TriStar

Engineered Plastic Solutions™

Plastic Bearing Design

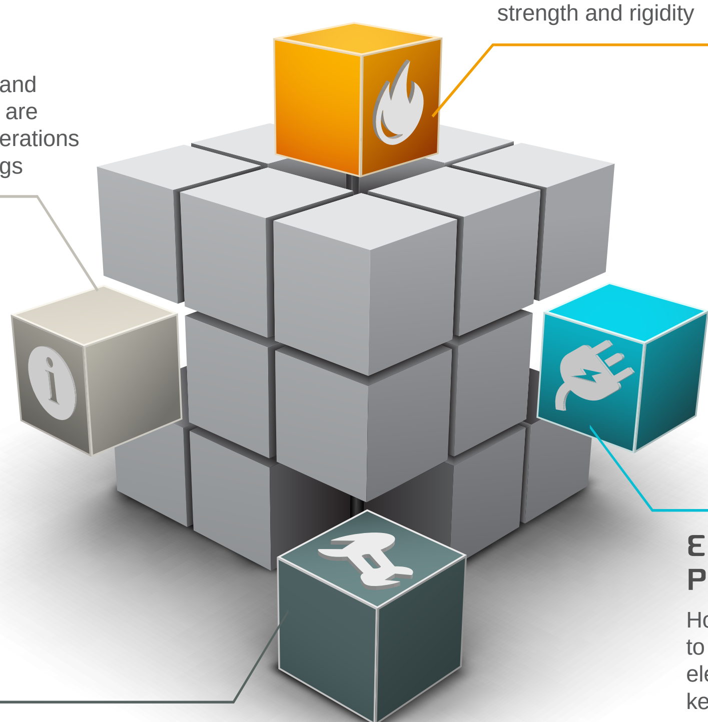
A Guide to Form, Function and Selection

Thermal Properties

Changes in continuous or maximum service temperature impact plastic strength and rigidity

General Properties

Elastic behavior and creep resistance are two basic considerations for plastic bearings



Electrical Properties

How a material reacts to the application of electrical current is a key design consideration.

Mechanical Properties

Good strength and load tolerance define mechanical attributes

In plastic bearing design, form follows function. To select the right bearing to match your requirements, consider all parts of the puzzle.

plastic bearing design

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Introduction

When it comes to selecting the right plastic bearing for your application, the options are virtually unlimited. Between unique composite formulations, specialized liners and custom fabrication, there are literally thousands of design options available to meet the requirements of your application. But how do you identify the precise material to fulfill your specific requirements? Which qualities should you look for? What options are even available today?

We've prepared this guide as the ultimate plastic bearing selection guide — your go-to resource for uncovering the right bearing form, with the specific properties you need to improve your industrial application performance. Join us as we explore the art of plastic bearing selection.

TriStar

Engineered Plastic Solutions™

At TriStar, our goal is to become your in-house engineering department. We provide engineering, custom fabrication and manufacturing of high-performance plastics and self-lubricating bearing materials. With TriStar, the Advantage is Clear.

Bearings: A Brief History

What is the purpose of a bearing? Simply stated, a bearing is a supportive structure, designed to "bear" or carry stress or load in a design application. Just as your skeleton supports your body (or form), it is your joints or "bearings" that allow free movement (or function) of each individual part.*

Bearings reduce friction levels at the intersection of two meeting points. They are available in two primary forms; contact (linear and rotary motion) and non-contact (fluid films and magnetic bearings). This paper will focus on the forms, functions and selection of contact bearings.

Original bearing designs date back to 2600 BC, when ancient Egyptians used a form of roller bearings to move massive stones to build the Pyramids. From primitive pyramid-building to present-day industrial use, both the form and function of bearings have evolved exponentially. Early bearing designs were made of wood, later versions of sintered bronze and various metals, until the breakthrough of plastic composites in the 1950s. From this point on, plastic composite bearings have revolutionized engineering design in virtually all industries.

Bearing functions range from plane bearings, rolling element, thrust bearings, to specialized bearings. Applications include virtually every conceivable industrial application, from rugged rail and construction, to high-sanitation food and medical environments. No matter the application, for the best success, bearings must have the right form to allow proper function.

** Fundamentals of Design, 2008 Alexander Slocum*

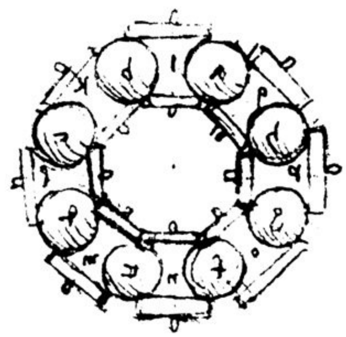
The Ancient Egyptians use a form of roller bearings to help move massive bricks during construction of the Pyramids.

Bearing Design: An Evolution

To better understand today's bearings, let's start at the beginning with a brief history:

- **2600 BC –** Ancient Egyptians use a form of roller bearings to help move massive bricks during construction of the Pyramids.
- **1500 AD –** Leonardo da Vinci described a type of bearing design; his ideas are still celebrated today
- **1600s –** Galileo described caged ball bearings as a means of preventing friction
- **1700s –** New manufacturing methods demand new bearings
- **1800s –** Isaac Babbit invented an alloy with a low-melt temperature that could be formed and molded to produce an ideal surface for bearings.
- **1900s –** Faster machining tools and the invention of the auto began a serious drive for metal bearings
- **1930s-1940s –** Invention of many durable plastics that eventually became primary bearing components (PS, nylon, PVC, PE, PU)
- **1950s –** Proliferation of plastic formulas (FEP, PFA, CTFE, ECTFE, ETFE, PP, PI, Acetal and PTFE/Rulon)
- **1960s –** PEEK comes to market, and self-lubricating polymer bearing designs first appear
- **Present day –** Plastic bearings excel in nearly every conceivable industrial application, from rugged rail and construction, to high-sanitation food and medical applications.

**Adapted from the American Bureau of Bearing Manufacturers*



Leonardo da Vinci incorporated drawings of ball bearings in his design for a helicopter around the year 1500.

Bearing Design: Plastics vs. Traditional Metal Bearings

Plastic or metal bearings – which is a better choice for my application?

