

# PERFORMANCE FIBERS



## PEEK White Paper

Performance Fibers recently optimized and expanded its production facilities for high performance PEEK fibers in Bad Hersfeld, Germany. The PEEK fibers that are available now have a unique combination of mechanical properties that are stable under extreme environmental conditions. Whether it is at high temperature, extreme moisture, alkaline or acidic environments, there is almost no other fiber that will do a comparable job.



## 1. PEEK POLYMER

PEEK (Poly Ether Ether Ketone) is a colourless, linear-aromatic organic polymer (Fig.1: molecular structure) that is well known as a semicrystalline, thermoplastic engineering material with excellent physical properties, as shown in table 1.

Apart from this unique combination of physical properties, PEEK maintains these properties under extreme conditions. It has excellent chemical and heat resistance and is renowned for its flame retardant properties.

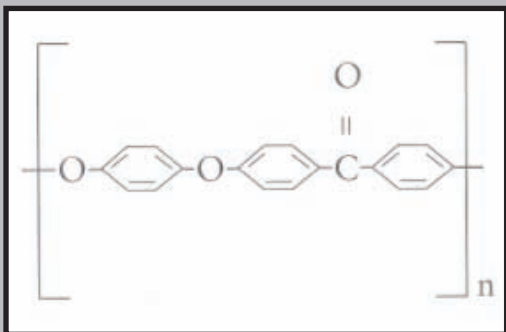


Fig.1. Molecular structure

PEEK polymer properties	
Density	1320 kg/m <sup>3</sup>
Young's Modulus (E)	3.6 Gpa
Tensile Strength ( $\sigma_t$ )	90-100 MPa
Elongation at Break	50%
Notch Test	55 kJ/m <sup>2</sup>
Glass transition temperature (Tg)	143 °C
Melting Point (Tm)	~ 343 °C
Thermal Conductivity	0.25 W/m.K
Water absorption, 24 hrs (ASTM D 570)	- 0.1 %

Table 1. Physical properties of PEEK

## 2. PEEK FIBERS

At Performance Fibers we have been able to melt-spin PEEK with its unique properties into endless fibers with a natural golden appearance. The resulting fibers have an unparalleled set of mechanical properties, as shown in table 2.

Performance Fibers PEEK			
Type		190, 410 f 24	190, 1230 f 72
LD	(denier)	370	1100
	(dtex)	410	1230
Filament Count		24	72
Breaking Strength	(lbs)	5.2	16.0
	(kg)	2.3	7.2
	(N)	23.0	71.0
Tenacity	(g/d)	6.2	6.5
	(cN/dtex)	5.5	5.7
Elongation @ 54 cN/tex	(%)	17.5	17.0
EAB	(%)	20.0	20.0
HAS (180 C, 0.01 gpd, 15 min.)	(%)	1.8	1.7

Table 2. Mechanical properties of Performance Fibers' PEEK fiber products

## 3. COMPARISON TO OTHER FIBERS

Table 3 shows the properties of PEEK fibers compared to those of other high performance fibers. From this chart the unique combination of properties that differentiates PEEK fibers from other fibers becomes clear.

Comparison of PEEK fibers with other fibers							
	PEEK	m-aramid	polyimide	PTFE	PPS	PET	PA-6
Tenacity (cN/tex)	> 30	40-45	35	15	> 50	70 - 85	70 - 85
Elongation (%)	20-40	25	30	13	> 19 - 25	10 - 20	18 - 25
Continuous Temperature of Operation °C	250	200	240	250	190	150	110
Moisture Absorption (%)	0.1	4.5 - 5.0	3	0	< 0.02	0.2 - 0.4	4.0 - 4.5
Flame Retardance	++	+	++	++	++	-	-
Oxidation Resistance	0	+	+	++	0	+	0
Wet heat / hydrolysis resistance	++	0	+	++	++	-	-
Resistance against acids	+	0	+	++	++	0	0
Resistance against alkaloids	+	+	0	++	++	-	-

++ = excellent    + = good    0 = moderate    - = poor / not recommended  
 \* depending on the medium



### 3.1 Chemical Resistance

Apart from their outstanding mechanical properties, further added value of Performance Fibers's PEEK products in contrast to most other polymer fibers comes from the stability of their excellent performance under severe environmental conditions. Whether it is at elevated temperatures or under the influence of various aggressive chemicals, in all these situations the fibers maintain their unique combination of properties. This is illustrated unequivocally in figure 2 where the influence of severe testing conditions is shown on the relative tenacity of a set of different high performance fibers. Performance Fibers's PEEK fibers consistently outperform the other high performance fibers.

