



victrex®

PASSION • INNOVATION • PERFORMANCE

Painel Aeroespacial

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11 3048-4140

Victrex Overview

30 Years of Innovation, Investment & Quality

- World leader in the fully integrated production and sales of **only** high performance polyaryletherketones materials (PEEK)
- Global company with its HQ and production in the UK
- Sales, marketing and technical teams serving more than 30 countries worldwide
- Alignment with customers to develop new applications for high performance polymers, supported by extensive application technology and expertise
- Technology centers in China and the UK

Passionately exploring new products, applications, and business opportunities – creating the future!



Global Organization

Victrex USA Inc.
Philadelphia

Victrex plc.
Hillhouse, UK
Victrex Manufacturing. Ltd.
Victrex Sales Ltd.



Victrex Europa GmbH
Hofheim, Germany

Victrex Japan Inc
Tokyo

Shanghai

- Asia HQ
- Asia Innovation and Tech Center



- ✕ World Headquarters & Global Technology Centre
- Technology Centres
- ▲ Sales Offices
- △ Distributors
- Subsidiaries

Serving customers globally





HIGH PERFORMANCE PEEK™ POLYMERS

PRODUCT SUMMARY

VICTREX® PEEK™ POLYMERS

Unfilled Grades

VICTREX® PEEK™ 90G	Easy flow grade for injection molding of thin sections and complex parts
VICTREX® PEEK™ 150G	Easy flow grade for injection molding of thin sections and complex parts
VICTREX® PEEK™ 450G	Standard flow general purpose
VICTREX® PEEK™ 450G903 Blk	Standard flow general purpose — black color

Depth-Filtered Grades

VICTREX® PEEK™ 151G	Easy flow for multi and monofilament extrusion
VICTREX® PEEK™ 381G	Standard flow for wire coating, capillary tubing, film and monofilament extrusion

Glass-Filled Grades

VICTREX® PEEK™ 90GL30	Very easy flow, 30% glass fiber reinforced
VICTREX® PEEK™ 90GL60	Standard flow, 60% glass fiber reinforced
VICTREX® PEEK™ 150GL15	Very easy flow, 15% glass fiber reinforced
VICTREX® PEEK™ 150GL30	Easy flow, 30% glass fiber reinforced
VICTREX® PEEK™ 150GL30 Blk	Easy flow, 30% glass fiber reinforced — black color
VICTREX® PEEK™ 450GL15	Standard flow, 15% glass fiber reinforced
VICTREX® PEEK™ 450GL30	Standard flow, 30% glass fiber reinforced
VICTREX® PEEK™ 450GL30 Blk	Standard flow, 30% glass fiber reinforced — black color

Carbon Fiber Reinforced Grades

VICTREX® PEEK™ 90CA30	Very easy flow, 30% carbon fiber reinforced
VICTREX® PEEK™ 150CA30	Easy flow, 30% carbon fiber reinforced
VICTREX® PEEK™ 450CA20	Standard flow, 20% carbon fiber reinforced
VICTREX® PEEK™ 450CA30	Standard flow, 30% carbon fiber reinforced
VICTREX® PEEK™ 450CA40	Standard flow, 40% carbon fiber reinforced
VICTREX® PEEK™ 90HMF20	Very easy flow, superior mechanical performance, 20% carbon fiber reinforced
VICTREX® PEEK™ 90HMF40	Easy flow, superior mechanical performance, 40% carbon fiber reinforced

Ultra-High Purity Grade

VICTREX® PEEK™ 450U002	Reduced extractable ionics for use in fluid streams, vacuums or high heat environments
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Friction and Wear Grades

VICTREX® PEEK™ 150FC30	Easy flow, filled with 30% carbon fiber, PTFE and graphite
VICTREX® PEEK™ 150FW30	Easy flow, filled with 30% carbon fiber and PTFE
VICTREX® PEEK™ 450FC30	Standard flow, filled with 30% carbon fiber, PTFE and graphite
VICTREX® PEEK™ 450FE20	Standard flow, filled with 20% PTFE

VICTREX® PEEK-HT™ Grades

VICTREX® PEEK-HT™ G22	Higher temperature performance unfilled resin
VICTREX® PEEK-HT™ 22CA30	30% carbon fiber reinforced PEEK-HT resin, for improved strength and stiffness at elevated temperatures
VICTREX® PEEK-HT™ 22GL30	30% glass fiber reinforced PEEK-HT resin, for improved strength and stiffness at elevated temperatures