This question remains an active debate among engineers in certain industries. Despite information to the contrary, some designers are reluctant to specify plastic bearings, thinking they are an inferior and expensive substitute for traditional metals. The simple fact is that plastic bearings are an excellent, value-driven replacement for bronze, stainless steel and cast iron. Plastics offer similar or even superior strength attributes compared to metals, plus they can excel in high temperatures and extreme environments all this from a lightweight material that gives engineers a more versatile design option. Why choose self-lubricating bearings over traditional metals? Consider:

Self-lubricating Plastic Bearings vs. Traditional Metal Bearings

- Low maintenance = cost savings
- No grease = resistance to debris and improved efficiency
- High-performance = chemical and temperature tolerance
- Lightweight = lighter design of final component with equal performance
- High-sanitation = industry-specific compliance (FDA, USP, 3A, ABS)
- Corrosion and rust resistance = longer wear and service life in wet environments
- Flexible design options = excellence in linear, oscillating, and rotary applications

Plastic bearings offer exceptional performance over traditional metals, but in the case of some plastic formulations, this level of performance may have a price.

Common Plastic Bearing Applications

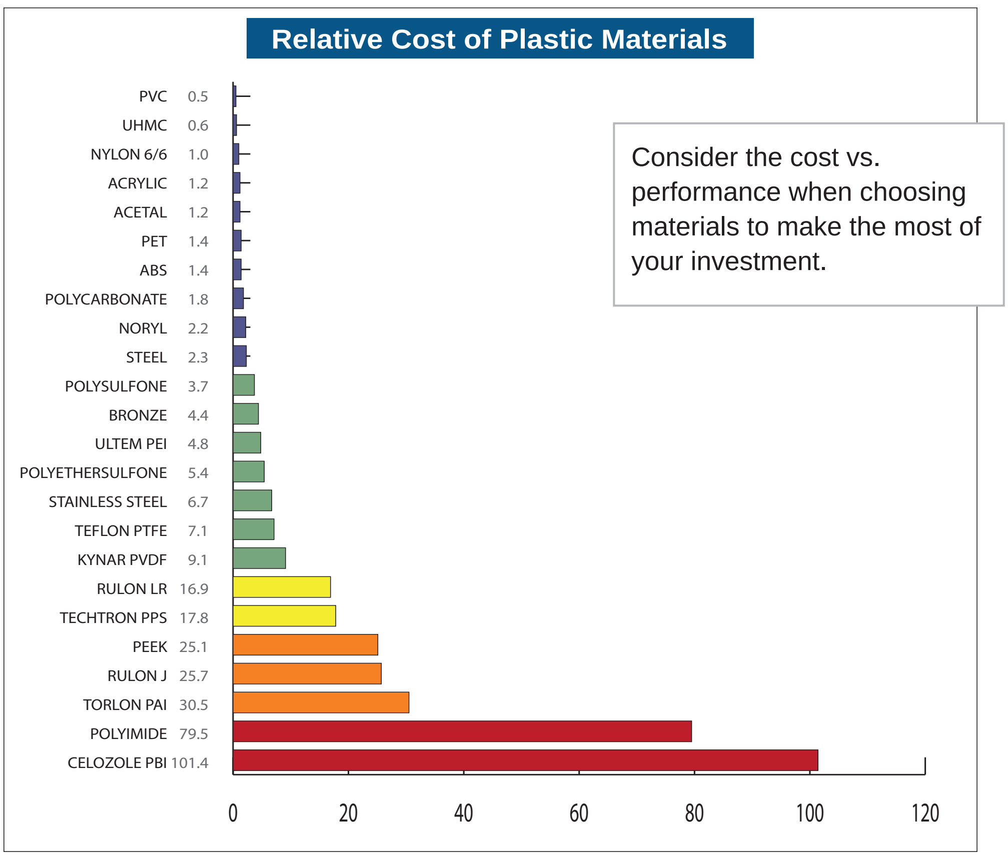
Look for plastic bearings in:

- *Automotive Industry*
- *Agriculture Equipment*
- *Construction Equipment*
- *Conveyors*
- *Cryogenic Equipment*
- *Dryer Oven Conveyors*
- *Hydraulic Presses*
- *Machine Tools*
- *Marine Industry*
- *Medical Equipment*
- *Mining*
- *Oil Fracking Equipment*
- *Food Packaging Equipment*
- *Food Processing Equipment*
- *Pumps*
- *Robotics*

Bearing Applications: Cost vs. Performance

It's true that plastic materials can be more expensive than traditional metals. PBI polymers, for example, can run 25x or more the price of cold-rolled steel. At these price points, it is critical to look beyond **initial unit expense**, and instead calculate **lifetime performance cost**.

Properly designed components can yield big savings down the line given longer-wear rates, fewer maintenance calls and superior service lifetime. Once you've selected a material based on your primary application requirements (environment, temperature, mating hardware, etc.), we then recommend that you look at the quality of the material.



Bearing materials should be chosen based on characteristics and performance, not cost. Properly chosen materials will help you reduce in-field failures and costly product recalls.

Bearing Design: Key Criteria

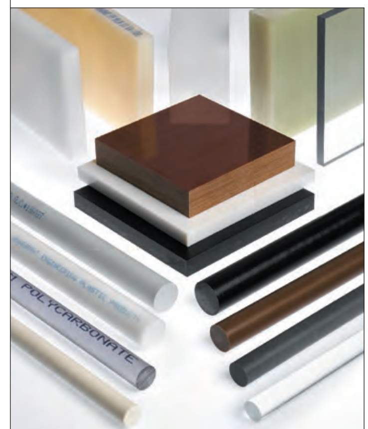
Ultimately, all **bearing design challenges** can actually be defined as **material selection challenges**. Meaning, simply, to determine the feasibility of a plastic material, it is critical to look at the following design criteria:

I. Basic plastic attributes

II. Mechanical properties

III. Thermal and electrical

IV. Miscellaneous considerations



When choosing bearing materials consider these four design categories:
I. Basic plastic attributes
II. Mechanical properties
III. Thermal and electrical
IV. Miscellaneous considerations

I. Basic Plastic Material Attributes

- **Elastic Behavior**

  Elastic behavior relates to the stress and strain placed on a plastic material. As stress levels reach a critical point, the yield (or deformation) of the plastic is directly impacted.

- **Impact Strength**

  A polymer's impact resistance is determined by the material's base resin plus any added modifiers and reinforcing agents. Impact strength is commonly measured by an Izod test for tensile strength; the higher the Izod measurement, the higher the impact strength.

- **Thermal Properties**

  Even a small change in temperature can have an impact on the strength and stiffness of plastics. To determine thermal properties, consider:

  - **Continuous service temperature –** the highest temperature at which a material will retain its physical integrity.
  - **Maximum service temperature –** the point at which temperatures stress and soften plastic materials, as defined by ASTM (see page 12 for information on ASTM).

- **Dimensional Stability**

  A material's dimensional stability (or rate of expansion/contraction) is directly impacted by exposure to extreme temperatures, moisture levels and loads. In fact, expansion levels (in heat) and contraction levels (in cold) can reach 10x (or more) the rate of metals. For example, a plastic part manufactured in a hot, dry desert warehouse will very likely present dimensional challenges when installed in a cold, wet winter application if it is not properly analyzed and cut.

