Engineering Plastics For Food Processing and Packaging Equipment

A guide to materials that meet the industry’s need for More and Faster production.
MORE. FASTER.

In the food processing and packaging industry, it means...
- Higher demands on the components in your equipment
- More frictional heat, more wear, more aggressive, hotter cleaning
- A whole new game in material selection

MORE cuts into downtime, and wear and lubrication become hot issues. That can mean more lubrication cost, and contamination. It can also mean unforeseen part failures from higher wear and from hotter, more aggressive cleaning to turn lines around faster.

FASTER means hotter, and some traditional materials can't take it. For example, higher temperatures mean more dimensional change in traditional parts, causing mating parts to buckle or gap and collect food. It can also mean poor fit and leakage.

New choices for new challenges. Quadrant has a proven and growing portfolio of engineering materials for components that handle these conditions. It includes materials that...
- Reduce weight and power requirements
- Survive a wide range of chemicals and temperatures
- Increase MTBR
- Outwear standard materials by a factor of 10 or more—while reducing frictional drag
- Hold dimensions over wide temperature swings
- Eliminate costly lubrication

To simplify things. A few key properties of engineering plastics—working in concert—have a major effect on equipment productivity. This guide helps simplify the material selection challenge:
- It groups materials by their application area, chemical service and temperature capability
- Each group then compares materials on a few most important properties
- It also compares another key factor—relative cost

We back all of this up with tech support, and the most capable network of plastics distribution and service centers in North America.

Consider Quadrant's EXTREME MATERIALS to improve efficiency and cost. Quadrant's unique Extreme Materials extend part life at a premium that can be negligible in finished part cost. Their low wear and friction reduce downtime and can minimize or eliminate replacement part cost and lost production associated with traditional materials.
Technical support from concept through production.

Application and production support when and where you need it. Quadrant's technical support team works with engineers and machinists from material selection through machining, for optimum performance, productivity and cost.

Quadrant locations around the world offer an experienced technical team and the most comprehensive testing laboratories in the industry. You can count on reliable support at every phase of your project:

- Evaluation of performance needs and application environment
- Material selection – including selection software
- Material certifications
- Regulatory agency compliance
- Set-up and production recommendations from experienced machinists
- A wide range of material selection, design and fabrication guides and tools — all available on the Quadrant Engineering Plastic Products website, www.quadrantplastics.com

Quality systems that ensure consistency.

From full lot traceability to ISO certifications, Quadrant meets your requirements for consistent quality, performance and machinability. As the first to line mark shapes materials, Quadrant sets the standard for traceability on our products right back to the resin lot and production shift. We have also kept pace with industry standards and quality systems to comply with the needs of the industries that your company also serves. Count on Quadrant. It is the inspiration behind our drive to provide the best levels of support for our materials in your applications.

FINISHED PART AND PROFILE SHAPE SOLUTIONS
See Page 19 For Ideas On New Problem Solvers
ENGINEERING PLASTIC TEMPERATURE PERFORMANCE GROUPS
Values based on Heat Deflection Temperature at 264 psi load.*

<table>
<thead>
<tr>
<th>&lt; 175°F</th>
<th>175° - 250°F</th>
<th>250° - 325°F</th>
<th>&gt; 325°F</th>
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</thead>
<tbody>
<tr>
<td>Proteus® PP</td>
<td>Acetron® GP POM-C</td>
<td>Techtron® PPS</td>
<td>Quadrant PSU</td>
</tr>
<tr>
<td>Sanalite® HDPE</td>
<td>Acetron® POM-H</td>
<td>Techtron® HPV PPS</td>
<td>Duratron® U1000 PEI</td>
</tr>
<tr>
<td>TIVAR® UHMW - PE</td>
<td>Ertalyte® PET-P</td>
<td>Ketron® 1000 PEEK</td>
<td>Quadrant PPSU</td>
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<tr>
<td>TIVAR® H.O.T. UHMW - PE</td>
<td>Ertalyte® TX PET-P</td>
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<tr>
<td></td>
<td>Nylatron® MC907 PA6</td>
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<td>Nylatron® LFG PA6</td>
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<td></td>
<td>Quadrant Nylon 101 PA66</td>
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<td></td>
<td>Fluorosint® HPV PTFE</td>
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<td></td>
<td>Fluorosint® 207 PTFE</td>
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</tr>
</tbody>
</table>

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*Engineering Note: Heat Deflection vs. Continuous Use Temperature Ratings:
Quadrant considers Heat Deflection Temperature @ 264 psi (ASTM D648) as typically the best way to compare materials for applications under load. Some supplier data unfortunately reflects only Continuous Use Temperature. This can be very close to the melting point. It is mainly meant to indicate loss of toughness from temperature exposure over time for electrical enclosures. Our data tables (pages 15-18) show both.

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< 175°F Applications

Quadrant stocks a broad range of materials for applications where high temperature is not a factor and where more traditional materials provide the strength in the system. These materials (PP, HDPE and UHMW-PE) are particularly well suited for chute and slide applications, as well as bumpers, supported parts in conveyors and packaging lines. This group also is frequently used as a durable cutting surface in commercial applications.

