



FLY **TOWARDS**  
**FUTURE** PERFORMANCE

PEEK POLYMER SOLUTIONS  
FOR THE AEROSPACE INDUSTRY



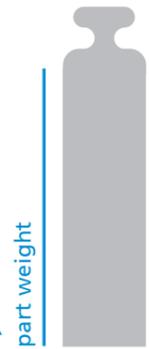
# FUTURE PERFORMANCE IN AEROSPACE



Fuel costs account for more than 35% of an airline's overhead. This volatile cost, along with fossil fuels being a limited natural resource, has put added pressure on aircraft manufacturers to deliver new levels of fuel efficiency. Analysts also believe that 35,000 new aircraft will be needed over the next 20 years in order to replace ageing fleets and to meet civilian flight demands. The industry is booming and airplanes need to fly off the assembly line to fulfill the backlog of orders. Aerospace engineers facing these challenges are seeking innovative technologies to develop fuel-sipping, easily-assembled, and low maintenance aircraft. One key to achieving this is metal replacement. Victrex has been working with leading companies for more than three decades to deliver PEEK polymer solutions that replace metals, thermosets and other plastics and can be found flying on more than 15,000 aircraft today. With our cutting-edge polymeric solutions and technical expertise, we can work together to soar past the obstacles of today into a brighter tomorrow.

**Reducing manufacturing and operating costs, helping the environment, improving assembly efficiency, and a reliable track record...that's future performance.**

# YOUR BENEFITS



**70%**

LIGHTER THAN METAL  
PROVIDING EQUIVALENT  
STRENGTH AND STIFFNESS

**\$5,000,000**

REMOVING 45 KG (100 LBS) ON 500  
AIRCRAFT RESULTS IN UP TO 5,000,000  
USD IN ANNUAL FUEL COST SAVINGS

## LIGHTER COMPONENTS

VICTREX® PEEK solutions are up to 70% lighter than metals while maintaining an equivalent strength and stiffness. Scrapping 45kg (100 lbs.) of metal per plane in a fleet of 500 can result in up to \$5,000,000 in fuel savings along with 17,000 tons of CO<sub>2</sub> emission reductions each year.

## SMARTER DESIGNS

Simplify, standardize, and consolidate parts by designing a highly-functional injection molded VICTREX PEEK component. Optimized components have led to 75% faster part assembly times. Our customers have realized faster cycle times and lower manufacturing costs with smarter thermoplastic designs.

## LONGER LIFE

An unscheduled production downtime for a single-aisle aircraft can cost \$120,000 per day. Whether it's aggressive aerospace fluids or a broad temperature range, VICTREX PEEK can help your parts survive the extremes and reduce maintenance cycles. Along with high mechanical properties and low fire, smoke, and toxicity emissions, these thermoplastic solutions can help achieve a new level of reliability.

**75%**

FASTER PART  
ASSEMBLY TIME



assembled planes

**15,000+**

PEEK FLYING ON MORE  
THAN 15,000 AIRCRAFT

## REST ASSURED

VICTREX PEEK has been specified by aerospace engineers from Airbus, Boeing, COMAC, the FAA, and military organizations for 25 years. Our solutions are flying on more than 15,000 aircraft today.

## ON-TIME DELIVERY

Our investment in a 70% capacity increase, a presence in more than 30 countries, and 3-7 day lead times shows our dedication to providing a stable supply chain for our customers.

# VICTREX PRODUCT PORTFOLIO

PERFORMANCE BY DESIGN

Victrex is the inventor of PEEK and has focused on developing high performance polymeric solutions for more than three decades. This dedication provides us with a wealth of polyketone knowledge that no other material supplier has. By working together, we can turn the toughest challenges into benefits.

**Our collaborative approach in providing only the most innovative and highest-quality solutions enables the industry to reach new heights today and tomorrow.**



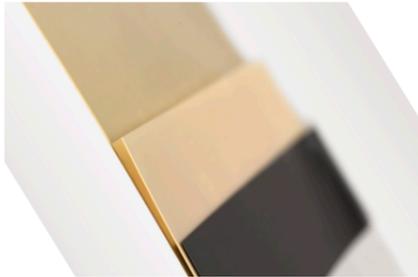
▲ VICTREX® PEEK

VICTREX® PEEK is THE metal replacement material that can enable optimum performance. Optimize the designs of your next-generation components to achieve significant weight savings with our vast portfolio of polymers.

