TriStar

Engineered Plastic Solutions™

# Rulon® Materials

## Quality Assurance Begins with Precision Processing

*The three controls critical to performance*

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rulon materials

# Rulon® Engineered Materials
# Quality Assurance Begins with Precision Processing
## *The three controls critical to performance*

Rulon® materials are universally recognized as the gold standard in bearing-grade material. By combining self-lubrication, extended wear, and low maintenance, they excel where it matters most: in mechanical, electrical, and chemical environments. But to guarantee this level of performance—even greater and more universal than metal—Rulon is manufactured according to the most stringent processing controls in the industry.

When only the performance advantage of Rulon will do for your application, how can you be certain of true quality? Which manufacturing controls should you look for to guarantee durability? And how can you choose from the 300+ varieties of Rulon to select just the right formula for your application?

At TriStar, we say, just Ask the Experts. As the exclusive supplier of Rulon materials, we can guarantee that your parts are manufactured with a strict adherence to processing controls. And we have an insider's knowledge to guide you thru the right selection, from basic shapes, standard bearings, tapes, to custom fabricated parts. Plus, we offer in-house engineering, design, and fabrication to make the job complete.

*Rulon® combines self-lubrication, extended wear and low maintenance to deliver enhanced value and efficiency for your next application.*

### *Three critical controls to precision processing*

Rulon is an incredibly versatile polymer material that can be formulated and produced to countless specifications. It delivers durability and performance in the most arduous of heavy-duty and high-load applications, and can withstand heat and drought, cryogenic temperatures, and even water, steam and hydrocarbon baths.

The key to Rulon's strength and reliability?

**Three critical controls:**

1. **Controlled molecular weight**
2. **Controlled crystallinity**
3. **Controlled porosity**

**1. Controlled molecular weight**

Molecular weight measures the polymer chain length, which is important to material flex life, tensile strength and elongation. As the molecular weight increases, so do its performance properties. Consider the following when you measure molecular weight:

1.1 Molecular weight may be decreased by sintering at too high of a temperature for too long of a time.

1.2 Precise gel temperatures and dwell times during sintering is critical to ensuring the optimum performance.

**2. Controlled crystallinity**

Controlled crystallinity is another chief consideration in Rulon processing, and can vary considerably with the size of a molded piece and the slow transfer of PTFE. Value can be seen in even small variations to the specific gravity, although most PTFE materials fall in the 50-60 percent range of crystalline. For proper crystallinity control:

2.1. The percent of crystallinity is decreased by rapid cooling or increased by slow cooling.

2.2. The higher the crystallinity, the higher the inherent specific gravity.

2.3 Actual specific gravity is determined by inherent specific gravity and the amount of void.

2.4 With increased crystallinity follows increased compressive strength, and decreased flex life, recovery values, permeability, transparency, and wear.

2.5 Thermal, chemical and non-stick properties do not vary with crystallinity.

*Rulon® follows the most stringent manufacturing controls in the industry:*

- *Controlled molecular weight*
- *Controlled crystallinity*
- *Controlled porosity*

**3. Controlled porosity**

Controlled porosity is the third, and perhaps most critical, parameter to guaranteeing optimum performance. Rulon delivers complete and controlled porosity:

3.1. Porosity is carefully controlled throughout part design and fabrication.

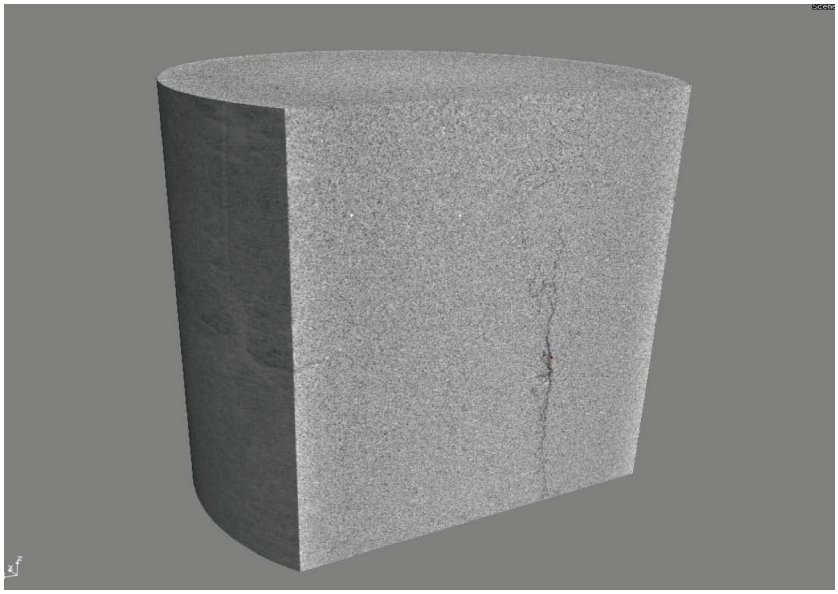
3.2. Void content is most strongly impacted by processing methods.

