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Tough Urethanes for Tough Applications

Contacts

Pleiger Plastics is a division of Paul Pleiger Maschinenfabrik. The Pleiger group has over 500 employees worldwide with manufacturing facilities in the United States, Germany, Korea and China. Pleiger manufactures plastics, hydraulics, electronics, pneumatics, pumps, laser optics and naval products.

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Pleiger Electronic Control Systems Ltd.
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Pleiger Maschinenbau
Witten, Germany
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Pleiger Laser Optik
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Pleiger Far East Co. Ltd.
Pusan, Korea
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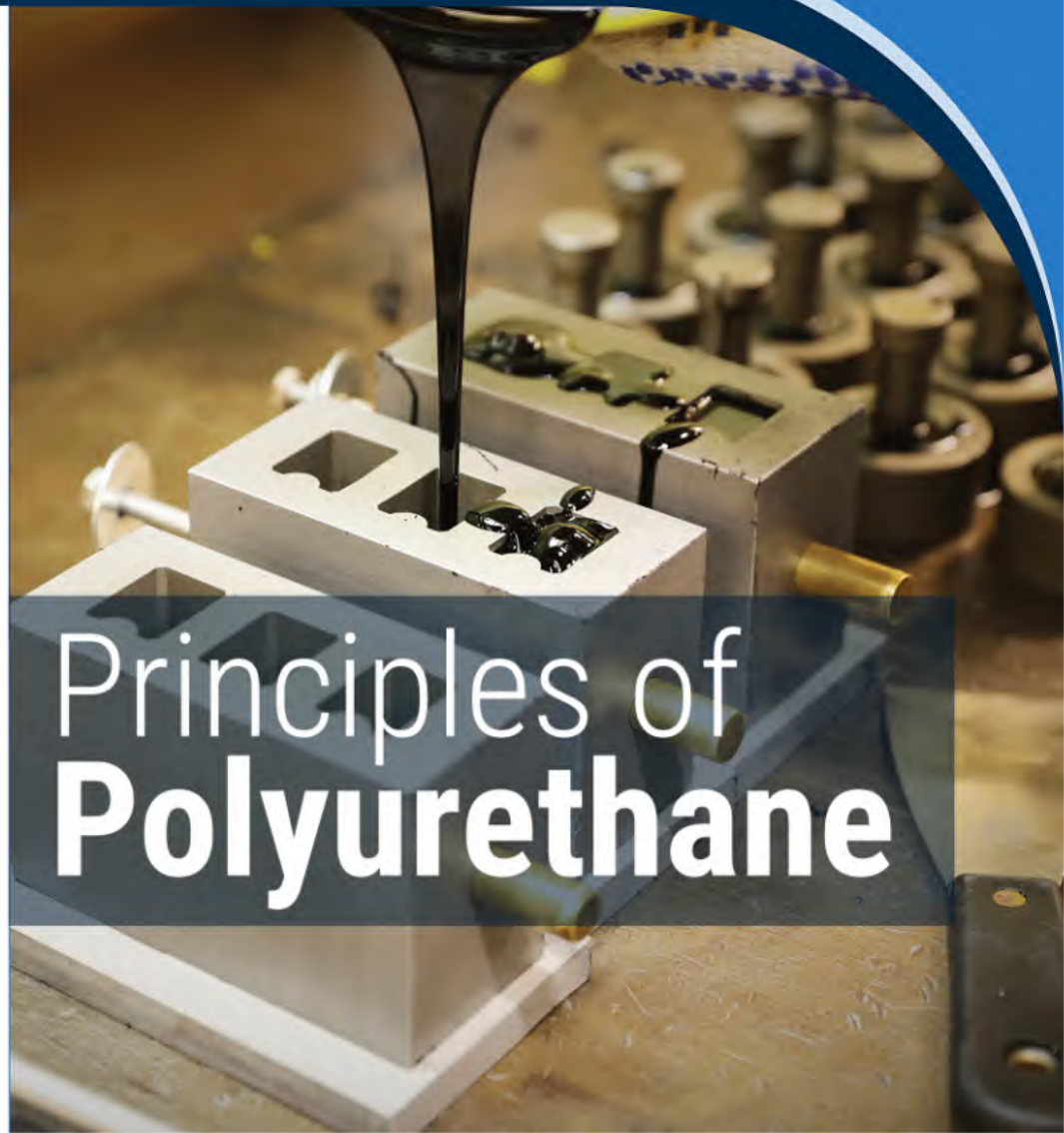
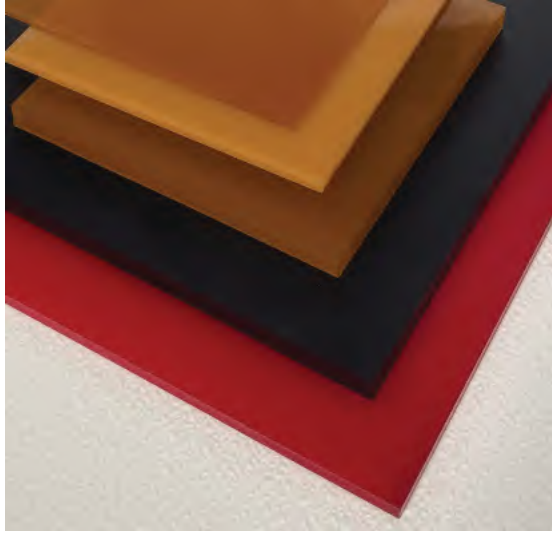