**Proteus® Polypropylene**

Manufacturers can rely on the family of Proteus® PP materials to perform in a variety of applications. Its excellent chemical resistance makes it well suited for tanks and corrosion resistant liners where harsh chemicals cause problems in applications below 180°F. Ease of fabrication—vacuum forming, fabricating and welding—make Proteus® PP a solid performer in many food related applications.

**Proteus® Homopolymer PP (natural)**

This is the most widely used grade. It has a high strength-to-weight ratio, excellent chemical resistance and performs well in corrosive environments, and is easily thermoformed.

**Product Profile:**
- Performs to 180°F (82°C)
- Resists most acids, alkalis and solvents
- FDA, 3A Dairy and USDA compliant for use in federally inspected meat and poultry facilities
- Vacuum formable
- Easy fabrication and weldable

**Proteus® Premium Gloss (white)**

This premium grade, based on homopolymer PP adds a high gloss finish suitable for aesthetic applications.

**Product Profile:**
- High gloss finish
- Other colors available
- FDA compliant
- Easy fabrication and weldable

**Proteus® Co-polymer PP (white)**

Co-polymer Proteus is modified to improve cold impact strength and toughness characteristics.

**Product Profile:**
- Performs to 170°F (77°C)
- Higher impact strength
- Cold weather impact strength to -34°F (-37°C)
- More pliable than homopolymer PP
- FDA compliant
- 3A Dairy compliant
- Easy fabrication and weldable

**CASE STUDY**

**Dairy System Coupling**

**Problem:** A dairy equipment manufacturer was looking for a coupling that was easy to machine, 3A Dairy compliant and forgiving during the alignment process.

**Solution:** A part machined from Proteus® homopolymer PP met their design criteria.

**Benefits:**
- Proteus® PP is lighter than the metal part it replaced, making it easier to handle.
- Harsh cleaning chemicals are no problem for Proteus® PP.
- Proteus® PP resists absorbing odors and flavors from the food products passing through.
< 175°F Applications

Proteus® High Density Polyethylene — HDPE (white)

HDPE is a widely used basic engineering plastic material with a variety of applications. It meets FDA 21CFR Section 177.1520 and is known for good impact performance under 180°F. It is well suited for tanks, corrosion-resistant wall protection and machined parts in many food industry components. HDPE can be extruded or pressed into sheets up to 4” thick.

Product Profile:
• Vacuum formable
• Excellent chemical resistance
• Good impact resistance
• High strength
• Non-toxic, non-staining
• FDA compliant

Sanalite® HDPE Cutting Board (white, black)

This is the most widely used grade. It has a high strength-to-weight ratio, excellent chemical resistance and performs well in corrosive environments.

Product Profile:
• Odorless and taste-free
• Pebbled, acid-resistant surface
• Easily cleaned
• Lightweight
• FDA, USDA, NSF and Canada AG compliant
• Consider polypropylene if a harder surface is required

CASE STUDY

Commercial Cutting Board

Problem: Many commercial kitchens and food processing facilities have struggled with wood cutting boards that absorb liquids, flavors and odors. In addition, many of these grow into bacteria that can contaminate food products.

Solution: Sanalite® HDPE or PP cutting boards eliminate these problems.

Benefits:
• Easy to clean and disinfect—and will not absorb liquid, flavor or odor.
• Sanalite® is lighter than wood which means easier installation.
• Cut resistant polymer provides a longer service life.
**TIVAR® Ultra-High Molecular Weight Polyethylene — UHMW-PE (white)**

Food processing and packaging equipment designers have learned that TIVAR® UHMW-PE materials can improve the efficiency and performance of handling systems. TIVAR® can help eliminate problems like noise, wear of mating parts and stretched chains that can cause costly downtime. With broad temperature performance, TIVAR® materials are ideal for freezing lines and operations that are intermittently exposed to temperatures up to 200°F.

**TIVAR® 1000 (white)**

TIVAR® 1000 UHMW is a widely recognized engineering material with a remarkable combination of lubricity, chemical resistance and impact strength. It also has no moisture absorption and retains most of its key properties to -22°F (-30°C). A broad range of shapes including sheet, rod, tube and profiles are possible.

**Product Profile:**
- Reduces noise and vibration
- Slippery, wear-resistant surface
- Very low moisture absorption
- Excellent chemical resistance
- FDA, USDA and 3A Dairy compliant

**TIVAR® Oil Filled (dark brown, grey)**

An FDA compliant lubricant is added to TIVAR® UHMW to enhance its already good bearing performance.

**Product Profile:**
- Higher PV rating
- FDA and USDA compliant

**TIVAR® CleanStat® (black)**

TIVAR® CleanStat provides UHMW performance with the added benefit of static reduction. This helps to manage fines that are generated during manufacturing, processing and packaging operations. Ideal in drums, hoppers, chutes, buckets or any environment where particles are generated and can cause a loss of efficiency.

**Product Profile:**
- Long-wearing surface with a lower coefficient of friction than steel or aluminum
- Helps to reduce cleaning time
- FDA, USDA and 3A Dairy compliant

**TIVAR® H.O.T. (white)**

Newly developed TIVAR® H.O.T. pushes the performance envelope of UHMW. It offers enhanced chemical and thermal performance in supported applications. With elevated temperature wear life up to 10x longer when compared to standard UHMW, TIVAR® H.O.T is a new choice for wear strips, rollers and drag flights for the food processing and packaging industry.