3.3. An increase in the level of void is detrimental to most properties, especially dielectrics.

*Rulon® delivers unsurpassed quality, and can outperform and outlast other PTFE materials; it even exceeds the strength of metal.*

By paying attention to these key processes through tight manufacturing controls, TriStar can guarantee that Rulon materials will outperform—and outlast—other PTFE materials.

An example of what can happen when these issues of control are not followed is shown in this CT scan of a rod made by another processor. This was a result of poor molding practices that would not have been seen by the end user until parts were made and possibly even installed in their equipment. Control—it is the key to quality!



## *Performance begins with the right selection*

Clearly, Rulon offers significant advantages over run-of-the-mill molders, but which Rulon is best for certain applications? To better understand your specific application needs, our team of experienced engineers will frequently ask:

1. What is the application function—is it a bearing, seal or gasket?
2. What is the operating temperature? For design purposes, we need to know how much press fit and close in to account for in the gradient.
3. What is the operating environment? Are you following FDA or USDA guidelines or are you resisting abrasion?
4. What is the speed? Is it rotating, oscillating or linear?
5. What are the bearing loads?
6. What type of hardware?
7. What is the surface finish?

Once we have all of this information, we can customize a solution just for you.

*With over 300 varieties of Rulon® — each possessing different characteristics — the TriStar team can help you match the precise formula to your application.*

## *Quality control delivers results*

There are literally hundreds of formulations of Rulon, but in our experience, the most popular are Rulon® 641, Rulon® J, and Rulon® LR. Each offers slightly different attributes, yet all have delivered superior results to our clients.

**Choose the Rulon that is right for your application:**

RULON® 641
FDA-compliant material suitable for stainless steel and soft mating surfaces down to Rb25 hardness. Excellent chemical resistance

RULON® J
Offers the lowest coefficient of friction and highest life for stainless steel and other soft mating surfaces down to Rb25 hardness. Good chemical resistance.

RULON® LR
Gives the best chemical resistance for mild-to-hardened steel shafting and counterfaces. Low deformation and self-lubricating.

## Rulon 641

Rulon 641 is a white, FDA-compliant material that was originally developed for the food and pharmaceutical industries. It delivers excellent load and wear, and was the first Rulon material to receive FDA compliance. And it has just received USP Class VI approval for direct contact with human tissue and fluids—**a claim no other filled PTFE can make.**

*Rulon® 641 is the ONLY filled PTFE material with USP Class VI approval for contact with human tissue and fluids.*

**Rulon 641 delivers:**

- White-colored material to indicate sanitation
- Works against stainless and aluminum, without wear
- Self-lubricating
- Resistant to wash-downs
- Maintains performance from cryogenic to scorching temperatures
- Meets medium load and speed requirements
- PV rating of 10,000
- Meet FDA standards for contact with food and pharmaceuticals

### The TriStar Advantage: Rulon 641 in Medical Devices

*Challenge:*

A major manufacturer of surgical devices approached us to improve the vacuum pressure controls and reduce noise levels on their new rotary vane pump; a device used to perform aspirations during cataract surgery. They cited that although the aspiration device would run at low speeds, housing conformity and vane sealability had to be ensured. And since the unit would have direct contact with the eye, all components needed to meet FDA certification.

*Solution:*

After close collaboration and research, our team recommended Rulon 641 for the vane seals. The material meets all appropriate FDA regulations, can withstand the sterilization wash-down procedures required of medical instruments, and boasts an expansive operating range. Our team also employed specialized fabrication techniques to ensure a tight tolerance and a superior finish so the seal would match the bore.

*Result:*

Our client reports the Rulon 641 vane seals have proven efficient and cost-effective—and more importantly—surgeons now have better control of vacuumlevels and volumetric flow to help ensure better surgical outcomes.

## Rulon J

Rulon J is a gold-colored material that excels with lower-abrasion and soft-mating surfaces. Rulon J is one of the original Rulon compounds, and uses a unique filler that adds temperature stability for improved wear. Shafts and bores made of aluminum, brass or stainless steel are unaffected by Rulon J, and it has a PV rating of 7500, which is lower than most types of Rulon. The material offers superior value combined with exceptional wear and friction properties.

*Rulon® J gives the lowest coefficient of friction and is a "shaft-friendly" compound.*

Choose Rulon J for:

- Low maintenance
- Self-lubrication
- Lowest friction of all Rulon's
- Compatible with soft mating surfaces

### The TriStar Advantage: Rulon J in Agriculture

*Challenge:*

A leading supplier of agricultural harvesting equipment needed a long-lasting, caustic-resistant bearing for the conveyor belts and suspension cylinders aboard their boon lifts. The boons are mounted aboard trucks used to harvest produce, such as pineapples, in steep hillside terrain. The bearings had to resist weather extremes, offer long life and low maintenance.