Principles of **Polyurethane**

What is **Polyurethane?**

Originating during World War II as an alternative to rubber, polyurethane evolved from a laboratory curiosity into an industrial product. Combining the outstanding properties of rigid plastic, metals, and rubbers, a superior plastic was born. What sets polyurethane apart from other elastomers and steel is its resilience and overall toughness.



Urethanes are made up of diisocyanate groups, polyols, and an extender.

Polyol
Ester, Ether, Caprolatones or Carbonates

Isocyanate
MDI, TDI, NDI, PPDI or TODI

Extender
Chain extender between two isocyonates (Glycol and Amine)

The terms urethane and polyurethane can be used interchangeably. There is a wide variety of urethanes available that are similar in characteristics but differ in specific properties.

Advantages of **Polyurethane**

Polyurethane compounds possess an extraordinary combination of physical, mechanical, and environmental properties. The type of resin and the ratio between the resin and the curative can be varied to optimize some of these properties.

Polyurethane Application Comparisons

Polyurethanes have definite advantages over plastics, conventional rubber and metals which make them a better substitute in applications where these materials are normally used.

... vs. Rubber	... vs. Metal	... vs. Plastic
high abrasion resistance	lightweight	high impact resistance
high cut, tear resistance	noise reduction	elastic memory
superior load bearing	abrasion resistance	abrasion resistance
thick section molding	less expensive fabrication	noise reduction
colorability	corrosion resistance	broader hardness range
oil resistance	resilience	resilience
ozone resistance	impact resistance	thick section molding
castable nature	flexibility	lower cost tooling
broader hardness range	easily moldable	low temperature resistance

Available as Thermosets

Thermoset –

Chemicals are combined and once the reaction occurs, it is poured into a mold before the urethane cures or sets. This process yields the high performance properties that are not obtained by any other process. Pleiger Plastics uses this process to make the Plei-Tech line of urethanes.

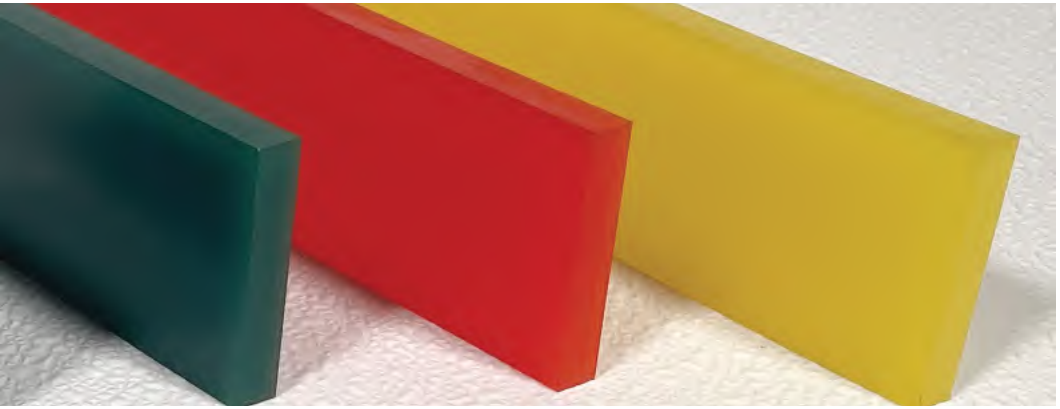
Advantages to Using Polyurethane:

- Excellent resilience
- Extra toughness and durability
- Very high load bearing and cut resistance
- Low compression set
- Very good impact resistance
- Excellent abrasion resistance
- Oil, solvent and water resistance

Selecting **Polyurethane**

All Polyurethanes are not equal when it comes to performance. A thermoset urethane is created by the molder. The type of polymer, the process parameters, and the ratio of curative play a critical role in the performance of the product. Pleiger Plastics uses only the highest quality raw materials as well as sophisticated procedures to produce the high performance products.