II. Plastic Properties 101: Mechanical Attributes

- **Tensile Strength**

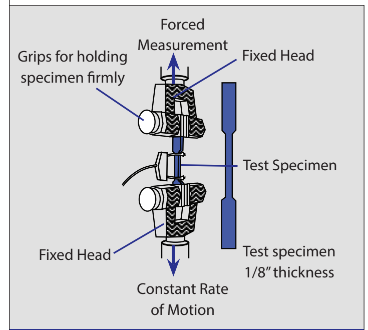
  Tensile strength measures a material's ability to withstand load under tension without a failure. Also known as ultimate strength, tensile strength is calculated in pounds per square inch (PSI). The higher the tensile strength, the stronger the bearing material and the better ability it has to resist cracking. Typical tensile strength of materials:

Tensile Strength

Material	Tensile PSI
Wood	1,100
Plastic Composites	17,500
Bronze Bushings	35,000
Steel	40,000

- **Tensile Elongation**

  Tensile elongation is the increase in length that occurs when a material is stretched, but before it breaks under tension. It is expressed as a percentage of the original length of the material. High tensile strength and high elongation together contribute to the overall toughness of a material.



Supplied by Quadrant Engineering Plastic Products

TENSILE STRENGTH
For this test, samples are either machined from stock shapes or injection molded. The tensile testing machine pulls samples from both ends to measure the force necessary to pull the specimen apart (Tensile Strength), and how much the material stretches before breaking (Elongation).

- **Compressive Strength**

  This measurement refers to the resistance of a material to breaking under compression. There is a wide variation in compressive strength between different grades of plastics.

- **Flexural Strength**

  Flexural strength translates to a material's ability to resist bending under load, also known as modulus of rupture or bend strength.

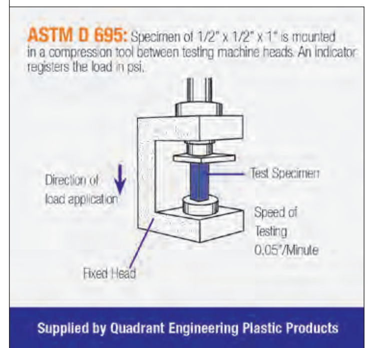
- **Hardness**

  Plastic hardness measures the resistance of the material to indentation, as measured by either the Rockwell or Shore testing methods.

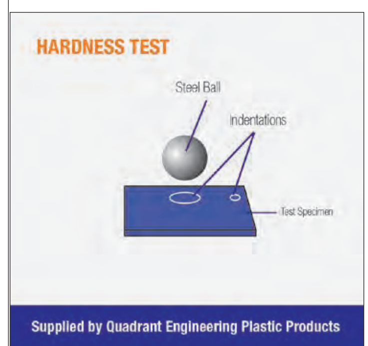
  - **The Rockwell Method** - generally used for harder plastics where the resiliency or creep of the polymer is less likely to impact results (nylon, polycarbonate, polystyrene, and acetal).
  - **The Shore/Durometer Method** - reserved for softer materials such as Urethane, PTFE and PVC. Hardness data is best used to compare materials, and does not correlate to other plastic properties or fundamental characteristics.

- **Modulus**

  Modulus covers tensile, compressive and flexural strengths and is defined as the ratio between stress or force per unit area. Adapted from Young's Modulus of Elasticity, modulus can predict the reaction of a material, as long as the stress is less than the yield of the material.



COMPRESSIVE STRENGTH (ASTM D 695)
Compressive strength measures a material's ability to support a compressive force.



HARDNESS
Hardness is usually reported by one of two test methods – Rockwell (ASTM D 785) or Indentation Hardness / Durometer (ASTM D 2240).

ASTM Testing Standards

ASTM International (formerly American Society for Testing and Materials) is the industry's governing body responsible for determining quality standards in plastics. ASTM's standards help to specify, test, and assess the physical, mechanical, and chemical properties of plastic products and their polymeric derivatives. Through ASTM, both plastic manufacturers and end-users are able to ensure quality and acceptability for safe utilization.

III. Plastic Properties 101: Thermal & Electrical

- **Coefficient of Linear Thermal Expansion (CLTE)**

  CLTE describes how the size of an object changes in relation to temperature. Measured in units of in./in./°F, CLTE is a critical consideration if dissimilar materials are to be assembled in applications involving large temperature changes. The CLTE of plastics can vary widely; the most-stable plastics approach the CLTE of aluminum, but exceed that of steel by up to ten times.

Plane Bearing Coefficients of Thermal Expansion

Material	Expansion IN/IN°F x 10E-6
TriSteel PT	6.0
1040 Carbon Steel	6.0
FCJ	7.0
CJ	7.0
Carbon Fiber PEEK	7.0
660 Bronze	10.0
Aluminum	12.4
Carbon/PTFE PEEK	17.0
Graphite PI	27.0
Ultracomp	33.0
Rulon	35-49.0
Nylon	55.0
Delrin AF	63.0
UHMW	130.0

Common ASTM Standard Test Methods for classifying plastic bearings:

D149 - Dielectric Strength

D150 - Dielectric Constant and Dissipation Factor of Plastics

D256 - Izod Impact

D638 - Tensile Properties of Plastics

D648 - Heat Deflection Temperature

D695 - Compressive Properties of Rigid Plastics

D570 - Water Absorption of Plastics

D774 - Flexural Fatigue Properties of Plastics

D790 - Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials

D792 - Specific Gravity

D953 - Bearing Strength of Plastics

D1822 - Tensile Impact

D2990 - Tensile, Compressive and Flexural Creep and Creep-Rupture of Plastics

D3418 - Melting Point

D3702 - Coefficient of Friction

*D7107 - Creep Measurement of Self-lubricating Bushings**

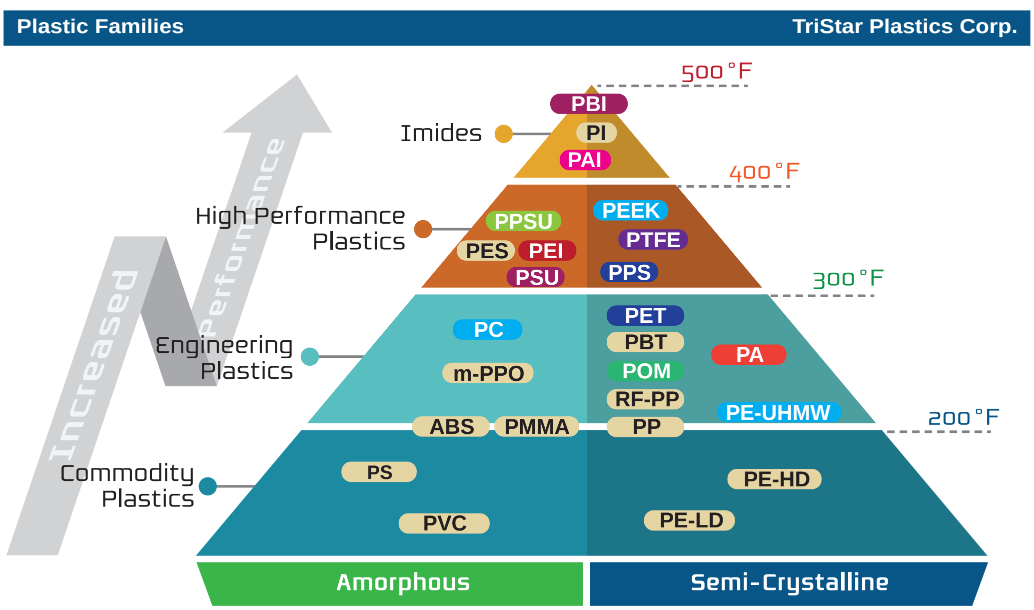
**ASTM International astm.org*

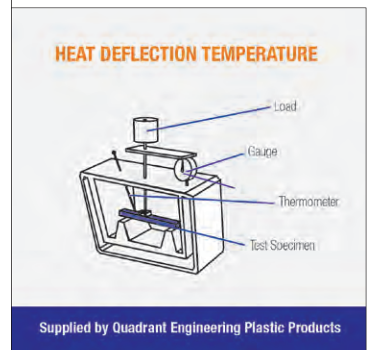
- **Heat Deflection Temperature**

  Heat deflection temperature is the point at which a 1/2" thick test bar, loaded to a specified bending stress, deflects by 0.010 in. It is also referred to as the heat distortion temperature. This value helps to determine the suitability of materials to perform at elevated temperatures short term, while also supporting loads.

- **Service Temperature**

  Service temperature indicates a plastic material's ability to retain certain physical properties when exposed to elevated temperatures for an extended period of time. Continuous service is defined as up to 10 years. When selecting a material, both heat deflection and service temperature are primary considerations.





HEAT DEFLECTION TEMPERATURE
Heat deflection temperature is the point at which a 1/2" thick test bar, loaded to a specified bending stress, deflects by 0.010 in.

- **Melting Point**

  The temperature point at which a thermoplastic changes from solid form to liquid form.

- **Resistivity**

  Resistivity is a fundamental indicator of a material's ability to electrically insulate. The resistivity value can be used to determine the critical properties of a material, such as dielectric breakdown, dissipation, moisture content and mechanical continuity.

  Resistivity is expressed in two ways:

  - **Volume (or Bulk) Resistivity -** Volume resistivity indicates how strongly a material can oppose the flow of an electric current. A low resistivity score indicates a material will readily allow the movement of an electric charge.
  - **Surface Resistivity -** Surface resistivity measures the ability of an electric current to flow over the surface of a material. The more easily a current flows, the lower the surface resistivity number (indicated as ohms/square area). Surface resistivity testing is critical in bearing applications with static charge dissipation.

- **Dielectric Strength**

  This refers to the maximum electric field that a pure material can tolerate under ideal conditions, without failure. Factors that affect dielectric strength in applications include: temperature, sample thickness, conditioning of the sample, rate of increase in voltage, and duration of testing. Contamination or internal voids in the sample also impact dielectric strength.

- **Dielectric Constant**

  Also referred to as permittivity, dielectric constant measures the ability of a material to store electrical energy. The higher the dielectric constant, the more electrical energy can be stored. Dielectric constants are dependent on frequency, temperature, moisture, chemical contamination and other factors.

Plastic temperature classifications:

Commodity Plastics - *lower cost and performance, typically below 200° F, with good chemical resistance*

Engineered Plastics - *300° F limit, generally more versatile, used in structural and wear applications, available with enhancements*

High-Performance Plastics - *handle high temperatures over 300° F, associated with the most extreme operating conditions - thermally stable, excellent inherent wear properties, broad chemical resistance.*

- **Dissipation Factor**

  This measurement indicates the ease at which molecular ordering occurs under an applied voltage. Dissipation factor and dielectric constant together help to predict power loss in an isolative (or insulative) material.

- **Flammability**

  Fire is a constant and deadly risk in certain environments, particularly in enclosed environments including rail road, transit, and aeronautical applications. Flammability tests are performed on plastics to determine a material's combustibility, smoke generation, and ignition temperature.

IV. Plastic Properties 101: Miscellaneous

- **Specific Gravity**

  Specific gravity is the ratio of the weight of a given volume of material at 73.4 °F (23 °C) to that of an equal volume of water at the same temperature (density of a material divided by the density of water). Specific gravity is used extensively to compare materials and determine part cost and weight.

- **Water Absorption**

  Water absorption is the percentage increase in weight of a material from soaking in moisture (both from immersion or environmental operating conditions). Measurements are taken at 24 hours after water immersion, and again when saturation is reached. These measurements are critical, since mechanical and electrical properties plus dimensional stability are affected by moisture absorption rates.

- **Coefficient of Friction (COF)**

  The coefficient of friction is the sliding resistance of one material over another. Given that friction generates heat, the COF is critical in order to compare the relative "slickness" of materials. The lower the COF value, the more slick (or lubricious) the bearing material. COF is often expressed as either static (the resistance of the initial movement from a bearing at rest), or dynamic (the resistance level once the bearing is in motion).

- **PV**

PV is another measurement of the performance capabilities of bearings. **P is expressed as pressure** (or pounds per square inch) on the projected bearing area. **V is the velocity** in feet per minute of the wear surface. **P and V do not occur independently and must always be dealt with in tandem!** Applications should be kept below the maximum PV as well as the known P and V for optimal operation of plastic bearing materials!

For sleeve bearings, the surface speed is Pi (ϖ) x diameter x RPM ÷ 12 in inches. P is the load on the bearing in pounds, divided by the projected area in square inches. For sleeve bearings, the projected area is the length times the diameter of the bearing.

