

# PTFE

## Frequently Asked Questions

Engineered Polymer Systems (“EPS”) Division



### **I’m currently using a PTFE seal. How can I determine if there is another PTFE material or design option that would work better in my application?**

Parker utilizes a DAR form, Design Action Request form, which can be downloaded from our website at the URL [www.parker.com/eps/dar](http://www.parker.com/eps/dar). When you fill out the form and send to us, it provides Parker engineers the information necessary to get started with a new application, get a conversation going, and work with new product development design engineers to figure out exactly what is needed to achieve optimum sealability and other performance goals in your specific application.

### **What is the shelf life of PTFE seals?**

Assuming the proper guidelines for storage conditions are followed, PTFE has an unlimited shelf life.

### **Why is PTFE used as a coating on nitrile seals?**

PTFE bonding onto nitrile rubber (sometimes erroneously referred to as “coating”) is mainly done to lower the coefficient of friction and to prevent stick-slip behavior of rubber in a dynamic application. We bond PTFE to the lip of Clipper® Oil Seal products to reduce friction either from start up or while running.

PTFE is an inert material with universal chemical resistance. PTFE bonding onto rubber significantly eliminates absorption and penetration of any chemicals like oil, solvents, acids, bases into nitrile rubber as a barrier to protect nitrile rubber from the chemicals in the media since nitrile rubber has relatively narrower chemical resistance.

Bonding PTFE to a rubber substrate also makes a seal easier to install and uninstall due to non-stick properties and reduces installation time and cost for high volume assembly operations.

### **Do PTFE backups provide chemical resistance to a rubber O-Ring?**

Parker has a handful of designs that incorporate a PTFE backup behind a rubber seal or rubber O-Ring. In those instances - no - PTFE backups are used for enhancing extrusion resistance, or basically strengthening the material at high pressure, but do not provide chemical resistance protection to the untreated rubber seal.

### **Is there a specific cross section ratio – width vs. height for PTFE Seals? In other words, how small of a seal can Parker manufacture?**

We make a FlexiSeal® product, which is a spring-loaded PTFE seal which can be made to fit as small as 1/16 inch (.062”) deep groove. FlexiSeal products are going to be taller in the axial direction than they are wide, meaning, In the direction of the shaft, the seal is going to be longer than it is deep for that groove. We also make rubber energized PTFE cap seals and those tend to have a deeper groove and an axially smaller profile. Those go down to .090” in the axial direction.



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### **Is a modified PTFE (mPTFE) material always going to outperform a regular or non-modified PTFE material in seal performance?**

Modified PTFE (mPTFE) has unique properties that outperform regular (homopolymeric) PTFE including lower deformation under load, better extrusion resistance, improved sealability, better gas impermeability and better stretch recovery - an important feature relating to installation of some seals. A drawback is that Modified PTFE is more expensive than standard PTFE. Therefore, if good sealing performance can be achieved by using the right filled PTFE material, or if you are only needing to marginally improve sealing performance, we would recommend use of a filled PTFE material as a more cost effective solution.

### **What is a good PTFE material for cryogenic gas applications?**

For cryogenic temperatures, your best choice would be modified PTFE (mPTFE). It has much better stretch recovery and flex recovery along with better gas impermeability and sealability. Also sold under the brand name of TFM®, a trademark of 3M Company, modified PTFE conforms much better than regular (homopolymeric) PTFE as a seal between the counter-surface and the seal surface. This is the beauty of using modified PTFE over PTFE, especially for cryogenic applications. However, there are some other PTFE blends which will work in cryogenic service. If you're needing wear and extrusion resistance with a cryogenic operation, polymeric-filled PTFE compounds are a good choice, such as Parker's 0601 material. Other good candidates are virgin PTFE or pigmented PTFE. We need to understand both the operating conditions along with the temperature to recommend the best option for the particular application.

### **How does PCTFE compare to PTFE for cryogenic applications?**

PCTFE is a high-performing fluoropolymer that can be used in a wide range of temperature applications from cryogenic up to 200 °C (400 °F). The beauty of using PCTFE is it has the lowest porosity and the best performance in terms of gas impermeability. PTFE, on the other hand, has much better cryogenic performance. You can dip PTFE directly into liquid nitrogen and still bend it. It will flex and it's not going to break. PCTFE has slightly better gas impermeability due to low porosity because it's a true thermoplastic; it's processed by using traditional thermoplastic processing methods like extrusion and injection molding. The cost of PCTFE, however, can exceed 10 times the cost of PTFE.