*Solution:*

Our team fabricated bearings made of Rulon J; a material prized for its low-abrasion and compliance with softer-mating surfaces. Rulon J is considered "shaft friendly" and outlasts other materials, even with start/stop applications where stick and slip must be eliminated.

*Result:*

Rulon J excels in harvesting because it can easily resist chemical substances, such as the sugar acidity in fruit. And because Rulon J bearings are self-lubricating and require no manual greasing or frequent changes, our partners report they have increased their efficiency and production rates.

## Rulon LR

Rulon LR, (previously known as LD), is maroon colored and is considered the "Go-To" material for general-purpose bearing applications. LR is durable, dependable, and readily available. It uses a reinforcing ceramic filler that requires a minimum 35RC hardness. This filler gives LR unique dielectric and thermal properties for enhanced insulation. LR excels in high-pressure gaskets, slide pads, compressor components, dielectric insulators and some light-to-medium structural applications. For continuous, non-lubricated service, Rulon LR sleeve bearings are capable of operating up to 10,000 PV, with even higher values possible with intermittent service.

*With superior chemical resistance and good dielectric and thermal insulation, Rulon® LR is the "Go-To" material for many common bearing applications.*

Choose LR for:

- High temperatures
- Chemical resistance
- Minimal moisture absorption
- Low friction

### The TriStar Advantage: Rulon LR in Military Defense

*Challenge:*

A military manufacturer partnered with TriStar for help in improving the recoil system on their 155mm Howitzer; a critical artillery cannon used by the Armed Forces of the United States. The original recoil design used bearings with a short lifespan, which required costly maintenance and upkeep; time that could not be wasted in the heat of battle.

*Solution:*

TriStar engineers developed an all-new sealing system for the hydro-pneumatic recoil unit used on the M198 towed unit and the M109 self-propelled unit. LR was an ideal material because of its extended wear and low maintenance.

*Result:*

Designing with Rulon LR, our engineers were able to improve the lifespan of the seals, while also reducing friction, and improving their abrasion-resistance qualities. With Rulon LR, our partner reports that the seals last longer, and respond better to the pressure and temperature fluctuations

of the weapon.

## *Beware of lower-quality products*

With our commitment to strict processing, TriStar can guarantee the performance of Rulon products, but there is no such assurance with lower-quality materials. In fact, failures with lower-quality products are common:

Mechanical Failures

- Loss of utility for low temperature applications
- Inconsistent coefficient of friction
- Lower stability at high-temperature transitions

Chemical Failures

- Porosity can lead to lower resistance in corrosive agents
- Non-solubility
- Reduction in long-term weatherability
- Loss or reduction of release properties
- Change in flammability properties

Electrical Failures

- Change in dielectric constant, surface resistivity, and volume resistivity
- Reduction in arc resistance
- Change in dissipation properties

*Not all bearing materials are created equally; beware of inferior materials that may cause mechanical, chemical and electrical failures.*

**Rulon gives unsurpassed performance:**

- Self lubrication
- Low friction
- Extended operation and wear
- Low maintenance
- Flexible material design
- Dimensional stable in liquids
- Low weight/high strength ratio
- Chemically inert
- Operating temperatures of –400 to + 500F
- PV ratings averaging 10,000 with P at 1000 psi and V at 4-500 fpm
- Available in machined stock or finished sleeve, flange or thrust bearings

When unsurpassed quality is paramount to the success of your bearing application, reach out to the TriStar team. Only TriStar can guarantee Rulon's performance, true property values, and strict processing controls. And with our extensive inventory, multiple distribution centers and coast-to-coast engineering and sales offices, we are poised to deliver. Call 1-800-874-7827 or visit www.tstar.com to experience the TriStar Advantage—and the true quality of Rulon® brand products.