PV is obtained by multiplying the P x V:

3/4” shaft @341 RPM:
90 lb total load, bearing length 1”

V = 3.1416 (pi) x Shaft Diameter x RPM ÷ 12
Or 3.1416 x .750 x 341 ÷ 12 = 67 sfpm

P = Total Load ÷ projected area
Area = .750 ID x1.0 long = .75 in projected bearing area

P = 90 lbs ÷ .75 = 120 psi

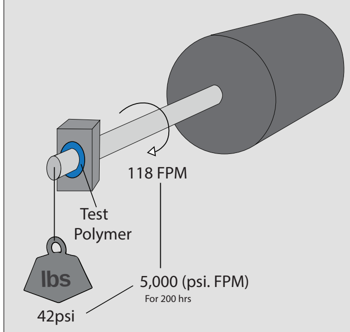
PV = 120 psi x 67 fpm = 8040 PV

Plastic Material Rating Overview			
Material	**Max PV**	**Max P**	**Max V**
Graphite PI	300,000	6,000	1,000
Carbon/PTFE PEEK	100,000	6,000	600
TriSteel PE (lubed)	100,000	40,000	2,000
TriSteel PT	50,000	36,000	1,000
Oilite Bronze	50,000	2,000	1,200
Carbon PEEK	50,000	6,000	600
FCJ	20,000	20,000	500
Ultracomp UC200	20,000	54,500	15
Ultracomp UC300	20,000	45,000	30
Rulon	10,000	1,000	400
CJ	10,000	35,000	150
Delrin AF	3,000	1,000	100
Nylon 6/6	1,000	300	360
UHMW	1,000	800	50

- **Wear Resistance (or the K factor)**

  Wear resistance relates to the bearing surface wear as compared to the variables of pressure, velocity and time; the lower the "K" factor, the greater the wear resistance. Results from this test can vary significantly if different pressure and velocity conditions are used, yet testing consistency is critical as a means of comparing materials.

WEAR FACTOR (K) TEST (QTM 55010)



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WEAR RESISTANCE / "K" FACTOR

The wear factor ("k" factor) relates bearing surface wear rate to the variables of pressure, velocity and time.

Bearing Types

There are many different types of bearings; each with unique characteristics designed to "bear" specific stress and load requirements. The bearing category also encompasses bushings (also known as plane bearings). The primary difference between bushings and bearings is that bushings are designed as a single part, while bearings can have multiple parts. Some industries, such as automotive, use the terms interchangeably.

Plane bearings

Plane (or plain) bearings are bearings in their simplest form; any non-rolling element bearing that is applied where two surfaces rub together. Common plane bearings are flange or sleeve bearings, slide plates or friction bearings. Plastic plane bearings can be reinforced with a reinforcing liner; others may require a specific mating material surface finish. The largest family of self-lubricating plane bearings are filled-PTFE blends; with Rulon (blended PTFE) as the most common option.

Plastic plane bearings provide:

- Simple components
- Easy installation and removal
- Self-lubricating properties
- Wide application range
- Good value vs. metal

Plane bearings excel in a wide range of environments; wet, dirty, chemical, clean rooms, FDA/USDA/3A/NSF — all without ever needing lubrication!

Flange bearings

Flange bearings are designed to support a shaft that runs perpendicular to a bearing's mounting surface; they reduce friction between surfaces in rotary or linear movements. The flange (or protruding rim) design is also used as a locating mechanism to hold the sleeve portion of the bearing in place   Flange designs are a critical support in applications with high speeds, heavy loads or vibration and movement.

Rulon J, Rulon LR and Rulon 641 are common flange bearings materials, and they are each available in different lengths and widths to ensure a custom fit.

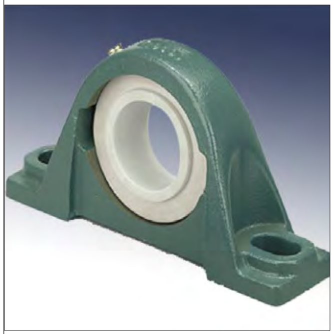
This Rulon Flange Bearing Selector Guide provides detailed specifications to help you match your design specs to the appropriate material:

Nominal I.D. x O.D.	I.D. -000",+002" (A)	O.D. -000",+.002" (B)	Recommended Housing Bore	Press Fit	Recommended Shaft Size	Flange DIA +/-.005"(C)	Flange THK +/-.003"(D)	Length +/-.005"(L)	Rulon LR Part Number	Rulon J Part Number	Rulon 641 Part Number
3/16x5/16	.191	.313	.312/.311	.004/.001	.1875/.1865	.437	1/16	1/4	DRF-0305-2	DRJF-0305-2	
								1/2	DRF-0305-4	DRJF-0305-4	
1/4x3/8	.254	.376	.375/.374	.004/.001	.2500/.2490	.500	1/16	3/8	DRF-0406-3	DRJF-0406-3	
								1/2	DRF-0406-4	DRJF-0406-4	DR6F-0406-4
3/8x5/8	.379	.626	.625/.624	.004/.001	.3750/.3740	.875	1/8	1/2	DRF-0610-4	DRJF-0610-4	DR6F-0610-4
								3/4	DRF-0610-6	DRJF-0610-6	
1/2x3/4	.504	.751	.750/.749	.004/.001	.5000/.4990	1.000	1/8	1/2	DRF-0812-4	DRJF-0812-4	
								3/4	DRF-0812-6	DRJF-0812-6	
								1	DRF-0812-8	DRJF-0812-8	DR6F-0812-8
5/8x7/8	.630	.876	.875/.874	.004/.001	.6250/.6240	1.000	1/8	3/41	DRF-1014-6	DRJF-1014-6	
									DRF-1014-8	DRJF-1014-8	DR6F-1014-8
3/4x1	.755	1.001	1.000/.999	.004/.001	.7500/.7490	1.250	1/8	1	DRF-1216-8	DRJF-1216-8	DR6F-1216-8
1x1-1/4	1.005	1.251	1.250/1.249	.004/.001	1.0000/.9990	1.500	1/8	1-1/2	DRF-1620-12	DRJF-1620-12	DR6F-1620-12
1-1/4x1-1/2	1.255	1.501	1.500/1.499	.004/.001	1.2500/1.2490	1.750	1/8	2	DRF-2024-16	DRJF-2024-16	DR6F-2024-16
1-1/2x1-3/4	1.506	1.751	1.750/1.749	.004/.001	1.5000/1.4990	2.000	1/8	2	DRF-2428-16	DRJF-2428-16	DR6F-2428-16
1-3/4x2	1.756	2.001	2.000/1.999	.005/.001	1.750/1.749	2.250	1/8	3	DRF-2832-24*		
2x2-1/4	2.006	2.251	2.250/2.249	.005/.001	2.000/1.999	2.500	1/8	3	DRF-3236-24*		

* i.d. and o.d. -.000 + .003

Mounted bearings

Mounted bearings come in the form of pillow block or flange style housings. These can be in many different forms with 2, 3 or 4 mounting holes. Mounted bearings can be retrofit with several different plastic plane bearing materials to improve wear and reduce or eliminate lubrication



Thrust bearings

Thrust bearings are simple washers. They are thin, easy to install and prevent metal-on-metal contact in any thrust load conditions. Much simpler to use than ball or needle bearings, thrust bearings do not require lubrication of any kind in most conditions.

