

RAUH Polymers

## PermaFlex®

Applications

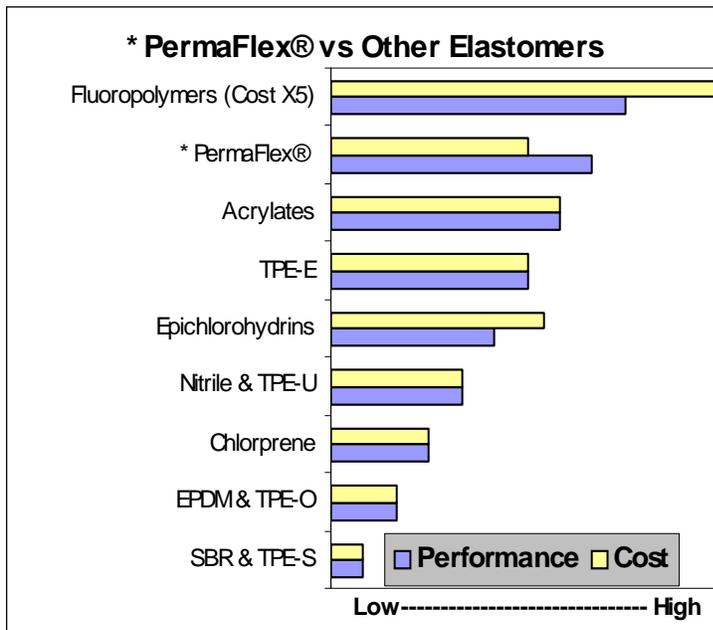
Properties

Processing

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## Introduction and Overview

PermaFlex, and all its grades, is a thermoplastic elastomer, based on copolyester chemistry, also known as COPE or TPE-E. It eliminates the demarcation between rubbers and engineering plastics. It combines the strength and processing characteristics of engineering plastics with the performance of thermoset elastomers, a combination of the most desirable characteristics of rubber and plastic. This combination provides benefits in processing and productivity for both molders and extruders. It also can be processed by blow molding or rotational techniques.



As a thermoplastic, PermaFlex does not involve the high cost of vulcanization to obtain optimal properties. This polyester-based material offers a consistent performance over its entire operating temperature range, since its' properties vary minimally from high to low temperature extremes. PermaFlex polyester-ester technology extends the traditional temperature range of thermoplastic elastomers.

The PermaFlex grades are 45, 50, 55, and 75, Shore D. These grade numbers represent approximate hardnesses. In addition, specialty grades are available, such as PermaFlex 35, for specific applications. All materials are available as a base polymer, polymer modifier, or as a compound for particular end use applications. PermaFlex offers the mechanical, physical, and chemical properties that qualify it for the most demanding applications. Its use is limited only by one's imagination.

## Basic Properties

A wide range of properties can be created, by varying the ratio of soft to hard block and the composition of the soft segment. PermaFlex stays tough as it flexes and recovers, having excellent characteristics as follows:

- Temperature resistance
- High tensile strength
- Impact resistance
- Wear and tear
- Abrasion resistance
- Resistance to weathering, oil and chemicals
- High permeability resistance to fuels & oils
- Flexural fatigue endurance
- UV stability
- Adhesion compatibility with paints, glues, plastics & metals
- Creep & compression resistance
- Excellent Moisture Vapor Transmission Rate
- Dielectric
- Good tactile and soft touch feel

### Components

PermaFlex copolyesters consist of fully polymerized hard and soft segments. Both hard and soft segments can be crystalline or amorphous esters. The ratio can be customized to meet specific applications. This differs from competition, where the hard segments are crystalline, and the soft segments are amorphous. The PermaFlex range of grades covers a broad variety of applications where flexibility, durability, low and high temperature performance and mechanical strength are a requirement.