**Product Profile:**
- Lasts up to 10x longer in elevated temperature environments
- Resists abrasion, corrosion, chemicals and moisture
- Excellent release characteristics
- FDA, USDA and 3A Dairy compliant
- Excels in a variety of industrial manufacturing environments where temperatures range up to 275°F

**CASE STUDY**

**Candy Mixing Paddle**

**Problem:** Aggressive cleaning chemicals and elevated temperatures caused failures and costly, frequent replacement of metal and PE mixing paddles. Downtime associated with part replacement increased the plant's production costs.

**Solution:** TIVAR® H.O.T. enhanced UHMW-PE solved the discoloration, galling and wear problems associated with the prior materials.

**Benefits:**
- TIVAR® H.O.T paddles last 6x longer than prior materials.
- Discoloration from the elevated temperatures has been completely eliminated.
- The enhanced UHMW-PE material is more resistant to harsh cleaning chemicals than stainless steel.

**Tech Notes:**
- TIVAR® products maintain many of their impact and tensile properties at cryogenic temperatures, making them ideal for flash or quick freeze applications.
Quadrant materials for this temperature range differ in bearing and wear, temperature and chemical resistance. All are more stable than UHMW in temperature swings, to minimize dimensional change in mating parts. Compare them for the best balance of cost and performance.

For non-food contact applications requiring extreme bearing and wear or structural loads see page 16.

**Acetron® GP POM-C** (white, black)
- Improved dimensional stability vs. nylon—lower moisture absorption
- Porosity-free rod and plate—minimizes bacteria build-up, easier to sanitize
- Low, consistent internal stress minimizes dimensional change in machining and use
- Uses: general bearing and wear and mixing components
- Compliance: FDA, USDA, NSF, 3A Dairy, Canada AG

**CASE STUDY**

**Commercial ice cream equipment**
**Problem:** Scraper blades in stainless steel were costly and wore mating parts quickly.
**Solution:** Replacement blades machined from Acetron® GP POM-C plate.
**Benefits:**
- Lower part cost, minimal wear and repair cost on mating surfaces
- Stiffness and low stress ensure fitness for mixing efficiency
- Porosity-free quality minimizes potential for trapped food and bacteria

Some acetals—even copolymer of claimed porosity-free material—can contain tiny holes that trap dirt and bacteria. (photo-micrograph @ 500x)

Only Quadrant Acetron® GP POM-C combines the assurance or porosity-free performance with the ease of machining, that the industry's lowest stress levels provide. (photo-micrograph @ 500x)

**Acetron® POM-H** — homopolymer acetal
- Slightly higher strength than co-polymer acetal
- Uses: General, Structural and Bearing Applications
  (Porosity may cause sanitation issues)
- Compliance: FDA, NSF, 3A Dairy

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Ertalyte® PET-P (white, black)

- Combines acetal’s dimensional stability, nylon’s strength—plus better wear resistance
- Higher temperature resistance of 240°F under load allows hotter cleaning solutions
- Resists staining, outperforms nylon, acetal in acidic environments
- Uses: precision parts needing dimensional stability at elevated temperatures
- Compliance: FDA, USDA, 3A Dairy, Canada AG
- Withstands “bleach solutions” unlike Nylon/Acetal

Ertalyte® TX PET-P (light grey)

- Far less wear than standard PET, PBT and lubricated acetal—best in class
- Excels in high velocity load-bearing applications—wet or dry
- Minimizes wear against soft metal and plastic mating parts
- Uses: Upgrade to longer life precision parts—reduce downtime and lubrication
- Compliance: FDA, USDA, 3A Dairy

CASE STUDY

Dairy food liquid filling equipment

Problem: High cost, wear rate of stainless steel
Solution: Pistons and valves machined from Ertalyte® PET-P rod
Benefits:
- Tight tolerances assure fill accuracy and efficiency—with a lower cost part
- Lower weight allowed lighter duty, lower cost drives—which outlasted former units
- Resistance to various liquids and chemicals afforded more production versatility

Temperature & Wear Resistance

![Temperature & Wear Resistance Chart]

Dimensional Stability

<table>
<thead>
<tr>
<th></th>
<th>ERTALYTE®</th>
<th>ACETAL</th>
<th>NYLON</th>
<th>UHMW-PE</th>
</tr>
</thead>
<tbody>
<tr>
<td>WATER ABSORPTION (24 HRL)</td>
<td>0.07</td>
<td>0.20</td>
<td>0.30</td>
<td>&lt; 0.01</td>
</tr>
<tr>
<td>COEFFICIENT OF LINEAR THERMAL EXPANSION (CLTE)</td>
<td>3.3 x 10⁻⁴</td>
<td>5.4 x 10⁻⁴</td>
<td>5.5 x 10⁻⁴</td>
<td>9 x 10⁻⁴</td>
</tr>
</tbody>
</table>

Tech Notes:

- Ertalyte® PET has machining characteristics different from those of nylon and acetal.
- Request our machining guidelines for easy adaptations to assure high quality machined parts.
- All polyesters including Ertalyte® are less resistant to hot water and steam than acetal.
- Contact Quadrant’s technical support team to review specific applications.
Nylatron® MC 907 PA6 (creamy white)
- Highest strength and hardness in cast nylon type 6
- Better dimensional stability and strength than UHMW
- Uses: general utility parts
- Compliance: FDA, USDA, 3A Dairy

Enhanced Wear Resistant Nylatron® LFG PA6 (creamy white)
- Lower coefficient of friction and higher PV
- Improves bearing and wear performance over standard grades
- Uses: alternative to standard cast nylon where external lubrication is impractical
- Compliance: FDA

Consider the versatility and cost saving potential of Nylatron® Custom Castings:

The nylon casting process allows a range of formulations and sizes including large heavy walled tube, large diameter rod, thick plates and blocks. It also allows casting custom parts and near net shapes that can cut cost vs. machining from a stock shape. This large part is FDA compliant Nylon cast over a steel shaft.