Pleiger offers engineering services to design or re-design molded parts to optimize performance and moldability. Once designs are finalized, low cost prototypes are produced for field testing and selection of the best compound.



When using polyurethane keep in mind these few points:

- What is your application? *(Bumper, wheels, scrapers)*
- What type of wear is the part exposed to? *(Impact, sliding, impinging)*
- What are the environmental factors? *(Chemicals, temperature, indoor/outdoor)*
- What material are you currently using? *(Rubber, PVC, metal)*
- Is this part typically replaced? If so, how often?
- What are its means of failure?

Determining the material's durometer is critical when selecting polyurethane. The durometer is one way to indicate the hardness or material's resistance to permanent indentation.

The Hardness Scale gives an approximate measure of materials and thecorresponding durometer.

Pleiger offers urethanes in 5A-80D.

Plei-Tech **Polyurethane**

All of Pleiger Plastics' Polyurethanes are marketed under the registered name of Plei-Tech. The Plei-Tech name has become known worldwide for high quality and high performance.

All Plei-Tech polyurethanes are thermoset materials characterized by their unusual toughness, and they combine resilience and high load-bearing capacity with resistance to and prevention of degradation. These polyurethanes are resistant to impact, abrasion, and compression set, while also avoiding degradation by oxygen, ozone, and oil, over a wide temperature range.

Pleiger Plastics offers over 15 different Polyurethane compounds. Trained Sales Representatives will help choose the right compound for your application. Available from 5A (soft as gum rubber) to 80D (hard as a bowling ball).

Most Popular Plei-Tech Materials

Plei-Tech 00
Polyester based compound developed in conjunction with Plei-Tech 22 to offer alternatives to Plei-Tech 15. Plei-Tech 00 offers outstanding tear strength, good abrasion resistance, excellent resistance to petroleum-based chemicals, and is suited for moderate dynamic loading. Plei-Tech 00 is available in 70° A to 95° A. Maximum service temperature is 200° F. Standard color is red, however, this product is not color stable.

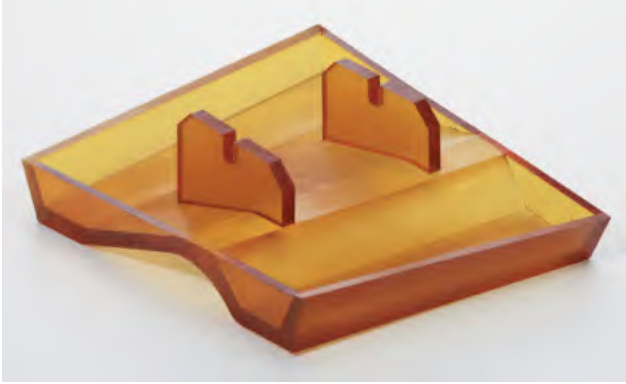
Plei-Tech 22
Polyester based polyurethane. Plei-Tech 22 is a compound developed by Pleiger Plastics Company as an alternative to Plei-Tech 15. Plei-Tech 22 offers excellent abrasion resistance, solvent resistance, and resistance to petroleum based chemicals. Plei-Tech 22 is available in hardnesses from 40° A to 52° D. This compound generally meets MSHA approval. Maximum service temperature is 190° F. Color coding is available.

Plei-Tech 95
Plei-Tech 95 is a polyether based polyurethane. Plei Tech 95 offers excellent performance in dynamic loading and shock absorption. Plei-Tech 95 is available in hardnesses from 80° A to 75° D. Plei-Tech 95 is suited for applications involving hydrolysis, mild acids, and gasoline. This product generally meets MSHA approval. Maximum service temperature is 200° F. Standard color is black, however, this material is not color stable.

Plei-Tech 15
Plei-Tech 15 is a polyester based polyurethane that utilizes NDI as a hard segment. Plei-Tech 15 offers excellent abrasion and cut resistance, and is well suited for high dynamic loading. Plei-Tech 15 performs well in solvent and oil environments, and is available in hardness from 60° A to 60° D. This compound generally meets MSHA approval. Maximum service temperature is 200° F. Color is natural which is a light brown that turns to dark brown when exposed to UV light. (No properties are lost in this color transformation).

Custom **Molded**

Pleiger Plastics was founded on the idea of molding high performance polyurethanes to meet and exceed the requirements of the most extreme applications. Today we are even more committed to that simple concept.