### Rheology

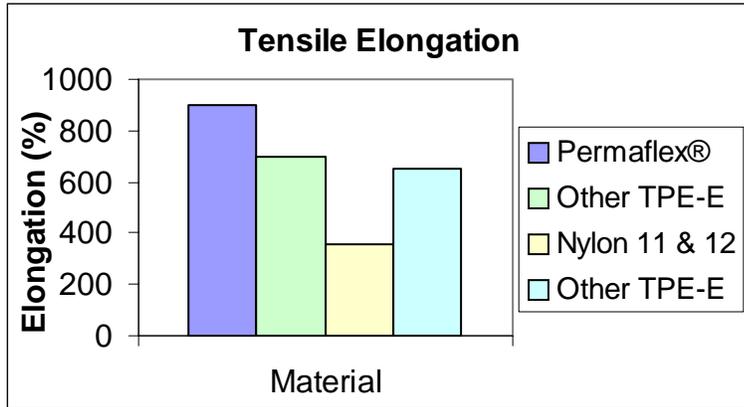
Lower viscosities of PermaFlex are available for injection molding, which will optimize the flow path length and weld lines. Shorter cycle times usually are realized with the higher crystallization temperature and lower viscosity. For some extruded parts, lower viscosity grades are best to realize increased line speed and consistency of wall thickness.

Medium viscosities of PermaFlex are available for extrusion processing. Melt stability of the extrudate is very good. Tighter tolerances can be obtained at higher line speeds on extruded products. Good rheological consistency is shown in blow molding viscosity.

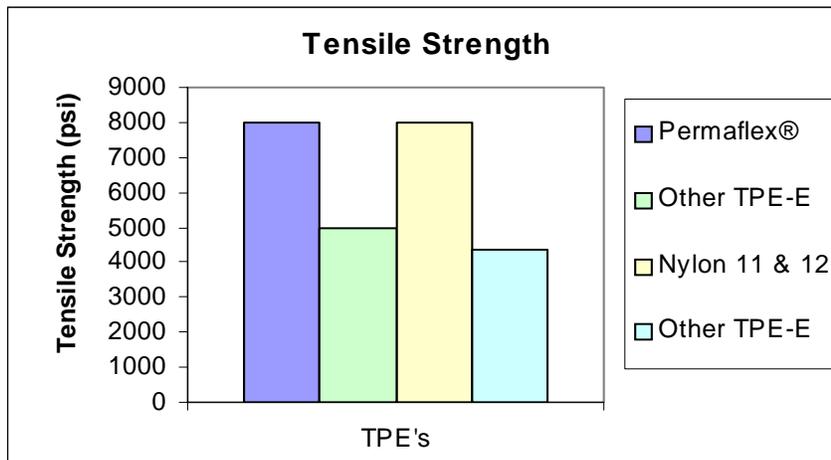
PermaFlex is the material to choose for superior productivity and process capability when requiring a copolyester elastomer.

## Mechanical

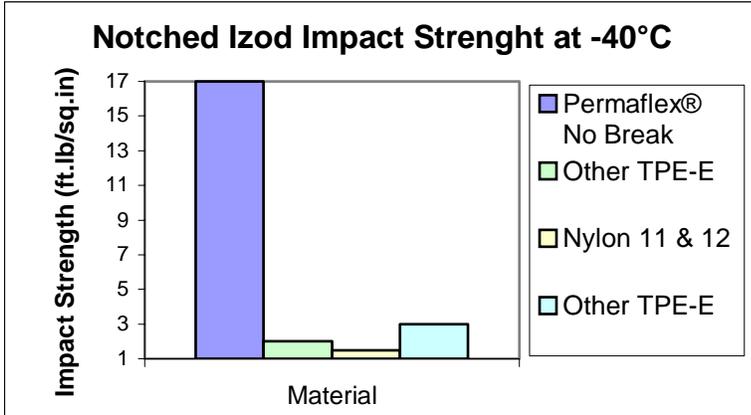
Since the stiffness of a product depends on the make up of the amorphous soft block and the hard block, as the proportion of the hard block increases, some properties (specific gravity, chemical and oxidative aging resistance, load bearing capability, stiffness, and creep resistance) increase.



As the proportion of the hard block decreases, other properties (flexural fatigue, compression set, cold temperature impact, and elongation at yield) improve. In particular, hydrolysis resistance will improve as the elastomeric properties of the soft block dominate.