VICTREX® T-Series™ Grades

VICTREX® T-Series™ TU-60	Unreinforced blend of PEEK and Celazole* PBI, for higher strength and stiffness at elevated temperatures, improved wear
VICTREX® T-Series™ TF-60V	Glass fiber reinforced blend of PEEK and Celazole* PBI, for higher strength and stiffness at elevated temperatures, improved wear
VICTREX® T-Series™ TL-60	Self lubricating blend of PEEK and Celazole* PBI, for tribological applications at elevated temperatures, speeds and pressures.
VICTREX® T-Series™ TF-60C	Carbon fiber reinforced blend of PEEK and Celazole* PBI, for higher strength and stiffness at elevated temperatures, improved wear

VICTREX® ST™ Grades

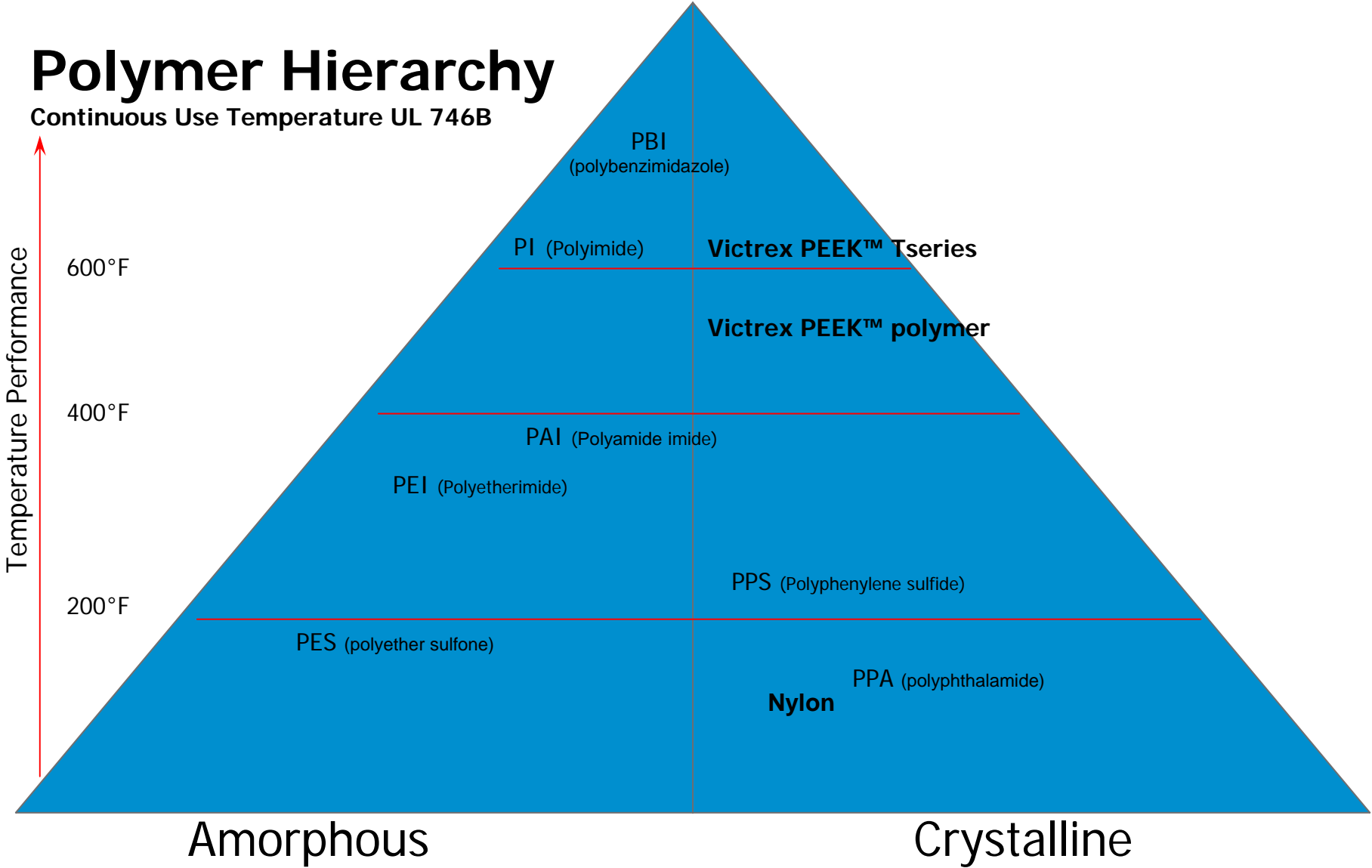
VICTREX® ST™ STG45	Higher temperature performance than PEEK-HT, improved mechanical performance at elevated temperatures
VICTREX® ST™ ST45GL30	30% glass fiber reinforced ST resin, for improved strength and stiffness at elevated temperatures