A few of our specialties include:

Engineering new parts based on the application

Matching the right compound to your application

Tooling design for any application

Cost effective molding techniques

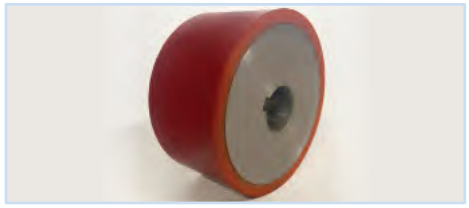
Product Applications

Industry	Application
Construction	Scrapers / Compaction Equipment / Bucket Scrapers / Bumpers / Tampers / Rammers
Public Municipalities	Salt & Sand Spreaders - Salt Trucks Cutting Edges - Plow Trucks / Check Valve Balls /Pumps
Mining	Belt Scrapers / Conveyor Belts / Draft Rubbers
Power Transmission	Couplings / Machinery / Vibration Isolation
Corrugated Box	Soft Touch Rollers / Box Machinery / Cutting Bars / Die Blankets
Newspaper	Cutting Bars / Printing Press / Foam Pads / Doctor Blades
Post Office	Rollers / Sorting Machinery
Printing	Rollers / Cutting Bars / Transporting
Laundry	Rollers / Material Handling
Automotive	Wheels / AGV's / Automated Conveyors / Bushings / Mounts / Suspension Products
Forklifts	Wheels / Load Tires
Elevator & Escalator	Rollers / Guide Rollers / Bumpers

Polyurethane Parts

Bumpers isolate and dampen high shock loads with minimal permanent set.

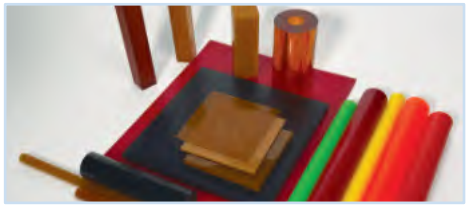
Doctor Blades are used in paper manufacturing, coating, printing and wastewater treatment industries.



Rollers are molded to suite small to large material transport applications.

Soft Touch Rollers used in transport prevent damage to surfaces while retaining excellent abrasion resistance.

Check Valve Balls are excellent for abrasion applications. Available with and without inserts.



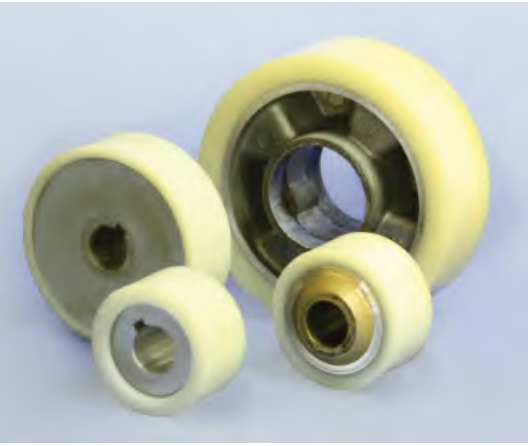
Stock Shapes: Rod, Sheet, Tube, and Bar have superior performance and wear life.

Plei-Tech Wheels are excellent in high load carrying applications. Exhibits high abrasion resistance and outstanding performance.

Cutting Edge Blades are used by airports, municipalities, etc. Abrasion resistant and resilient to prevent damage and absorb impact.

Vulkollan (Plei-Tech 15)

Vulkollan is a highly elastic cross-linked polyurethane elastomer. It is the highest grade urethane available, due to its superior mechanical characteristics:



- High dynamic load capacity
- Higher abrasion and tear resistance than other compounds
- Highest modulus of elasticity of all elastomers
- Excellent wear resistance and impact resilience
- Reduced compression set
- Good chemical resistance to UV radiation, mineral oils, greases, and solvents

Specially recommended for towing applications where load capacity, rebound resilience, continuous use, speed and durability are mandatory. Therefore, Vulkollan is preferred for drive and load wheels for industrial trucks, and heavy duty material handling applications.

Vulkollan Foam (PT-15 Foam)

Plei-Tech 15 Foam is an open/closed cell polyurethane foam based upon Vulkollan (Plei-Tech 15) chemistry. It is excellent for shock absorption of light to medium loads at high frequency. A cellular Vulkollan piece is able to be compressed up to 70% of its original height with minimal permanent set. Cellular Vulkollan complements solid Vulkollan in applications where increased deformability and reduced stiffness are required. PT-15 foam parts are available in custom molded shapes as well as rod, sheet and tube.