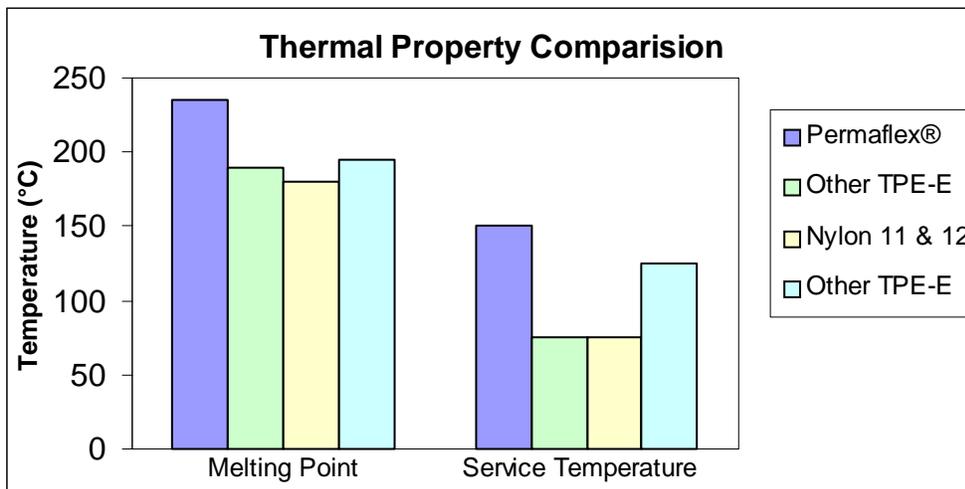


Cold temperature fatigue capabilities are excellent for PermaFlex 45 and 50 Shore D grades. These grades will perform better than the harder copolyester elastomers in compression set and cold temperature impact, and also will exhibit higher elongation at high working strain areas. The 50 grade is best for both mechanical and elastic capabilities.



PermaFlex 55 and 75 Shore D grades exhibit better creep and chemical resistance, as well as load bearing capability at high temperatures. PermaFlex 55 grade is a high heat thermoplastic elastomer based on polyester soft block.

This polyester soft block is why PermaFlex has unsurpassed heat-aging results.



To define the strain range in which material will function with elastic results: the lower the hardness of the material, the lower the stress at yield and the higher the elongation at yield. If you exceed the yield point, the permanent plastic deformation and dimensional change will show in the part.

### Chemical Resistance

PermaFlex displays excellent chemical resistance to greases, hydrocarbons, oils and fuels. PermaFlex is a good choice in the presence of chemicals for use in automotive applications. See chemical resistance chart for specifics.

### Coloring

PermaFlex can be colored by color concentrates in master batches that are based on ABS, TPE-E, TPU. If color heat resistance or color consistency were needed, it would be best to use a PermaFlex MB, using the base material as a carrier.

### Moisture

To obtain the best consistency in processing, the material should be pre-dried to constant moisture content. When running a change over, this is also important. A dehumidified air oven or vacuum drier can be used. A short-term dry time is 4 hours at 212 degrees F.

### Electrical

PermaFlex copolyester elastomer grades have very good electrical properties. They have low moisture absorption, and are a good choice in electrical applications, and are very stable against copper. Surface, volume resistivities, dielectric strength, dielectric constant and dissipation factors are high.

### Safety

While processing, avoid contact with molten polymer and inhaling fumes, otherwise, PermaFlex is non-hazardous through inhalation or skin contact.

## **Automotive Applications**

### Tubes and Hoses

Cost savings and excellent properties such as temperature resistance, chemical resistance and flexibility, work together in PermaFlex to make it the choice for tube and hose applications. Advantages:

- better heat resistance
- better dynamic abrasion
- better chemical, ozone, and fatigue resistance
- shorter cycle times with weight savings
- consistent product and long lifetime

Specifically, it can be used in fuel and fuel vapor tubing due to excellent low fuel permeation, pneumatic tubing coils due to excellent creep, pressure and tensile properties, and hydraulic hose assembly due to excellent oil resistance. All these properties, along with excellent heat resistance, give PermaFlex the advantage in wire harness convoluted tubing conduit under hood.

### Constant Velocity Joint Boots

PermaFlex 50 grade can replace rubber, TPE and other TPE-E's currently used in fixed and plunge CVJ boots, with many advantages and cost savings as well. Those advantages for CVJ and other hydraulic seals include:

- centrifugal expansion is lower at a high spin rate

- tougher at cold temperatures while maintaining flexibility
- use of regrind during processing
- compatible with new greases
- wide temperature operating range from –45 to 320 degrees F
- accommodates the more compact designs

Though PermaFlex works very well with this application, design factors need to be taken into account.