### **Does carbon fiber-filled PTFE damage the shaft in rotary shaft sealing applications?**

Common fillers like fiberglass and carbon fiber are abrasive to soft metal shafts, especially in rotary applications where it's running in the same counter-surface location for a long time. In those applications, we recommend a hardened surface coating on the shaft. A hard chrome plating could work or through hardening is best for many high pressure applications where a thin coating could become damaged. Hardness of 60 Rockwell C or higher is recommended for those abrasive fillers. If you have an application where something soft like stainless steel has to be used for the shaft - such as a pharmaceutical or food application - we have many fillers that are both tough and can be used on the softer rotating shaft without scratching it.

While carbon fibers can be abrasive to the counter surface, the abrasion is less than glass fiber formulations. Plus, there are basically two different types of carbon fiber fillers. One of them is PAN based (poly-acrylonitrile). The second is pitch based, also known as electrographitized or graphitic carbon fiber. Graphitic carbon fiber is smoother and more lubricating. Compared to PAN based carbon fiber filled formation, it's gentler to the counter surface. Parker EPS offers carbon fiber filled PTFE formulations utilizing both PAN based and pitch based carbon fibers.



### **Are FEP and PFA considered thermoplastic?**

Yes. Both are processed using traditional thermoplastic manufacturing methods like extrusion and injection molding. FEP is not fully fluorinated while PFA is fully fluorinated, which is why it's known as perfluorinated thermoplastic. The chemical resistance of PFA is better than FEP as are the thermal resistance and other properties. FEP's temperature rating is lower than PFA. PFA is basically the closest thermoplastic to PTFE, but PFA is almost 5-8 times more expensive than PTFE.

### **What are the benefits or advantages of different spring types used to energize PTFE seals?**

For FlexiSeals®, we offer three different spring shapes and one of those shapes is offered in different spring load sizes. The reason to get different levels of loading and for different applications. For static applications or really slow applications that need to seal very tightly and friction is not a concern, we can install a heavy spring to get achieve a tight seal where friction and seal wear is less of an issue. On the other hand, if friction is a concern, we can install a light load spring which allows the seal to wear much longer and generate less friction as it moves. Typically, in those applications, leakage is less of a concern. Friction and sealing tend to go hand in hand. If your application can tolerate a lot of friction, you would use a heavy load spring to produce a very tight seal and vice versa.

### **Does Parker EPS Division offer PTFE compounds approved by the FDA for use in food applications?**

Yes. Parker can provide FDA compliant materials per Title 21 CFR177.1550. The FDA does not test, certify, or approve any specific compound or material for use in food applications. However, Parker has materials which are compliant with FDA requirements for use in food applications including proprietary mineral filled PTFE. See the Parker brochure [EPS5250](#).

### **What is the radiation resistance of PTFE and mPTFE?**

PTFE is highly resistant to low energy types of radiation such as IR, UV and sunlight. It's not affected by ageing (both thermal and environmental ageing) because of chemical resistance. However, PTFE is not resistant to high energy radiation types such as gamma radiation or electron radiation. This is a concern in a lot of medical applications where gamma radiation is common for sterilization. In those conditions, UHMW is a common material used to make clean grade seals. Gamma radiation does not chemically attack PTFE, it breaks apart PTFE's long chain molecules into smaller molecules. In fact, that's one process used in some industries to recycle virgin PTFE for use as reprocessed PTFE. Thus, for sterilization of PTFE-based components in medical or bio-processing applications, high energy radiation should not be used.

### **Do different cylinder coatings and treatments affect seal performance and friction levels?**

There are many different types of coatings available so it is not possible to provide a "blanket" statement for all of them. Parker's general recommendation is that if the surface finish of the coating falls within our recommendation for PTFE seals — which is usually no greater than 12 micro inch (measured in Ra) — the surface coating should be fine. There are instances, however, where coatings can peel off under pressure. Pressure causes some micro deformation of the surface of the metal, or whatever the substrate is, and causes that coating to fatigue and peel off. In turn, the imperfection creates leakage and accelerates seal wear. A coating's durability and surface finish are critical. There are some low friction, PTFE impregnated coatings available which are also very hard. As long as they're durable, they work well.



### **What is more common, specification of PTFE filler by weight or by volume?**

All PTFE formulations are specified according to percentages by weight. However, it's always good to understand the amount of filler by volume because the fillers used in PTFE vary in density. For example, polymeric fillers have low density whereas bronze and other metallic fillers have high density. The material specifications provided by ASTM, AMS, or even in customer specifications always specify PTFE compounds in weight percentages.