 70% lighter vs. steel  
55% lighter vs. titanium  
40% lighter vs. aluminum

 Injection molding unfilled, carbon-fiber reinforced, and glass-filled grades

 Proprietary grades available to achieve thinner wall sections, higher modulus, and minimal wear



▲ APTIV® FILM

Take advantage of the properties of VICTREX® PEEK in a thin film format for demanding aerospace systems. By offering unmatched processing opportunities, APTIV film allows for the design of durable, lightweight solutions.

 Up to 60% lighter vs. polyvinyl fluoride (PVF) film

 Laminate, seal, weld, metallize, and many more

 Available in thicknesses from 5 to 750 microns



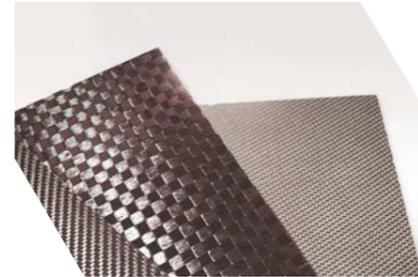
▲ VICTREX PIPEST™

Lightweight tubing manufactured from VICTREX® PEEK polymer can be used for protective sheathing, cable conduits and low pressure fluid transport systems. Benefit from the ability to custom design tubing systems to fit your spacing requirements.

 60% lighter vs. stainless steel  
45% lighter vs. titanium  
33% lighter vs. aluminum

 Bend, form, fit, flare, and clamp

 Excellent corrosion resistance and fire, smoke, and toxicity properties



▲ POLYMERS FOR COMPOSITES

Combine strength and light weight by specifying VICTREX® PEEK as a composite matrix material. This innovative technology allows engineers to design for the most demanding environments.

 Up to 70% lighter than metal alloys

 5x higher specific strength  
4x higher fatigue strength  
4x higher specific stiffness vs. aluminum

 Available in braid, fabric, flake, long fiber pellets, tow, and unidirectional tape and sheet



▲ VICOTE® COATINGS

Durable VICTREX® PEEK coatings enhance the lifetime of metal substrates while being friendly to the environment. Enhance the performance of your components with Victrex liquid and powder dispersions.

 Use a one-coat system for a smooth, uniform surface

 Excellent resistance to wear, abrasion, high heat, creep, and chemicals

 Halogen-free with no additives



# APPLICATIONS

RIGOROUSLY TESTED.  
CUSTOMER APPROVED.

Victrex collaborates with industry-leading companies to turn demanding challenges into benefits. We have seen it all from weight reduction goals and design optimizations to performance in harsh environments and system cost-downs.

Our PEEK expertise allows us to provide unmatched application development support to help in the manufacture of next-generation components.

**Involve us from the beginning – we can get there together.**



## CLAMPS AND STAND-OFFS

Amphenol PCD worked with our team to specify VICTREX® PEEK in system attachments for the Boeing 787. The lightweight, ergonomic, and highly durable design is helping engineers reach new heights.

- 20% weight reduction vs. metal
- 30% faster to install vs. metal
- Elimination of anti-corrosion treatments



## STRUCTURAL BRACKETS

Tri-Mack Plastics relies on composites made from VICTREX® PEEK for high-strength brackets. Efficient manufacturing and metal replacement are just a few of the benefits realized when specifying this solution.

- Up to 70% lighter vs. metal
- Manufacture parts in minutes compared to hours for thermosets
- Up to 5x higher mechanical properties vs. metal



## THERMAL ACOUSTIC INSULATION

Lamart chose APTIV® film for durable, flame resistant insulation systems. Realizing significant weight savings and providing safety for passengers is the definition of optimal performance.

- Up to 60% lighter vs. PVF film
- Film supplied in standard widths to meet aircraft insulation formats
- Passes latest FAA burn-through barrier and cover film laminate testing



## TUBING SYSTEMS

PFW Aerospace selected VICTREX Pipes™ for the cargo drainage system on the Airbus A350 XWB. The inaugural PEEK tubing system provided significant weight savings and helped to expedite the installation process.

- 33% lighter vs. metal
- Bend, flare, and form to meet spacing requirements
- Excellent corrosion resistance and low fire/smoke/toxicity emissions



## FASTENERS

Tiodize specified VICTREX® PEEK for its fastening components. Nuts, bolts, inserts and other fasteners provide lightweight joining and harnessing systems for critical aerospace components.

- Up to 80% lighter vs. metal
- Up to 4x higher fatigue strength vs. metal
- Better corrosion resistance and vibration dampening vs. metal



## CONNECTORS

Amphenol PCD designed a new lightweight connector from VICTREX® PEEK polymer. The durable polymer helps engineers reduce installation times while increasing the lifetime of the part.