### Airducts

For airducts operating at ranges of high temperature at pressure, some advantages by using PermaFlex:

- continuous temperature max of 1000 hrs at 311 degrees F
- retains oil resistance at high temperature
- can tolerate temperature peaks of 401 degrees F
- flexibility permits compensation of engine movements
- light in weight for assembly ease
- simple processing with little waste

With its ideal properties, PermaFlex can be used with blow molding processes, while reducing the number of parts and assembly, which result in cost savings over traditional rubber materials.

### Other Automotive

Properties of TPE-Es permit complete recycling, conforming to End of Life Vehicle recycling directives. Processing is also environmentally friendly, leading to many applications throughout the vehicle. Additional automotive applications:

- Airbag covers and other safety components
- Instrument knobs
- Airless tires
- Seals, gaskets, belts, bushings, pump diaphragms
- High voltage protection wire coatings
- Antenna and window motor housing
- Energy absorbing parts

## **Film Applications**

### Introduction

Properties such as flexibility and elasticity, chemical resistance, thermal stability, and permeability to water vapor are in demand for hi-tech films and coatings in breathable applications such as construction, medical, textile and industrial. Non-breathable applications such as packaging and high heat resistant film show the PermaFlex resins to be advantageous, too. These thermoplastic materials can be made into pinhole free coatings or films by extrusion coating into a substrate. Casting or blowing into a film and then laminating into a substrate is another alternative.

Properties of PermaFlex in film for applications that require breathability and water impermeability are:

- High temperature resistance for cooking and sterilization
- Waterproof with high moisture vapor transmission rate
- High chemical and abrasion resistance
- Good resistance to weathering
- Elastic with good mechanical properties
- Stable at temperature extremes
- Water, blood and bacteria impermeability

#### Moisture Vapor Transmission Rate

MVTR is a measurement for breathability, or the ability to pass water vapor. TPE-E monolithic hydrophilic films breathe through a process of absorption-diffusion-desorption. Water is absorbed into the side of the film with the greatest concentration of water molecules, is diffused through the film, and desorbs on the side with the lowest concentration of the molecules. The difference in partial water vapor pressure across the film is the reason this occurs. PermaFlex has a good MVT rate because of its ester ester linkage.

#### Additives and Masterbatches

TPE-E based masterbatches are the simplest ways to color PermaFlex, but PE based can be used as well.

### **Other Applications**

#### Consumer Products Applications

The colorability, printability and good processability along with low temperature ductility makes PermaFlex a good choice for many consumer products such as sports equipment parts. Also, the chemical resistance and good abrasive properties allow it to be used in personal care products, watchbands, tools, footwear, luggage, and electrical appliances. It can even have the look and feel of leather.

#### Energy Absorption Applications

Heavy industries such as railway, transport and belting, demand excellent fatigue resistance along with chemical and weather resistance. Comfort riding passenger tracks and load bearing freight tracks can benefit from PermaFlex materials in the railway pads to protect concrete cracking. Difficult designs are also possible with PermaFlex, due to its wide modulus range and excellent flow processing.

#### Medial Applications

Approvals are being pursued for PermaFlex applications in surgical thread, and medical tubing. The fact that one can over-mold or co-extrude with other TPEs, makes it possible to use in highly integrated applications, with great cost savings over standard multi-assemblies.

### Food Applications

All materials that make up PermaFlex are FDA approved. PermaFlex can be used in applications such as liquid dispensers and other food contact, after its FDA approval is complete.

### Electrical and Electronic Applications

The excellent dielectrical properties, creep and heat resistance of our copolyester elastomer lends its use for equipment, medical and automotive wiring. Some other electrical applications include high temperature convoluted wire conduit, antenna and cable jackets, controller buttons, electrical cable connectors, and retractable phone coiled cords.

### Miscellaneous Applications

PermaFlex may be used as a modifier for oils, asphalts and other polymers, and has applications in high temperature adhesives and coatings.

PermaFlex can be used in soft-touch applications.