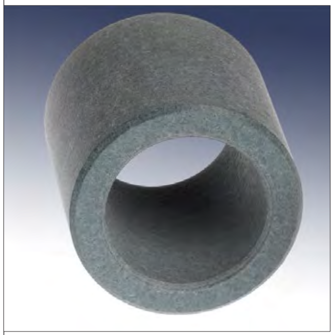
Common thrust bearing applications include:

- Automotive
- Marine
- Aerospace applications

Rulon Thrust Bearing Selector Guide:

Nominal I.D. x O.D.	I.D. -000",+005" (A)	O.D. +000",+003" (B)	Thickness +/-.003"(L)	Rulon LR Part Number	Rulon J Part Number
1/4x3/8	.254	.625	.060	DRT-0410-2	DRJT-0410-2
3/8x3/4	.379	.750	.060	DRT-0612-2	DRJT-0612-2
1/2x1	.504	1.000	.060	DRT-0816-2	DRJT-0816-2
3/4x1-3/8	.755	1.375	1/8	DRT-1222-4*	DRJT-1222-4*
1x2	1.005	2.000	1/8	DRT-1632-4*	DRJT-1632-4*
1-1/2x3	1.506	3.000	1/8	DRT-2448-4*	DRJT-2448-4*

* i.d. and o.d. -.000 + .003

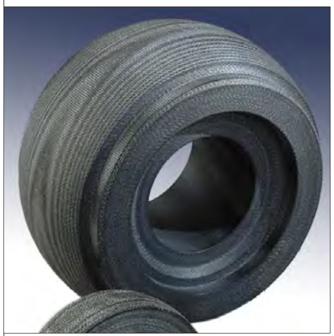


Sleeve Bearings

Sleeve bearings are the most common type of plane bearing, and are suitable for use in a range of applications. Sleeve bearings are designed to carry linear, oscillating or rotating shafts, and function via a sliding action. Plain and sleeve bearings are also referred to as bushings or journal bearings, and are compact, lightweight, and offer good value.

Common sleeve bearing applications include:

- Automotive – Transmission shafts, links, pins and crank components
- Agriculture – Linkage assemblies on attachments, steering gear
- Off-road – Clevis bearings for hydraulic cylinder pins
- Marine – Steady bearings for drive shafts
- Food Processing & packaging – Conveyor and filling devices



Spherical Bearings

Spherical bearings are designed to allow for shaft misalignment, as they can rotate from two directions. Spherical bearings typically support a rotating shaft in the bore that calls for both rotational and angular movement.

Bearing Liners

The selection of reinforced bearing liners is dependent on a number of factors; as each liner material has a specific wear rate that is dependent on these factors. And choosing the right combination of shell and liner will give added protection in the event of a wear-through or other bearing failure.

To select a liner type, consider the following conditions:

- Operating
- Environmental (lubricated or unlubricated)
- Indoor or outdoor use
- Temperature
- Speed
- Load
- Chemical
- Friction
- Mating hardware

Once the above conditions are determined, bearing shells and liners may include:

Standard shells:

Z (Zinc-plated Steel)

S (Stainless)

P (Copper-plated Steel)

B (Bronze)

Standard liners:

PT (PTFE)

AC (POM)

PE (PEEK)

PTS (Lead-free food grade PTFE)

AT (POM/PTFE)

PE (Modified PEEK)

PR (Modified PTFE)

P4 (Modified PTFE for higher speeds)

Seal Design

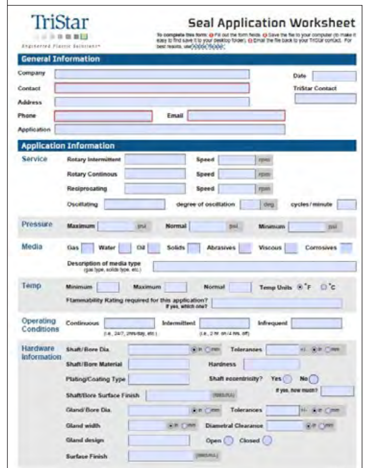
Bearing seals are aptly named, as they "seal" or protect bearings from contaminants. Service, pressure, hardware, temperature and media all contribute to seal selection.

Surface Modification

The surface modification of polymers is a growing trend in countless industries – from food and beverage processing to medical, oil and gas, aerospace and more. Surface Modification is the combination of physics and chemistry working together to improve adhesion, micro-clean, functionalize, produce biocompatibility, or render hydrophobic or hydrophilic characteristics.

Surface modification techniques:

- **Plasma -** readily primes any surface for adhesion, painting, coating or printing applications. Plasma is a good option for components that require a longer treatment hold before moving to the next step in manufacturing.
- **Corona discharge -** is a form of plasma at standard atmospheric pressure and is normally used with in-line processes such as plastic film.
- **Parylene -** a conformal coating applied in thin layers (typically a few mils or fractions of a mm) through dipping, spraying or simple flow coating.
- **Photolysis -** combines principles of both corona and plasma. The systems use high voltage to excite gas in an emitter, which then radiates to the surface of a polymer.


TriStar
Engineered Plastic Solutions
Seal Application Worksheet
General Information
Company / Date
Contact / TriStar Contact
Address
Phone / Email
Application
Application Information
Service: Rotary Intermittent, Speed rpm; Rotary Continous, Speed rpm; Reciprocating, Speed rpm; Oscillating, degree of oscillation deg, cycles / minute
Pressure: Maximum psi; Normal psi; Minimum psi
Media: Gas, Water, Oil, Solids, Abrasives, Viscous, Corrosives; Description of media type (gas type, solids type, etc.)
Temp: Minimum, Maximum, Normal, Temp Units °F °C; Flammability Rating required for this application? If yes, which one?
Operating Conditions: Continuous (i.e., 24/7, 2hrs/day, etc.); Intermittent (i.e., 2 hr. on/4 hrs. off); Infrequent
Hardware Information: Shaft/Bore Dia., Tolerances; Shaft/Bore Material, Hardness; Plating/Coating Type, Shaft eccentricity? Yes No, If yes, how much?; Shaft/Bore Surface Finish; Gland/Bore Dia., Tolerances; Gland width, Diametral Clearance; Gland design, Open, Closed; Surface Finish

TriStar's Seal Design Worksheet

- [*Direct Link*]
- [*View all of our Design Worksheets*]

Plastic Bearing Selection: The TriStar Advantage

TriStar Plastics Corp. provides engineering, custom fabrication and manufacturing of high-performance plastics and self-lubricating bearings materials. Our capabilities include component design, material selection, prototype, production and manufacturing.