Quadrant Nylon 101 PA66 (creamy white, black)
- Highest strength and rigidity of all nylon products
- Uses: screw-machined electrical insulators and food contact parts
- Sizes: range includes small diameter rod, thin plate
- Compliance: FDA, USDA, 3A Dairy, NSF

CASE STUDY
Candy manufacturing equipment

Problem: Metal rollers wore out too quickly and held heat during production.
Solution: Parts were replaced with machined Quadrant Nylon 101 PA66.
Benefits:
- Far longer wear life and time between maintenance cycles
- Reduced downtime for system lubrication and parts replacement

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**Fluorosint® HPV PTFE**
(light tan)
- Most wear resistant of all Fluorosint® grades
- Able to withstand higher PV loads than most PTFE based materials
- Resistant to steam and moisture
- Compliance: FDA 21 CFR 175.300
- Ideal for seals and bearings in high load applications

**Fluorosint® 207 PTFE**
(white/grey)
- Excellent dimensional stability among PTFE's; non-permeable in steam
- Wear life at < 300°F (150°C) 20 times greater than typical filled PTFE
- Nearly 10 times more resistant to deformation under load than PTFE
- Uses: Aggressive service, tight tolerance bearings and bushings
- Compliance: FDA 21 CFR 175.300, USDA
- Ideal for seals and gaskets up to 500°F, where standard PTFE loses stability

**CASE STUDY**
Bearing in commercial frying equipment

**Problem:** Premature part wear at high temperature, contamination from lubrication of metal.

**Solution:** Composite design—bearing surfaces made from Fluorosint® 207 PTFE supported by metal.

**Benefits:**
- Fluorosint® 207 PTFE eliminates high wear from dynamic load
- Metal adds structural strength and avoids wear exposure
- Avoids deformation and degradation from exposure to hot cooking oils

**Relative Wear Resistance (Lower is Better)**

**Limiting PV (Higher is Better)**
240° - 325°F Applications

Quadrant has an ongoing development effort in materials for this application range as cleaning methods get hotter and more aggressive. These advanced materials deliver unique levels of wear and chemical resistance, dimensional stability and strength retention. Their diversity provides options for the best balance of cost and performance, without expensive over-engineering.

For non-food contact applications requiring extreme bearing and wear or structural loads see page 16.

**EXTREME Techtron® PPS (grey/beige)**
- Unsurpassed chemical resistance in this range
- Unique Quadrant technology—toughest, most durable unfilled PPS available
- Takes structural load to 240°F—in steam, hot water and cleaning chemicals
- Uses: structural mixing and handling components that see high temperatures in cleaning and use
- Compliance: FDA

**EXTREME Techtron® HPV PPS (medium blue)**
- Unique combination of ultra-low wear, extreme chemical resistance in the 200°-240°F range
- No abrasive glass fibers common to filled PPS—minimizes counter-face wear
- Similar electrical, chemical and hydrolysis resistance of natural Techtron® PPS
- Uses: cost-effective high performance alternative to PEEK below 250°F
- Compliance: FDA

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**CASE STUDY**

Guide rail—commercial meat portioning and packaging equipment

**Problem:** Traditional plastic materials failed as wash-down temperatures increased.

**Solution:** Replace existing material with FDA compliant Techtron® PPS.

**Benefits:**
- Faster line turn-around using hotter cleaning methods
- Eliminated part damage and hard to clean gaps from dimensional changes

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**Temperature & Wear Resistance**

<table>
<thead>
<tr>
<th>Material</th>
<th>Relative Wear Resistance</th>
<th>Practical Limiting PV</th>
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</thead>
<tbody>
<tr>
<td>Techtron® PPS</td>
<td>250°F 100</td>
<td>2,400</td>
</tr>
<tr>
<td>Techtron® HPV PPS</td>
<td>240°F 62</td>
<td>375</td>
</tr>
<tr>
<td>Ketron® 1000 PEEK</td>
<td>320°F 375</td>
<td>8,500</td>
</tr>
</tbody>
</table>

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Ketron® 1000 PEEK (light beige)

- Ideal for food contact bearing and wear applications from 240° - 325°F
- Resists wide range of aggressive, hot chemicals and cleaning solutions
- Uses: Oven and hot process parts; exposure to steam, chemicals under pressure
- Compliance: FDA, USDA, 3A Dairy