### **Regarding filler, is particulate always better than a fibrous filler? For example, is a carbon particle filled PTFE also good in water?**

In general, fibrous fillers perform better than particulate fillers in terms of wear resistance and extrusion resistance. Keep in mind that fibrous fillers (like carbon fiber) are more expensive, but they can achieve similar properties as particles by using lower percentage. For example, 10% carbon fiber-filled PTFE compound can achieve similar or even better wear performance and extrusion resistance compared to 15% or 20% carbon-filled compounds.

The ultimate decision, however, will depend on the pressures, temperatures, speeds, media, and other aspects of the application and what you're looking for when you compare carbon-filled PTFE materials and carbon fiber-filled PTFE materials. If you're looking for chemical agent resistance, carbon fiber typically would be a better selection over carbon particulate. If you're looking for thermal conductivity from the seal, then you would want to choose a carbon particulate over a carbon fiber. Both carbon and carbon fiber are good in compression resistant applications, high temperature resistance, thermal stability and wear resistance. From a water application perspective, you can refer to Parker's 0502, 0307 or 0301 material. They would both be good selections for seals in water applications.

### **What is the max size for your rotary test fixture and what media can be used?**

Parker has a number of rotary testing fixtures. The largest we can handle is 16 inches or 400 millimeters in shaft size. We have custom programming capabilities on these machines. From a fluid perspective, we test a wide range of oils. We can also test water. If you want to test something specific, we can look at it, but we would review the MSDS to make sure there's no hazardous components that would require some safety precautions.

### **Do lubricating agents impact particle generation?**

This depends on how you compound the fillers in PTFE. Dry lubricants like graphite can dissociate from the surface of the PTFE matrix. Similarly, moly (MoS<sub>2</sub>) has a very small particle size that emerges to the surface and improves the hardness of PTFE. They can sometimes come out from the surface and wear out the surface of PTFE. If you have a good compounding and co-coagulate those types of filler in PTFE very uniformly and distribute them, you can minimize that issue.

### **Is there any reason friction or seal wear may increase over time under stable operating conditions?**

If seal wear is increasing over time, something in the system is changing. Is heat buildup occurring? Is there potentially a hardening on the surface of the shaft? For example: If a shaft surface was case hardened and material wears through into the substrate, this can occur. It also depends on the filler. We always say fibrous fillers are great for wear resistance and extrusion resistance, but they are more abrasive than the particulate fillers. So with PTFE seals, the best performance is to deposit a nice sliding surface on top of the counter surface in order to achieve a good sealability, low coefficient of friction and good wear. Since fibrous fillers, such as glass or carbon fiber, are abrasive, they sometimes prevent



uniform formation of that sliding surface on top of the counter surface. That's why sometimes you'll see increase and decrease of coefficient friction when the seal is running and rotating on the counter surface. On the other hand, polymeric fillers or dry lubricants form a very stable transfer film on top of the counter surface, so the running temperatures and the coefficient of frictions are more uniform and steady.

### **Can you explain carbon filler's corrosion problem when combined with aluminum?**

When carbon-filled PTFE compounds run against aluminum counter surfaces in dynamic sealing applications, galvanic corrosion of aluminum can be observed due to electrical conductivity of carbon-filled PTFE compounds. The intensity and morphology of the galvanic corrosion strongly depends on the type of aluminum, the carbon content of the PTFE seals as well as environmental conditions. During galvanic corrosion of aluminum, white aluminum oxide layer forms on the surface of the aluminum. Galvanic corrosion of aluminum can be minimized by anodization of aluminum.

### **How crucial is the method of PTFE molding, isostatic versus compression, to the performance of the parts yielded? And what type does Parker use?**

The processing of PTFE has a big impact on final performance. At Parker EPS, we mostly use compression molding. Compared to isostatic molding, compression molding has slightly different mechanical properties in two different directions. Even though isostatic molding results in biaxial mechanical properties, compression molded seals result in higher radial direction mechanical properties (tensile, elongation, modulus) which is highly desired for dynamic fluid sealing applications.

Along with the molding process, thermal history is also important. The way the material is sintered - whether it is fast cooling or slow cooling- determines the final physical properties (along with some other wear performance, extrusion resistance) of PTFE compounds. We have the capability to manufacture using different molding and sintering methods.