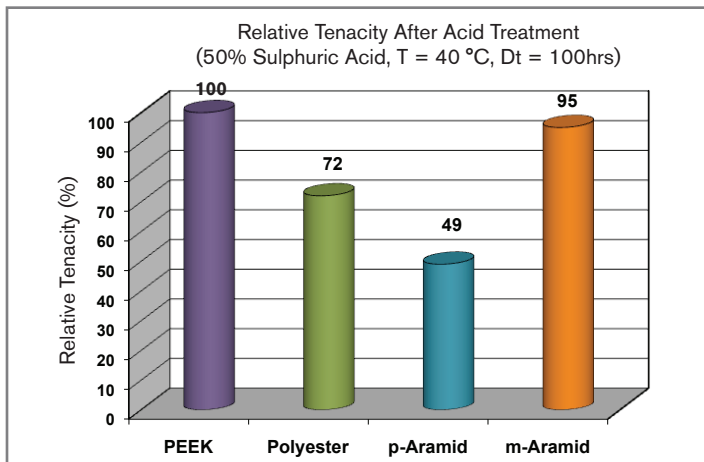
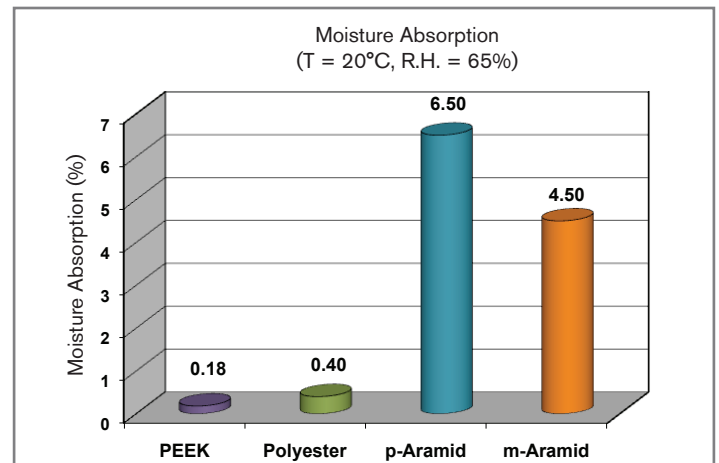
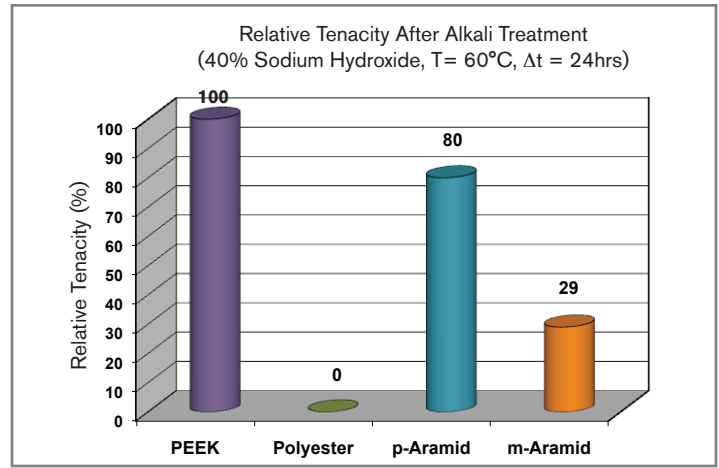


Figure 2: Illustration of the chemical resistance of Performance Fibers's PEEK fibers in comparison with other polymers

“ Whether it is at elevated temperatures or under the influence of various aggressive chemicals, in all these situations the fibers maintain their unique combination of properties.”

## 3.2 Thermal Resistance

The PEEK fibers from Performance Fibers have a broad thermal application window that ranges from -60 °C to +250°C. In hot air at 260°C the tensile strength still is some 60% of the value measured at 20°C. Even prolonged treatments at higher temperatures result in only a minor reduction of the strength. This is clearly indicated in figure 3.