<table>
<thead>
<tr>
<th>Ketron® 1000 PEEK</th>
<th>Techtron® PPS</th>
<th>Techtron® HPV PPS</th>
<th>Acetal POM-C</th>
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</thead>
<tbody>
<tr>
<td>Overall Chm. Resist.</td>
<td>Very Good</td>
<td>Excellent</td>
<td>Excellent</td>
</tr>
<tr>
<td>Moisture Absorption</td>
<td>Very Good</td>
<td>Excellent</td>
<td>Excellent</td>
</tr>
<tr>
<td>Steam Resistance</td>
<td>Good</td>
<td>Good</td>
<td>Good</td>
</tr>
<tr>
<td>Wear Resistance (dry)</td>
<td>Very Good</td>
<td>Poor</td>
<td>Excellent</td>
</tr>
<tr>
<td>Cont. Service Temperature</td>
<td>480°F (250°C)</td>
<td>425°F (220°C)</td>
<td>430°F (221°C)</td>
</tr>
<tr>
<td>Heat Deflection Temperature</td>
<td>320°F (160°C)</td>
<td>250°F (120°C)</td>
<td>240°F (115°C)</td>
</tr>
<tr>
<td>% Flexural Strength Maintained at 300°F (150°C)</td>
<td>94%</td>
<td>23%</td>
<td>25%</td>
</tr>
<tr>
<td>at 500°F (260°C)</td>
<td>10%</td>
<td>5%</td>
<td>25%</td>
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</tbody>
</table>

**CASE STUDY**

**High temperature production line**

**Problem:** High process unit temperatures warped portioning unit components. Required a cooling unit that reduced production efficiency.

**Solution:** Machined components from high temperature resistant Ketron® 1000 PEEK.

**Benefits:**
- Eliminated distortion from high temperatures; improved production life of parts
- Eliminated cooling unit; closer placement of portioning unit increased production output and efficiency

**Tech Notes:**
- Designing with high temperature plastics requires adjustments from typical metal designs. Refer to Quadrant’s Design and Fabrication Guide for clearances, bearing designs and fit calculations.
- Visit us at www.quadrantplastics.com or call 800-366-0300.
The materials in the 300°F+ class open the weight saving and design versatility benefits of engineering plastics to applications once restricted to specialty metals and glass. Their lighter weight can mean lower-cost drive systems—and they can reduce part cost depending on the type of metal or glass replaced.

For non-food contact applications requiring extreme bearing and wear and structural loads, see page 16.

**Quadrant PSU**
*transparent light amber*
- Structural strength to 340°F
- Withstands hot water and steam—tough, durable
- Uses: sight glass, material conveying bins
- Compliance: FDA, USDA, 3A Dairy

**CASE STUDY**
*Sight glass—hot process equipment*
- **Problem:** Glass breakage concerns; temperature failure in other transparent plastics.
- **Solution:** Transparent Quadrant PSU sight glass units.
- **Benefits:**
  - Durable—no breakage
  - Cost effective vs. glass
  - Resists hot cleaning agents and acidic solutions in processing

**Duratron® U1000 PEI — polyetherimide**
*transparent dark amber*
- Higher structural strength than polysulfone to 400°F
- Excellent electrical properties—rated UL V-0
- Uses: similar to polysulfone with a higher temperature limit under load
- Compliance: FDA, USDA and NSF (STD. 51)

**CASE STUDY**
*Cookie filling distribution spool*
- **Problem:** Costly metal part required disassembly to clean. Temperatures eliminated many plastics.
- **Solution:** One-piece spools machined from Duratron® U1000 PEI.
- **Benefits:**
  - Durable, long lasting parts withstand high temperatures near baking environment
  - One piece machined part reduced cost and cleaning time vs. metal assembly

**Quadrant PPSU**
*white, black*
- Best resistance to multiple sterilization cycles and chemicals in this range
- Higher impact resistance plus strength at temperatures to 410°F
- Excellent electrical properties—rated UL V-0
- Uses: similar to polysulfone, Duratron® U1000 PEI with greater chemical and impact resistance
- Compliance: FDA

Available in a broad range of FDA compliant colors!

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**PHYSICAL PROPERTY GUIDE—Less than 175°F**