- Engineering
- Custom Fabrication
- Manufacturing
- Surface Modification

Explore our industry solutions:

CJ Bearings

- Non-lubricated, High-Load
- Variety of climates and operating environments
- Long wear and extended operating life
- Replacement for steel and bronze

Rulon Plane Bearings

- Strong
- Wear resistant
- Self-lubricating
- High-performance
- Chemical Resistance

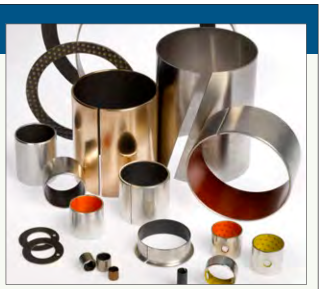
Ultracomp

- High-load, low speed applications
- Exceptional resistance to vibration and impact
- Compressive strength of up to 54,000 psi
- Fabricate to your specifications

Rulon Materials

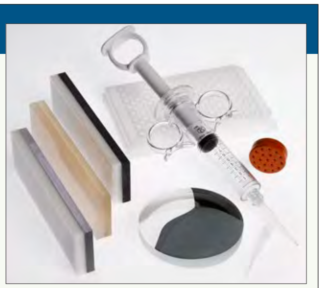
- High Temp
- Self-lubricating
- Wear resistant
- High-performance

TriSteel



- Metal backed, self lubricating
- Good for the most rigorous requirements
- Withstands high loads, high speeds and adverse environments

Surface Modification

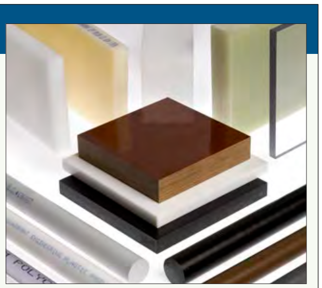


- Dry and environmentally friendly techniques to modify the surface of polymers, elastomers, and film
- Ongoing innovation and research

Custom Components

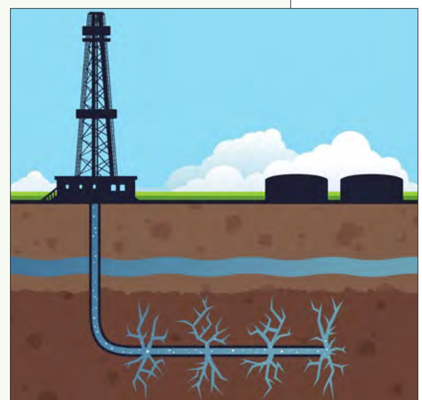
- Manufactured to your specific requirements
- State-of-the-art fabrication facility with CNC milling, turning and machining
- We work with you each step of the way

Stock Shapes



- High-temperature/chemical resistance
- FDA compliance
- Aircraft and aerospace
- Oven and dryer bearings
- Semiconductor and robotics

The TriStar Advantage: Custom Seals for Oil and Gas Industry



Challenge:

A manufacturer of engines for the oil and gas industry cited the seals on their fracking equipment were continually failing, which caused frequent operation shutdowns in this arduous, 24/7 environment. The seals were located on a dual-clutch transmission which was mated to a 3000 HP diesel engine. Each time the transmission seal failed, fracking activity came to a halt, which quickly added up to a serious loss of oil production — and profits.

Solution:

The goal of this application was to seal the rotating shaft where the clutch mates to the transmission engine. After visiting the worksite, TriStar engineers looked to the past to design for the future; channeling a 1960s-era auto transmission schematic for inspiration. By using a proprietary seal material, the team increased the seal pressure to improve the engines' overall efficiency.

Result:

Since replacing metal with the new custom seal material, our partner reports the power train has led to improved fracking equipment uptime and better production rates.

The TriStar Advantage: Composite Plastic Bearings for Military/Defense Industry

Ultracomp and CJ Bearings expand capabilities of remote tracked vehicles.

Challenge:

A major defense manufacturer approached us to help them spec the ideal bearings to replace failed bronze in remote-tracked, ATV-type vehicles. They noted their vehicles were used in military and first-responder defense environments to help personnel evaluate hostile situations. Operating conditions ranged from war-torn dirt roads in Afghanistan to bomb-detection applications at stateside shopping malls.

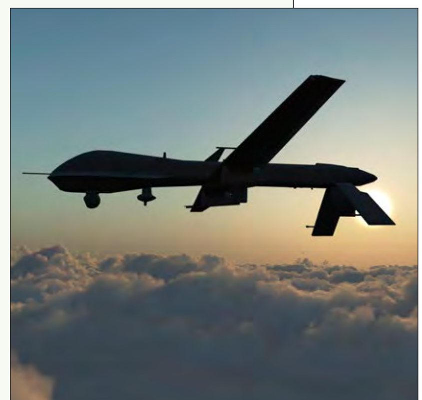
Solution:

This tough application required bearing materials that could tolerate rough terrain with agility, stability, and accuracy; plastic composites were the answer. We installed CJ composite as a drop-in replacement for the failed bronze bushings. Unlike metal bushings, CJs can tolerate high load and abrasion levels and resist corrosion. As designs evolved, we added Ultracomp bearing to accommodate new configurations and intricate functions at the lowest possible friction levels. Ultracomp delivers tight tolerances to meet the requirements of the vehicles' lifting arms and rotating grips.

Result:

TriStar's CJ and Ultracomp composite bearings have provided military designers the best bearings on the market in terms of load-tolerance, corrosion-resistance and low-friction, plus maintenance-free service.

The TriStar Advantage: Surface Modification for the Aerospace Industry



Challenge:

As the huge market potential for drone applications is realized, demand for these devices has grown steadily. We joined forces with a major drone manufacturer to help them improve the aerodynamics of their wing material. Our partner cited that after many flights, the edge of the wing flaps began to separate, which caused the drones to steer off course. This posed a huge danger in the air, where precision in flight is critical.

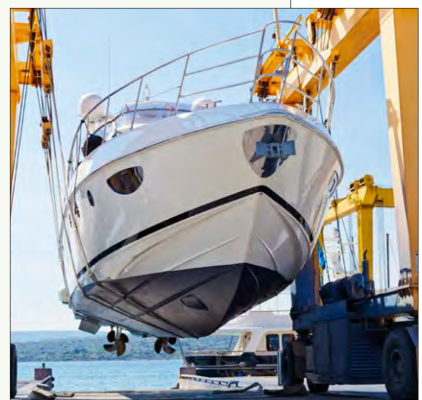
Solution:

Our team noted the wings were built of a strong carbon composite material, and were ideally suited for plasma treatment. Plasma treatment changes the surface properties of plastics to improve surface energy through bonding, micro-cleaning, or to render materials hydrophobic and hydrophilic. We primed both the carbon fiber and the resin of the wing edges with vacuum plasma treatment.