- Up to 9% weight savings vs. metal
- Consolidated several clips into a one-piece component
- Passed requirements after being tested in 70°C (160°F) hydraulic fluid for 1,000 hours



**Blow Molded Ducting**  
Burn-Through Barriers for Cargo Holds  
**Burn-Through System Cover Film**  
Cable Conduit Tubing  
**Cable Ties and Harnesses**  
Cargo Door Nut Plate  
**Cargo Liner Support**  
Door Handles Drain Ports  
**Electric Wire Bundle Clamps**

Electrical Connectors  
**Mounts and Spacers**  
Electromagnetic Effects Spacers  
Engine Bearing Cages  
**Engine Seals** Engine Stators and Fans  
**Environmental Control Systems** Ducting Insulation  
**Fasteners** Floor Panels and Engine Nacelles/Housing

Fluid Sensor Housing **Fuel/Hydraulic Brackets**  
**Fuel Level Probe Brackets** Fuel Line Isolators  
Fuel Tank Manhole Covers **Fuselage Structures**  
**Impeller Blades** Inlet Guide Vanes  
Internal Laminates **Landing Gear Hubcaps**  
**Lightning Strike Protection Film Laminates**  
Low Pressure Ducting with Pressure Valves  
**Pylon Fairings** Quarter Turn Clips  
Radomes **Spanner Brackets**  
**Speed Sensors** Stand-offs

Thermal Acoustic  
Blanket Insulation Films  
**Tube Connectors and Fittings**  
Tubes, Ducts, and  
Convolute Tubing Tubing Clamps  
**Wall Panel Composite Structures**  
Water Separator Wire Coating  
**Wire Harness Protection Wire Labels**



# MATERIAL DATA

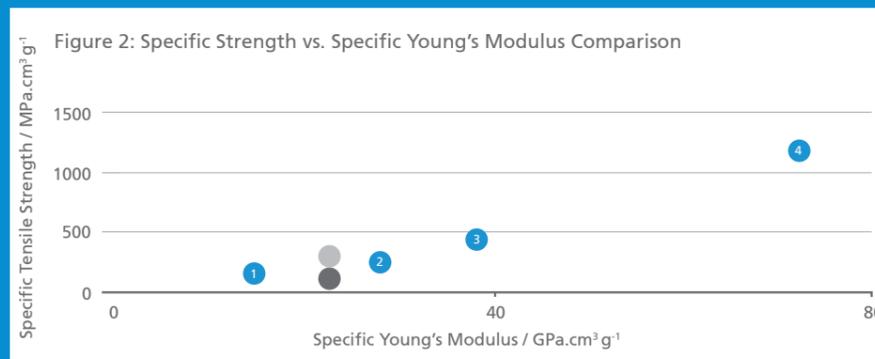
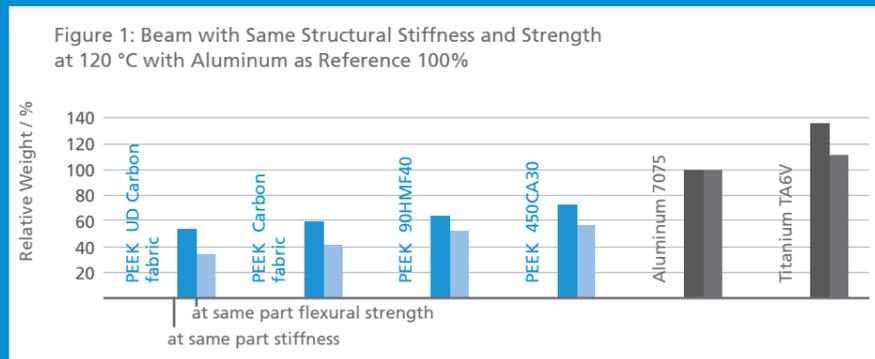
PERFECTION IS A SCIENCE

Take advantage of talking to the people that invented PEEK and can reference the largest polyketone database of testing in the world. Our scientists and engineers go the extra mile to make sure that our customers have all of the information they need when designing their critical components.