<table>
<thead>
<tr>
<th>Property</th>
<th>Method</th>
<th>Unit</th>
<th>Proton® Natural Homopolymer PP</th>
<th>Proton® Natural Copolymer PP</th>
<th>Sanalite® PP</th>
<th>HDPE</th>
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<tr>
<td>Specific Gravity</td>
<td>ASTM D792</td>
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<td>0.2</td>
<td>0.9</td>
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<tr>
<td>Yield Point</td>
<td>ASTM D638</td>
<td>psi</td>
<td>4,500</td>
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<tr>
<td>Elongation at Yield</td>
<td>ASTM D638</td>
<td>%</td>
<td>14</td>
<td>11</td>
<td>12</td>
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<tr>
<td>Tensile Break</td>
<td>ASTM D638</td>
<td>psi</td>
<td>4,500</td>
<td>4,900</td>
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<tr>
<td>Elongation at Break</td>
<td>ASTM D638</td>
<td>%</td>
<td>360</td>
<td>390</td>
<td>550</td>
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<tr>
<td>Tensile Modulus</td>
<td>ASTM D638</td>
<td>psi</td>
<td>165,000</td>
<td>152,000</td>
<td>176,000</td>
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<tr>
<td>Flexural Modulus</td>
<td>ASTM D790</td>
<td>psi</td>
<td>156,000</td>
<td>190,000</td>
<td>170,000</td>
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<tr>
<td>Izod Impact</td>
<td>ASTM D2562</td>
<td>ft-lb/in²</td>
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<td>6.0</td>
<td>1.3</td>
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<td>Hardness</td>
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<td>Type D</td>
<td>70</td>
<td>72</td>
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<tr>
<td>Static Friction</td>
<td>ASTM D1894</td>
<td>units</td>
<td>-</td>
<td>-</td>
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<tr>
<td>Dynamic Friction</td>
<td>ASTM D1894</td>
<td>units</td>
<td>-</td>
<td>-</td>
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<td>Compressive Modulus</td>
<td>ASTM D696</td>
<td>psi</td>
<td>-</td>
<td>-</td>
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<td></td>
</tr>
<tr>
<td>Coefficient of Thermal Expansion</td>
<td>ASTM D696</td>
<td>°F</td>
<td>-</td>
<td>-</td>
<td>-</td>
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</tr>
<tr>
<td>Melt Point</td>
<td>ASTM D3410</td>
<td>°F</td>
<td>324</td>
<td>385</td>
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<td></td>
</tr>
<tr>
<td>Continuous Service Temperatures in Air (max.)</td>
<td>ASTM D3410</td>
<td>°F</td>
<td>190</td>
<td>180</td>
<td>180</td>
<td></td>
</tr>
<tr>
<td>Water Absorption</td>
<td>ASTM D570</td>
<td>%</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>&lt; 0.1</td>
</tr>
</tbody>
</table>

Values are averages and are not specifications. ASTM test methods are under current procedures.

**CHEMICAL RESISTANCE GUIDE—Less than 175°F**

<table>
<thead>
<tr>
<th>Chemical Families</th>
<th>%</th>
<th>Temp [°F]</th>
<th>Proton® Homopolymer PP &amp; Copolymer PP</th>
<th>Sanalite® PP</th>
<th>HDPE</th>
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<tbody>
<tr>
<td>Acid, Weak: acetic acid, dilute hydrochloric or sulfuric acid</td>
<td>70</td>
<td>75°F</td>
<td>A</td>
<td>A</td>
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<td>Acid, Strong: zonic, hydrochloric or sulfuric acid</td>
<td>75</td>
<td>75°F</td>
<td>A</td>
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<td>Alkalies, Weak: dilute ammonia or sodium hydroxide</td>
<td>73</td>
<td>73°F</td>
<td>A</td>
<td>A</td>
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<tr>
<td>Alkalies, Strong: strong ammonia or sodium hydroxide</td>
<td>73</td>
<td>73°F</td>
<td>A</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>Hydrocarbons, Aromatic: benzene or toluene</td>
<td>73</td>
<td>73°F</td>
<td>U</td>
<td>U</td>
<td></td>
</tr>
<tr>
<td>Hydrocarbons, Aliphatic: gasoline, hexane, grease</td>
<td>73</td>
<td>73°F</td>
<td>U</td>
<td>U</td>
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<tr>
<td>Ketones, Esters: acetone, methyl ethyl, ketone</td>
<td>73</td>
<td>73°F</td>
<td>U</td>
<td>U</td>
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<tr>
<td>Ethers: diethyl ether or tetrahydrofuran</td>
<td>73</td>
<td>73°F</td>
<td>U</td>
<td>U</td>
<td></td>
</tr>
<tr>
<td>Chlorinated Solvents: methyl chloride, chloroform</td>
<td>73</td>
<td>73°F</td>
<td>U</td>
<td>U</td>
<td></td>
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<tr>
<td>Alcohols: methanol, ethanol, anti-freeze</td>
<td>73</td>
<td>73°F</td>
<td>A</td>
<td>A</td>
<td></td>
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<tr>
<td>Inorganic Salt Solutions: sodium chloride, potassium cyanate</td>
<td>73</td>
<td>73°F</td>
<td>A</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>Continuous Sunlight</td>
<td>73</td>
<td>73°F</td>
<td>-</td>
<td>-</td>
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</tr>
</tbody>
</table>

**Food Industry Typical Exposure**

| Hydrogen peroxide | 1 | 75°F | L | A | |
| Nitric acid       | 1 | 75°F | A | A | |
| Nitric acid       | 5 | 175°F| A | A | |
| Phosphoric acid   | 1 | 75°F | A | A | |
| Phosphoric acid   | 5 | 175°F| A | A | |
| Sodium hydroxide  | 1 | 75°F | A | A | |
| Sodium hydroxide  | 5 | 175°F| A | A | |
| Sodium hypochlorite (300 ppm active chlorine) | 88 | 88°F | A | A | |
| Steam sterilization (single autoclaving) | UD | 273°F| U | U | |
| Steam sterilization (repeated autoclaving) | UD | 273°F| U | U | |
| Sulphuric acid    | 1 | 75°F | A | A | |
| Sulphuric acid    | 3 | 140°F| A | A | |
| Water             | UD | 140°F| A | A | |
| Water             | UD | 175°F| A | A | |
| Water             | UD | 203°F| A | A | |
### PHYSICAL PROPERTY GUIDE—175°F to 325°F +

