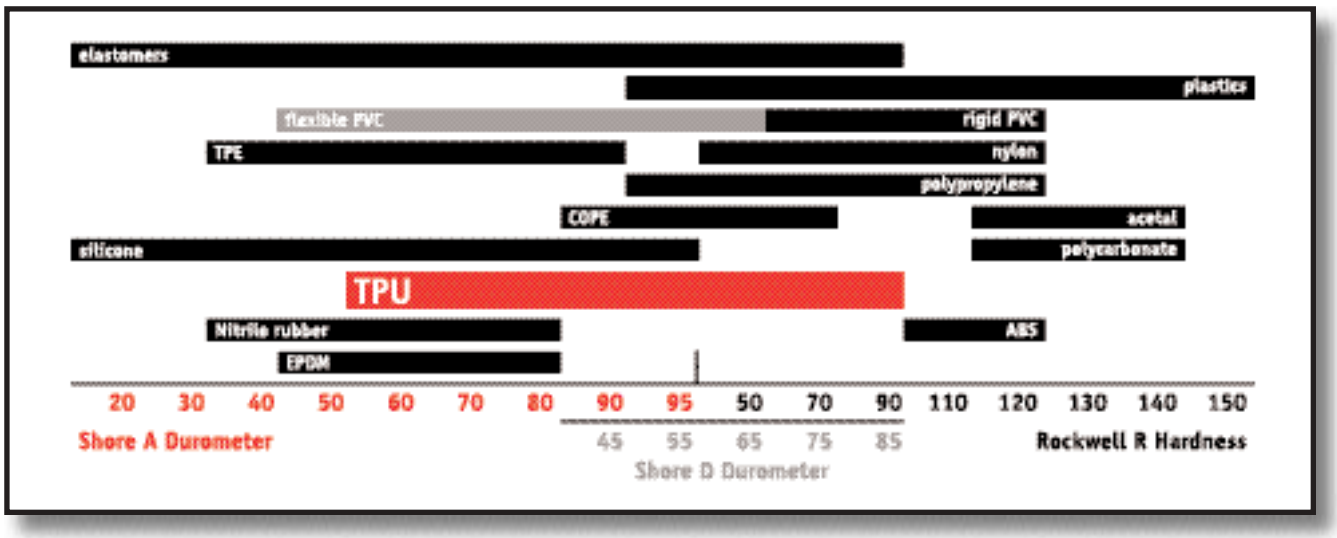
TPU is an outstanding contributor of properties in polymer blends. When added to polymers such as PVC, TPU helps improve toughness, abrasion resistance, low temperature flexibility and compression set.

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!



Physical Property Ranges

aromatic TPUs		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	50-60	20-30	20-30	80-100

aliphatic TPUs		ASTM	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 polyurethanes

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®
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KRYSTALGRAN®
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