**We welcome the opportunity to use our three decades worth of knowledge to help speed up your application developments.**

## HIGH MECHANICALS AT LIGHTER WEIGHTS

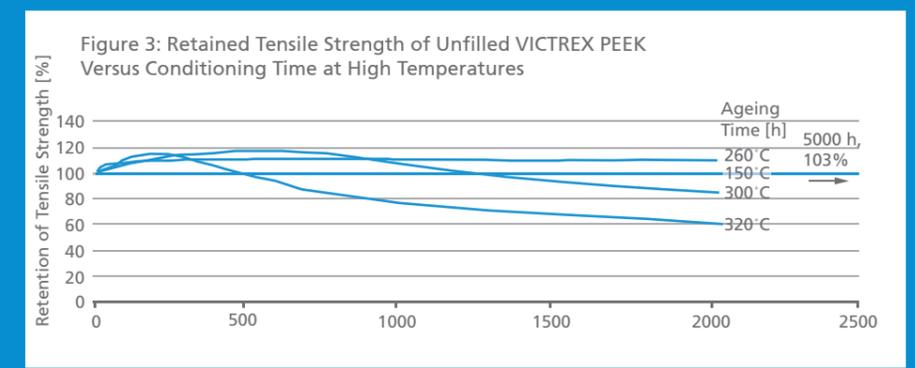
VICTREX PEEK 90HMF40 injection molding grade and VICTREX PEEK-based composites can provide engineers with equal part stiffness and strength at up to 55% lighter weights when compared to aerospace metals as seen in Figures 1 and 2.



- 1 VICTREX PEEK 450CA30
- 2 VICTREX PEEK 90HMF40
- 3 VICTREX PEEK Carbon Fabric
- 4 VICTREX PEEK UD Carbon Tape
- Aluminum 7075\*
- Titanium TI-6Al-4V\*

## STABILITY ACROSS BROAD TEMPERATURE RANGE

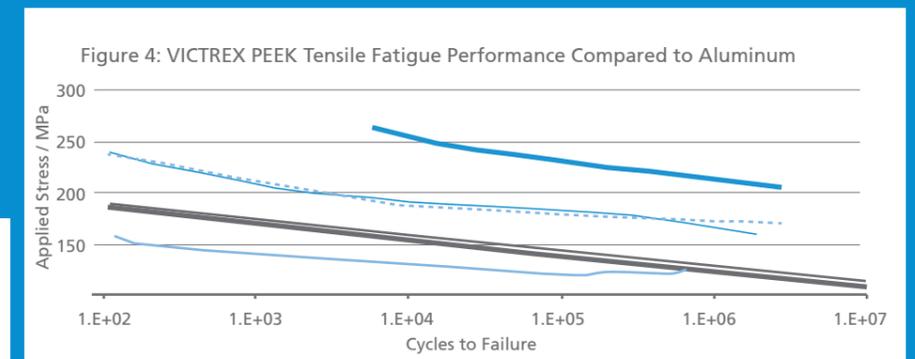
With some applications enduring long-term exposure to high temperatures, VICTREX PEEK is able to maintain its tensile strength with no performance loss over 5,000 hours at 260°C (500°F). (Figure 3). VICTREX PEEK also exhibits high mechanical properties at extremely low temperatures down to -65°C (-85°F).



## FATIGUE RESISTANCE

VICTREX PEEK 90HMF40 polymer provides up to 100x longer fatigue life than typical aerospace aluminum alloys as seen in Figure 4.

- VICTREX PEEK 450CA30 (120°C)
- VICTREX PEEK 450CA30 (23°C)
- VICTREX PEEK 90HMF40 (120°C)
- VICTREX PEEK 90HMF40 (23°C)
- Aluminum 7075 T7351\*
- Aluminum 2024 T3\*