<table>
<thead>
<tr>
<th>Property Description</th>
<th>Test Method ASTM</th>
<th>Units</th>
<th>Tivar®1000 UHMW-PE</th>
<th>Tivar® J.O.T. UHMW-PE</th>
<th>Acetron® GP POM-C</th>
<th>Acetron® POM-H</th>
<th>Erytal® PET-P</th>
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<tr>
<td></td>
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<td>UHMW Polyethylene</td>
<td>Host Resistant UHMW Polyethylene</td>
<td>Copolymer Porosity-free Acetal</td>
<td>Homopolymer Acetal</td>
<td>Semi-crystalline Thermoplastic Polyether</td>
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<td>1 Specific Gravity, 73°F</td>
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<td>0.93</td>
<td>0.94</td>
<td>1.41</td>
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<td>2 Tensile Strength, 73°F</td>
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<td>psi</td>
<td>5,800</td>
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<td>12,400</td>
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<td>3 Tensile Modulus of Elasticity, 73°F</td>
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<td>psi</td>
<td>100,000</td>
<td>100,000</td>
<td>400,000</td>
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<td>4 Tensile Elongation (at break), 73°F</td>
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<td>300</td>
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<tr>
<td>5 Flexural Strength, 73°F</td>
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<td>psi</td>
<td>3,500</td>
<td>3,500</td>
<td>12,000</td>
<td>13,000</td>
<td>18,000</td>
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<tr>
<td>6 Flexural Modulus of Elasticity, 73°F</td>
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<td>psi</td>
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<td>7 Compressive Strength, 10% Deformation, 73°F</td>
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<td>15,000</td>
<td>16,000</td>
<td>15,000</td>
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<tr>
<td>8 Compressive Modulus of Elasticity, 73°F</td>
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<td>psi</td>
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<td>80,000</td>
<td>400,000</td>
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<td>420,000</td>
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<td>9 Hardness, Rockwell, Scale as noted, 73°F</td>
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<td>50</td>
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<td>10 Hardness, Durometer, Shore “D” Scale, 73°F</td>
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<td>D2240</td>
<td>D66</td>
<td>68</td>
<td>66</td>
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<td>11 Izod Impact (notched), 73°F</td>
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<td>ft-lb/in. of notch</td>
<td>D256 Type “A”</td>
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<td>12 Coefficient of Friction (Dry vs. Steel) Dynamic</td>
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<tr>
<td>13 Limiting PV (with 4:1 safety factor applied)</td>
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<td>ft-lb/in.² ft/min</td>
<td>QTM 55007</td>
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<td>14 Wear Factor “x” x 10°°</td>
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<td>15 Coefficient of Linear Thermal Expansion (40°F to 300°F)</td>
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<td>1.1 x 10⁻⁶</td>
<td>1.1 x 10⁻⁶</td>
<td>5.4 x 10⁻⁶</td>
<td>4.7 x 10⁻⁶</td>
<td>3.3 x 10⁻⁶</td>
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<td>16 Heat Deflection Temperature 264 psi</td>
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<td>°F</td>
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<td>17 Tg-Glass transition (amorphous)</td>
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<td>18 Continuous Service Temperature in Air (Max.)</td>
<td></td>
<td>°F</td>
<td>-</td>
<td>180</td>
<td>275°F</td>
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<td>19 Thermal Conductivity</td>
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<td>BTU in/hr. ft.²°F</td>
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<tr>
<td>20 Water Absorption Immersion, 24 Hours</td>
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<td>% by wt.</td>
<td>D570 (2)</td>
<td>&lt;0.01</td>
<td>&lt;0.01</td>
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<td>21 Water Absorption Immersion, Saturation</td>
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<td>% by wt.</td>
<td>D570 (2)</td>
<td>&lt;0.01</td>
<td>&lt;0.01</td>
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<tr>
<td>22 Acids, Weak, 73°F, acetic acid, diute hydrochloric or sulfuric acid</td>
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<td></td>
<td>A</td>
<td>A</td>
<td>L</td>
<td>L</td>
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<tr>
<td>23 Acids, Strong, 73°F, conc. hydrochloric or sulfuric acid</td>
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<td></td>
<td>A</td>
<td>U</td>
<td>U</td>
<td>L</td>
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<tr>
<td>24 Alkalies, Weak, 73°F, dilute ammonia or sodium hydroxide</td>
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<td>25 Alkalies, Strong, 73°F, strong ammonia or sodium hydroxide</td>
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<td>26 Hydrocarbons-Aromatic, 73°F, benzene, toluene</td>
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<td>27 Hydrocarbons-Aliphatic, 73°F, gasoline, hexane, grease</td>
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<td>28 Ketones, Esters, 73°F, acetone, methyl ethyl ketone</td>
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<td>A</td>
<td>A</td>
<td>A</td>
<td>A</td>
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<tr>
<td>29 Ethers, 73°F, diethyl ether, tetrahydrofuran</td>
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<td>L</td>
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<td>30 Chlorinated Solvents, 73°F, methylene chloride, chloroform</td>
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<td>L</td>
<td>L</td>
<td>L</td>
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<tr>
<td>31 Alcohols, 73°F, methanol, ethanol, anti-freeze</td>
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<td>A</td>
<td>A</td>
<td>A</td>
<td>A</td>
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<td>32 Inorganic Salt Solutions, 73°F, sodium chloride, potassium cyanide</td>
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<td></td>
<td>-</td>
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<td>A</td>
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<tr>
<td>33 Continuous Sunlight, 73°F</td>
<td></td>
<td></td>
<td>-</td>
<td>-</td>
<td>L</td>
<td>L</td>
<td>L</td>
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<td>34 Relative Machinability (1-10, 1=Easier to Machine)</td>
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<td>35 Flammability @ 3.1 mm (1/8 in.)</td>
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<td>UL 94</td>
<td>HB</td>
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</tbody>
</table>

**Chemical Resistance:** A= Acceptable, L= Limited, U= Unacceptable

(1) Chemical resistance data are for little or no applied stress. Increased stress, especially localized may result in more severe attack. Examples of common chemicals also included.