Result:

Through plasma treatment, we were able to microscopically alter the composite surfaces of the wings. Our partner now reports the wing adhesion has improved dramatically, and the drones resist wind forces during flight.

The TriStar Advantage: Rulon FCJ Bearings for the Marine Industry



Challenge:

Marine cranes are responsible for a rugged, yet delicate marina application. These massive movers must be tough enough to haul massive ships throughout a marina, yet delicate enough to support precision and care of the most elite vessels. Our partner needed a bearing material for the pivot points of the crane that could ensure smooth, yet precise movement without failure in a tough, corrosive environment. Their metal bearings were not up to the task, as they continually failed to the elements.

Solution:

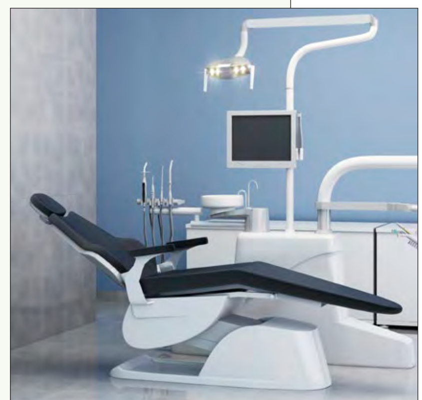
We installed Rulon FCJ bearings on the cranes' pivot points. Rulon FCJ combines a unique Rulon shell with a composite-journal liner. Together, these materials provide excellent shock and vibration resistance, plus superior load and strength capabilities. And since the materials are self-lubricating, they never need manual greasing.

Result:

Rulon FCJ has eliminated the jerky, uneven motion of the cranes, so that they glide with smooth precision. FCJ has also proven compatible with stainless wear surfaces, which contributes to a longer pin life and a maintenance-free service on these moving components.

The TriStar Advantage: TriSteel Bearings for the Medical/Dental Equipment Industry

Challenge:



As dental offices look to improve office esthetics and patient comfort, we worked with a dental chair company to help them improve the functionality of their dental chairs. They noted that over time, the sticky, oilite bronze bearings they were using lost lubrication, which caused the chairs to resist fluid movement. This posed a problem for dentists (who were unable to achieve proper chair positioning for exams), and patients (who had difficulty entering/exiting the chair). The dry bearings also released a loud, shrill sound as the chair moved into position.

Solution:

We replaced the dry bronze bearings with self-lubricating TriSteel; a reinforced plastic bearing.

TriSteel bearings have given the chairs fluid, consistent movement to enhance positioning and patient comfort. The reinforced material also provided silent operation.

Result:

Based on this success of the chair application, our partner has also specified TriSteel bearing to improve the swivel movement and quiet operation of their exam stools and instrument trays.

The TriStar Advantage: Rulon 641 Bearings for the Food Industry

Challenge:

A major manufacturer of bakery equipment needed to determine why their stainless steel bearings continually failed on their doughnut conveyor systems. They had been using metal bearings exclusively on the belts, supporting rollers and hot-oil troughs, yet found the material required frequent, costly replacement. A durable, value-driven alternative was needed.

Solution:

Our team discovered the stainless bearings deteriorated from extended exposure to the hot frying oils and cleaning chemicals required on the production line. As the metal absorbed moisture, the bearings expanded to the point of failure. We recommended Rulon 641, a material with FDA-clearance designed specifically for food processing.

Result:

Since installing Rulon 641, our partner reports improved bearing durability and production rates, plus better FDA sanitation compliance.

The TriStar Advantage is Clear

Ready to learn more about the form and function of TriStar's plastic bearings? We're here to help with your selection! Below we've highlighted a couple of our most popular bearing design resources.

Our Plastic Materials Database

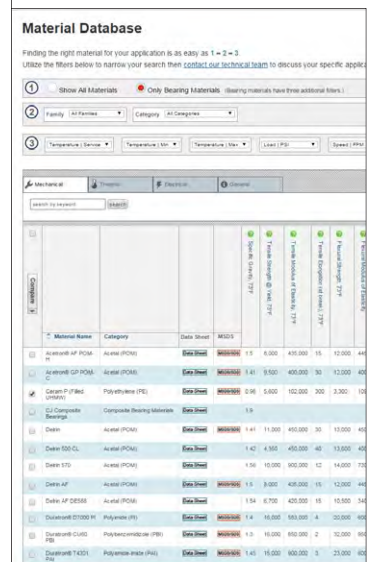
The success of any application begins with sourcing the right component materials. To that end, we've built an **interactive materials database** containing detailed product information and technical specifications for over 400 of the most-common engineered materials.

Our database features an intuitive search tool that can be used to customize and filter search options to locate an exact match to a specific application need. Once the proper material has been identified, you can load a single page spec sheet (which is optimized for printing) or download an MSDS sheet (when available).

Interactive Design Worksheets

When it comes time to produce your bearing, the more information we have, the simpler the process can be. That's why we've designed a series of one-step Application Worksheets. Click on the links below to submit your technical specifications:

- Liner Design
- Surface Modification Design
- Flange Bearing Design
- Seal Design
- Sleeve Design
- Structural Design
- Thrust Bearing Design
- Feedscrew Design
- Linear Plane Bearing Design
- Parylene Design



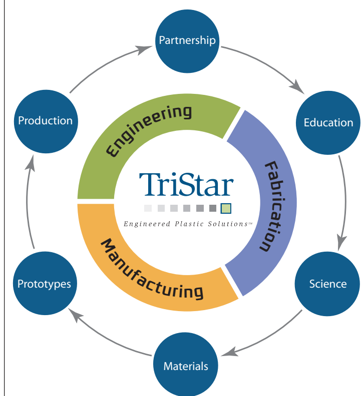
TriStar's Material Database

This interactive resource has over 400 of the most commonly utilized plastics and composites to assist you in choosing the right material for your application.

And That's Not All...

Visit our website at www.tstar.com for more information about plastic bearing design. We have real-world case studies, video seminars, and much more to explore. If you have any questions you can send us a query via our Ask the Expert portal.

The TriStar Advantage delivers superior plastic bearing forms, improved function, and the best selection in the industry.



The TriStar advantage means we have a comprehensive circle of services that include:

- *Engineering*
- *Fabrication*
- *Manufacturing*

We have all the resources you need, when you need them. No more cobbling together a team to get the job done. We have it right here for you… All in-house.

TriStar
Engineered Plastic Solutions™

QUADRANT

This paper was prepared in association with Quadrant.

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