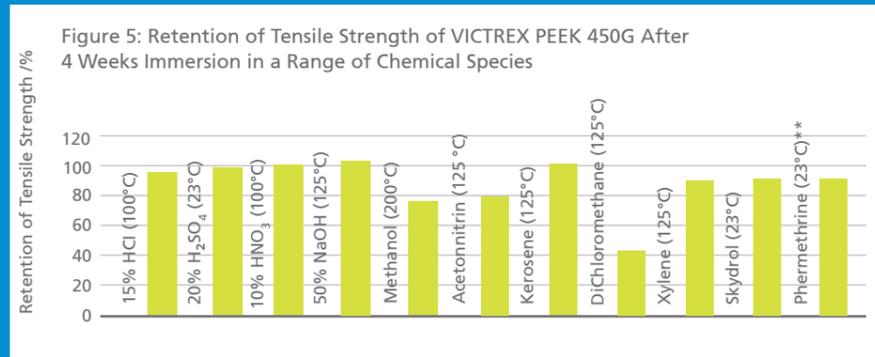
\*THE ALUMINIUM DATA IS TAKEN FROM CES SELECTOR 2012 FROM GRANTA DESIGN LIMITED

# MATERIAL DATA

PERFECTION IS A SCIENCE

## CHEMICAL RESISTANCE

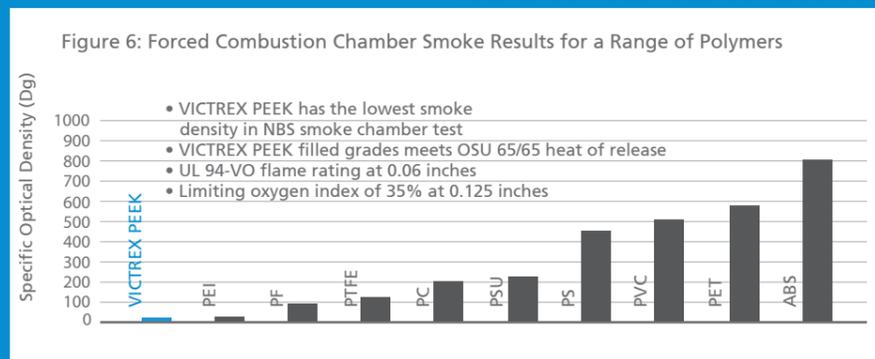
VICTREX PEEK is widely regarded as having excellent resistance to chemicals over a wide temperature range as seen in Figure 5. VICTREX PEEK has also been specified in areas that are exposed to insecticides as the chemical compound can cause damage to critical components made from other plastics such as PEI.



\*\*VICTREX PEEK 151G IMMERSED IN PERMETHRINE AT 23°C FOR 10 DAYS

## LOW FIRE, SMOKE AND TOXICITY RATING

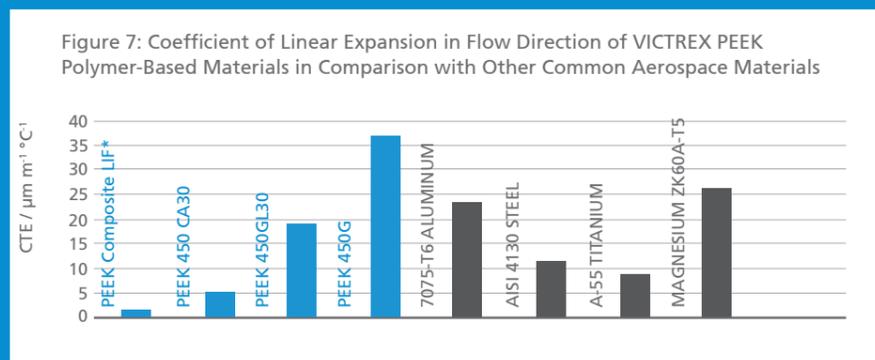
VICTREX PEEK performs well when subjected to fire due to it being inherently flame retardant. When compared to other plastic materials, this thermoplastic has the lowest value of specific optical density of all the materials tested (Figure 6).



- VICTREX PEEK has the lowest smoke density in NBS smoke chamber test
- VICTREX PEEK filled grades meets OSU 65/65 heat of release
- UL 94-VO flame rating at 0.06 inches
- Limiting oxygen index of 35% at 0.125 inches

## DIMENSIONAL STABILITY

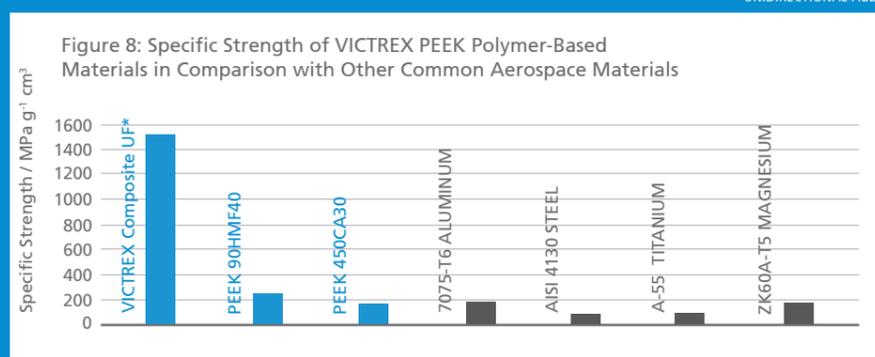
Filled VICTREX PEEK grades are comparable to metals in that polymers reduce the coefficient of expansion ultimately leading to less risk arising due to differential expansion.