(2) Estimated rating based on available data. The UL 94 Test is a laboratory test and does not relate to actual fire hazard. Contact Quadrant for specific UL "Yellow Card" recognition number.

www.quadrantplastics.com • 800-366-0300
<table>
<thead>
<tr>
<th>Ertalyte® TX PET-P</th>
<th>Nylon® M65(R115)</th>
<th>M65(R)120</th>
<th>Fluorosint® 207 PTFE</th>
<th>Fluorosint® HPV PTFE</th>
<th>Techron® PPS</th>
<th>Techron® HPV PPS</th>
<th>Ketron® U1000 PEEK</th>
<th>Quadrant® PSU</th>
<th>Duraton® U1000 PEI</th>
<th>Quadrant® PPSU</th>
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<td>R54</td>
<td>M65</td>
<td>M64</td>
<td>M100(R126)</td>
<td>M92(R128)</td>
<td>M112(R125)</td>
<td>M96(R120)</td>
<td>M98(R120)</td>
<td>M96(R120)</td>
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## CHEMICAL RESISTANCE GUIDE—175°F to 325°F +

![Chemical Resistance Chart](image)

**Legend to the table:**
- **A**: Resistant. Little or no change in weight. Small effect on mechanical properties. In general acceptable service life.
- **B**: Partially resistant. In course of time, there is a distinct deterioration in mechanical properties and a change in weight. In many cases a short term exposure or limited number of cleaning cycles may be considered allowable (to be evaluated by practical testing).
- **C**: Non-resistant. After a short time, the material is seriously affected (considerable reduction of the mechanical strength and changes in weight). Using the material under these conditions is not recommended.
- **NA**: Not applicable for this material

**Concentration (%):**
- A number, e.g. 5, indicates “5g of solute per 100g of aqueous solution” 5% by weight.
- UD: Undiluted (technically pure chemical)

**Temperature (°C):**
- RT: Room temperature (15 - 25°C)

**Important considerations regarding chemical resistance, cleaning and autoclaving:**

Many factors can affect chemical resistance of a material, and it is virtually impossible to test and provide data for all potential combinations to which an application can be exposed. Chemical resistance, autoclaving and cleaning data from any source can only serve as a guideline based on tests at specific conditions. The user must make his own determination of a material’s suitability for use based on testing of finished parts in their practical environment.

Variables — alone or in combination — that can affect chemical resistance and should be considered include the influence of machined-in stresses, assembly and application loads, part design, cleaning cycle times, pressures, chemical concentrations and combinations, and temperatures.

Ratings in the data above — derived from raw material supplier data, literature on chemical resistance of plastics, and from experience — are a guideline only and refer to unstressed parts. In particular, thermoplastic (PC, PSU, PEI and PPSU) are sensitive to “stress cracking” under certain conditions. Thus, environments normally harmless to unstressed parts may cause stress cracking in contact with stressed parts.

Quadrant has an extensive database of chemical resistance information. Please feel free to contact our technical services group for more specifics about your application.
SOLID SOLUTIONS FOR FOOD INDUSTRY APPLICATIONS

Quadrant manufactures a wide range of profile shapes, narrow board stock and tube from FDA and NSF compliant TIVAR® UHMW-PE. Many shapes can be shipped from stock, with custom shapes and formulations possible with short leadtimes.

To see all of our standard profile shapes and wear strips, visit www.quadrantplastics.com and click on the TIVAR® family in our Products section.

Quadrant can manufacture series parts machined from materials like TIVAR® UHMW-PE, Nylatron® PA6, Ertalyte® PET-P and all the other products we’ve developed for the Food Processing and Packaging Industry. Send us a drawing and we’ll help you find the best way to produce your design. No one knows more about designing and manufacturing parts from these materials than the people who invented them.

PROBLEM SOLVERS FOR NON-FOOD CONTACT APPLICATIONS

TIVAR® Dryslide is ideal for chutes, slides and conveyor systems that move packaged products. TIVAR® Dryslide is widely used by catalog and parcel services and is just being introduced to manufacturers of food and food production equipment. TIVAR® Dryslide eliminates the need for coatings or lubricants applied to handling systems and removes the chance for unsafe behavior associated with relieving jammed lines.

TIVAR® Cerami P® gives engineers, designers and maintenance professionals all of the benefits of UHMW-PE and adds increased wear resistance in loaded sliding applications without sacrificing the strength and stability usually associated with lesser “lubricated” products.
Quadrant has extensive product and machining resources available online. Our website is a portal to a wealth of technical data and the easiest way to engage our application specialists. Our team stands ready to help offer solutions to your toughest problems.

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