*TriStar is the exclusive US distributor of Rulon® and can guarantee true performance and strict processing controls.*

## Design Criteria Rulon® 641

| | |
|---|---|
| Temperature - Typical Range ˚F (˚C ) | -400/ + 550 (-240/ + 288)* |
| Maximum PV (continuous) (MPa•m/s) | 10,000 (0.35)* |
| Maximum P - psi (static) (MPa) | 1,000 (6.9)* |
| Maximum V -SFM (no load) (m/s) | 400 (2)* |
| Shaft Hardness – Minimum | Rb25 |
| Shaft finish recommended Ra µin(µm) | 8 - 16 (0.2-0.4)* |
| Shaft Material | Mild, 303 & 316 Stainless Steel |

### Engineering Information

| | |
|---|---|
| Friction - static & dynamic | 0.10 - 0.30 |
| Water Absorption ASTM D570 | 0% |
| Flammability ASTM D635 | Non-Flammable |
| Chemical Resistance | Inert |
| Thermal Conductivity BTU/hr/sq. ft./˚F/in. (W/m•K) | 2.6 (0.37)* |
| Linear Coefficient of 78˚ to 300˚F | Diameter 4.2 (7.5)* |
| Thermal Expansion (26˚ to 149˚C) | Length 5.7 (10.2)* |
| x 10 -5 in/in °F (x 10 -5 m/m °C) | |

### Physical Data

| | |
|---|---|
| Elongation ASTM D4894 | 175% |
| Tensile Strength ASTM D4894 (MPa) | 2000 psi (13.8)* |
| Deformation ASTM D621 | 4% (1500 psi- 24 hr RT) |
| Specific Gravity ASTM D792 | 2.25 |

## Design Criteria Rulon® J

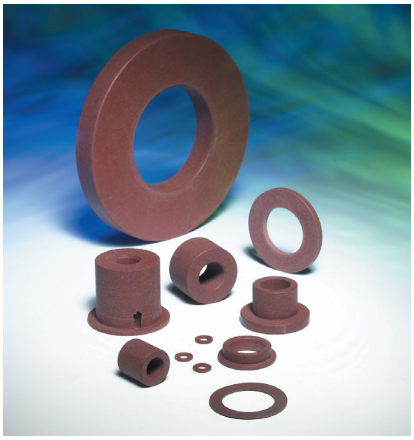
| | |
|---|---|
| Temperature - Typical Range ˚F (˚C ) | -400/ + 550 (-240/ + 288)* |
| Maximum PV (continuous) (MPa•m/s) | 7,500 (0.26)* |
| Maximum P - psi (static) (MPa) | 750 (5.2)* |
| Maximum V -SFM (no load) (m/s) | 400 (2)* |
| Shaft Hardness – Minimum | Rb25 |
| Shaft finish recommended Ra µin(µm) | 8 - 16 (0.2-0.4)* |
| Shaft Material | 316 Stainless Steel and Non-Ferrous |

### Engineering Information

| | |
|---|---|
| Friction - static & dynamic | 0.12 - 0.20 |
| Water Absorption ASTM D570 | 0% |
| Flammability ASTM D635 | Non-Flammable |
| Chemical Resistance | Data Available |
| Thermal Conductivity BTU/hr/sq. ft./˚F/in. (W/m•K) | 1.7 (0.24)* |
| Linear Coefficient of 7 8˚ to 300˚F | Diameter 5.2 (9.3)* |
| Thermal Expansion (26˚ to 149˚C) | Length 6.8 (12.2)* |
| x 10 -5 in/in °F (x 10 -5 m/m °C) | |

### Physical Data

| | |
|---|---|
| Elongation ASTM D4894 | 180% |
| Tensile Strength ASTM D4894 (MPa) | 2000 psi (13.8)* |
| Deformation ASTM D621 | 3% (1500 psi - 24 hr. RT) |
| Specific Gravity ASTM D792 | 1.95 |



## Design Criteria Rulon® LR

| | |
|---|---|
| Temperature - Typical Range ˚F (˚C ) | -400/ + 550 (-240/ + 288)* |
| Maximum PV (continuous) (MPa•m/s) | 10,000 (0.35) |
| Maximum P - psi (static) (MPa) | 1,000 (6.9)* |
| Maximum V -SFM (no load) (m/s) | 400 (2) |
| Shaft Hardness – Minimum | Rc35 |
| Shaft finish recommended Ra µin (µm) | 8-16 (0.2 - 0.4) |
| Shaft Material | Steel |

### Engineering Information

| | |
|---|---|
| Friction - static & dynamic | 0.15 - 0.25 |
| Water Absorption ASTM D570 | 0% |
| Flammability ASTM D635 | Non-Flammable |
| Chemical Resistance | Inert |
| Thermal Conductivity BTU/hr/sq. ft./˚F/in. (W/m•K) | 2.3 (0.33)* |
| Linear Coefficient of 78˚ to 300˚F | Diameter 5.1 (9.2)* |
| Thermal Expansion (26˚ to 149˚C) | Length 5.9 (10.6)* |
| x 10 -5 in/in °F (x 10 -5 m/m °C) | |

### Physical Data

| | |
|---|---|
| Elongation ASTM D4894 | 150% |
| Tensile Strength ASTM D4894 (MPa) | 1500 psi (10.3) |
| Deformation ASTM D621 | 3% (1500 psi - 24 hr. RT) |
| Specific Gravity ASTM D792 | 2.27 |