\*UNIDIRECTIONAL FIBERS

## HIGH STRENGTH-TO-WEIGHT RATIO

Reinforcing VICTREX PEEK with chopped glass or carbon fibers helps the material meet or exceed the strength and stiffness of aerospace metals. This thermoplastic also delivers high mechanical properties well past the glass transition temperature due to its semi-crystalline structure (Figure 8).



\*UNIDIRECTIONAL FIBERS

PROPERTY	CONDITIONS	TEST METHOD	UNITS	VICTREX PEEK 450G (unfilled)	VICTREX PEEK 150GL30 (glass filled)	VICTREX PEEK 150CA30 (carbon filled)	VICTREX PEEK 90HMF40
<b>GENERAL</b>							
Density	Crystalline	ISO 1183	$\text{g/cm}^3$	1.30	1.52	1.40	1.45
	Amorphous	ISO 1183		1.26			
Water Absorption (3.2 mm thick tensile bar)	24h, 23°C	ISO 62-1	%	0.07	0.04	0.04	0.03
	Equilibrium, 23°C			0.40	0.30	0.30	0.30
<b>MECHANICAL</b>							
Tensile Strength	Break, 23°C (Yield*)	ISO 527	MPa	100*	190	260	330
	Break, 125°C (Yield*)			50*	115	150	220
	Break, 225°C (Yield*)			13*	55	70	
Tensile Elongation	Break, 23°C	ISO 527	%	45	2.5	1.5	1.2
Flexural Strength	23°C	ISO178	MPa	165	280	360	480
Flexural Modulus	23°C	ISO 178	GPa	4.1	11.5	24	37
Izod Impact Strength	0.25 mm notch, 23°C	ISO 180/A	$\text{kJ/m}^2$	7.5	9.0	7.0	10.5
	Unnotched, 23°C	ISO 180/U		no break	50	40	60
<b>THERMAL</b>							
Melting Point		ISO 11357	$^\circ\text{C}$	343	343	343	343
Glass Transition (Tg)		ISO 11357	$^\circ\text{C}$	143	143	143	143
Specific Heat Capacity	23°C	DSC	$\text{kJkg}^{-1} \text{ } ^\circ\text{C}^{-1}$	2.2	1.7	1.8	1.8
Coefficient of Thermal Expansion	Along flow below Tg	ISO 11359	$\text{ppm/ } ^\circ\text{C}$	45	20	5	3.0
	Average below Tg			55	45	40	35
	Along flow above Tg			120	20	6	1.0
	Average above Tg			140	110	100	80
Heat Deflection Temperature	1.8 MPa	ISO 75A-f	$^\circ\text{C}$	152	335	339	349
Thermal Conductivity	23°C	ISO 22007-4	$\text{W/mK}$	0.29	0.30	0.95	2.0
Continuous Use Temperature	Electrical	UL 746B	$^\circ\text{C}$	260	240		
	Mechanical w/o impact			240	240	240	
	Mechanical w/impact			180	220	200	
<b>FIRE, SMOKE AND TOXICITY</b>							
Flammability Rating		UL94	n/a	V-0 @ 1.5 mm	V-0 @ 0.5 mm	V-0 @ 0.5 mm	
Limiting Oxygen Index	0.4 mm thickness	ISO 4289	%O <sub>2</sub>	24			
	3.2 mm thickness			35			
<b>ELECTRICAL</b>							
Dielectric Strength	2.5 mm thickness	IEC 60243-1	$\text{kV/mm}$	16	17		
	50 $\mu\text{m}$ thickness			190			
Loss Tangent	23°C, 1MHz	IEC 60250	n/a	0.003	0.004		
Dielectric Constant	50Hz, 0-150°C	IEC 60250	n/a	3.2	3.3		
	50Hz, 200°C	IEC 60250		4.5			
Volume Resistivity	23°C	IEC 60093/ ASTM D4496	$\Omega\text{cm}$	$10^{16}$	$10^{16}$	$10^5$	$10^5$



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Victrex is an innovative world leader in high performance polymer solutions with products sold under the brand names of VICTREX® PEEK, VICOTE® Coatings, APTIV® film and VICTREX Pipes™. With production facilities in the UK backed by sales and distribution centers serving more than 30 countries worldwide, our global sales and technical support services work hand-in-hand with OEMs, designers and processors offering assistance in the areas of processing, design and application development to help them achieve new levels of cost savings, quality, and performance.

[www.victrex.com](http://www.victrex.com)

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