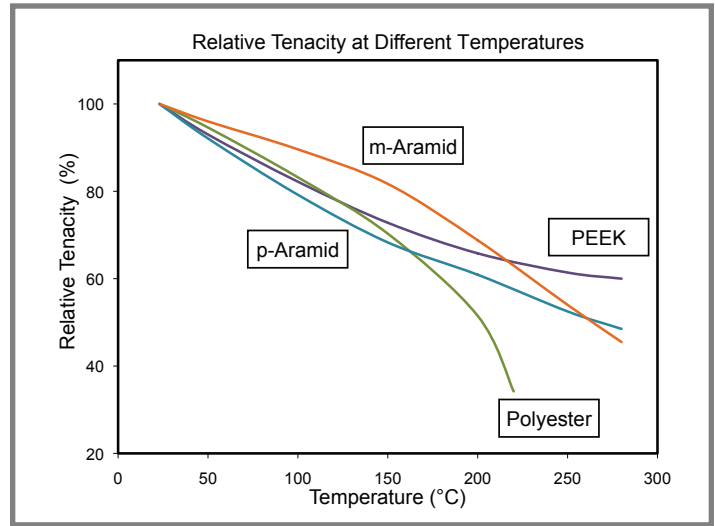
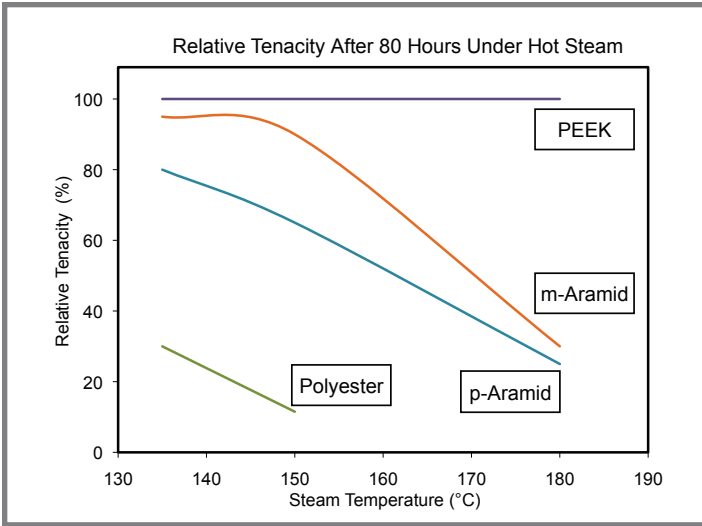
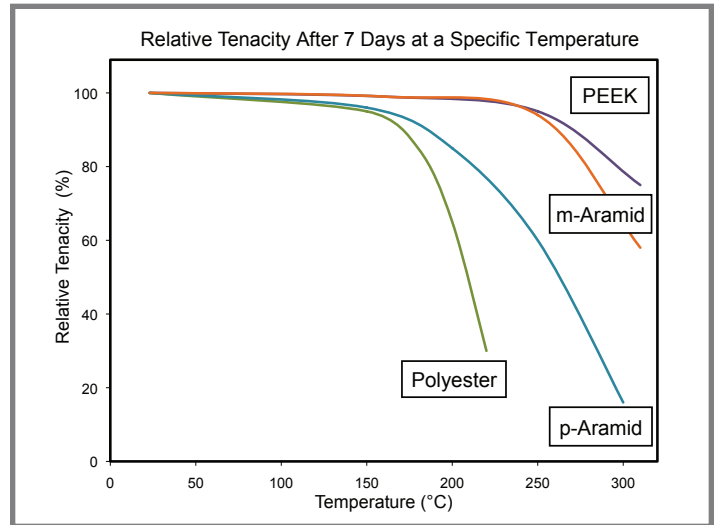


Figure 3: Influence of temperature and moisture on the tenacity of a selection of high performance fibers.

## APPLICATION AREAS

PEEK fibers have a variety of versatile applications, whether it is as a monofil or a multifil, whether they are twisted, woven, knitted, spun or needled into the full range of conventional textile structures.

Since PEEK fibers show excellent mechanical properties under extreme conditions, MRG (Mechanical Rubber Goods) applications at higher temperatures are possible; hose reinforcement in the automotive sector (“under the hood”, brake, fuel, cooling and power steering) or in chemically harsh environments. The mechanical performance also enables open mesh conveyor belts at higher temperatures, e.g in the paper drying industry, non-woven bonding, fabric heat setting, textile printing, etc. and hot gas filtration.

- Due to their low coefficient of friction and high abrasion resistance, application is possible without lubricants.
- PEEK fibers are Ultra High Vacuum compatible (no out-gassing, no particle formation from abrasion) and show excellent tribological behaviour.
- The UHV compatibility, combined with its potential for weight savings and the excellent mechanical properties at extreme (temperature) conditions, also enable PEEK fibers to be considered for Aerospace applications.
- Providing good electrical insulation at higher temperatures makes PEEK fibers useful for various applications in the Electronics industry.
- Since PEEK is biocompatible and its properties are resistant to consecutive autoclave sterilization treatments, PEEK fibers are also suited for Medical applications. This suitability is enhanced by their good resistance against beta and X-rays.
- Finally, PEEK fibers are free of halogens and are RoHS compliant, which makes them suitable for applications where recycling is important.

## THE FUTURE

Apart from the information presented in this paper, the PEEK fibers that are available from Performance Fibers now are only the beginning. Our R&D team is continuously investigating product improvements and our product specialists are looking forward to discussing your challenges or questions with you in order to find the right solution with Performance Fibers PEEK products.

**For more information on our products, availability, lead times or samples, please contact:**

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