Why Choose **Pleiger Plastics?**

Founded in 1986, Pleiger Plastics Company was one of the first molders in the United States to process Vulkollan, Europe's highest performing polyurethane systems for molding engineering parts. Pleiger Plastics' business philosophy is to provide high performance, high quality polyurethanes worldwide.

By offering full service molding, Pleiger Plastics gives its business partners cost-effective solutions to difficult problems. Starting with short turnaround quotations, the Pleiger solution lets our customers build the framework for a successful molding project.

In addition to custom molding services, Pleiger Plastics offers a full range of polyurethane sheet, rod, and tube semi-finished goods. Durometers range from 5A to 80D. Special colors and sizes are available upon request.

A full testing lab is used to insure that products manufactured by Pleiger meet our published specifications. These lab services can also be used to identify existing products and determine an appropriate substitute. All of these services are combined to optimize design and performance, which leads to longer lasting products that can be effectively molded and delivered anywhere worldwide

Key Terms

Abrasion Resistance – The ability of a material to withstand mechanical action such as rubbing, scraping, or erosion, that tends progressively to remove material from its surface. Such an ability helps to maintain the material's original appearance and structure. Also known as Taber or NBS Index. Measured in mg loss.

Bashore Resilience – An ASTM test (D-2632) for the rebound characteristics of elastomer. High Bashore resilience generally implies low heat buildup in the roll when used at high speeds under high loads. Measured in % rebound.

Coefficient of Friction – Measure of a body's resistance to motion. Static and Kinetic; normally static is significantly higher than kinetic.

Compression Set – The characteristic of the elastomer to remain permanently deformed after deforming forces are removed. ASTM D 395

Conductivity – The measure of a material's ability to transmit electrical energy. Measured in ohm-cm.

Creep – The tendency of an elastomer or plastic to change shape over time.

Durometer – The hardness of the final elastomer, or the gauge used to measure the hardness. Shore A scales (ASTM D-2240) is commonly used as well as Shore D & O.

Elastomer – A polymer that expresses elastic properties.

Filled – Term describing a material which has secondary compounds added to affect physical properties and performance. Common fillers are glass fiber, MOS2, clay, and silicans

Hysteresis – The tendency of an elastomer to build up heat through cycles of stress and relaxation. Higher stress or cycle speeds increase heat build up. Hysteresis should not be compared or confused with heat resistance.

Isocyanate – Compound that reacts with a polyol and extender to form polyurethane.

MDI	Methylene diphenyl diisocyanate
NDI	Naphthalene diisocyanate
TDI	Toluene diisocyanate
PPDI	Para-phenylene diisocyanate
TODI	Ditolylene diisocyanate

Key Terms

Modulus – The stiffness of an elastomer, measured typically as the force required to stretch a strip of the elastomer to a given extent. Modulus is closely related to hardness. Measured in psi.

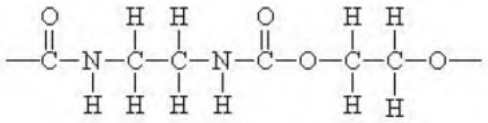
Mold Release Agent – A lubricant that prevents the surface from adhering to the mold. Typically silicon based but can also be wax or teflon.

Polyester – Polyester's are resistant to petroleum based chemicals and are highly resistant to cutting, tearing, and chunking. There are many varieties of polyesters each expressing unique properties.

Polyether – Polyether's chemical makeup is a continuous chain making it hydrolysis resistant. In addition to water, it is also resistant to acid based chemicals and gasoline. Used in high-speed and load-bearing applications and shock absorbing applications. There are two types of ether: PPG which is the lowest performance and PTMEG which is the highest performance type.

Polymer – The solid polyurethane produced from the chemical reaction between the prepolymer and the curative.

Polyurethane – The polymer prepared by reacting a polyisocyanate (prepolymer) with polyhydroxy-terminated compound (curative).



Polyurethane

Service Temperature – Ambient temperature where an elastomer will still maintain its modulus and physical properties. Thermoset materials maintain a constant modulus over temperature up to their service temperatures. Thermoplastic modulus and physical properties typically decline as temperature increases.

Shape Factor – Constant used in spring calculations which relates compressed area to "free to bulge" area.

Tear Strength – A measure of the resistance of the elastomer to tear and gouge. Tear strength usually correlates to the material's abrasion resistance. ASTM D 470 or 624

Tensile Strength – The resistance of a material to a force tending to tear it apart, measured as the maximum tension the material can withstand without tearing. Measured in psi. ASTM D 412