*Celazole is a registered trademark of PBI Performance Products



Polymer Hierarchy

Continuous Use Temperature UL 746B



VICTREX® PEEK™ Products



HIGH PERFORMANCE PEEK™ POLYMERS



VICOTE™
COATINGS

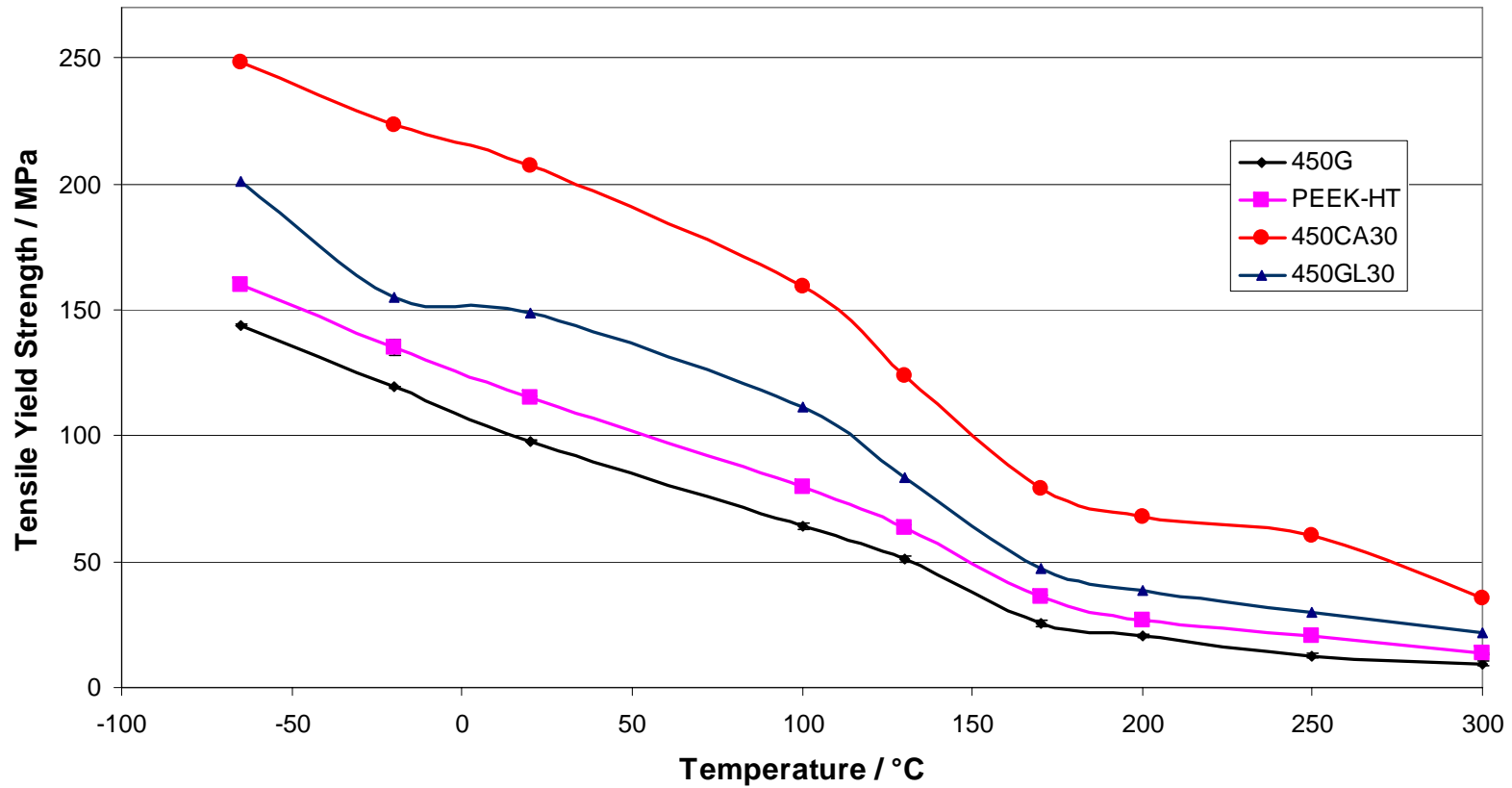


aptiv™

VICTREX® PEEK™ FILM TECHNOLOGY



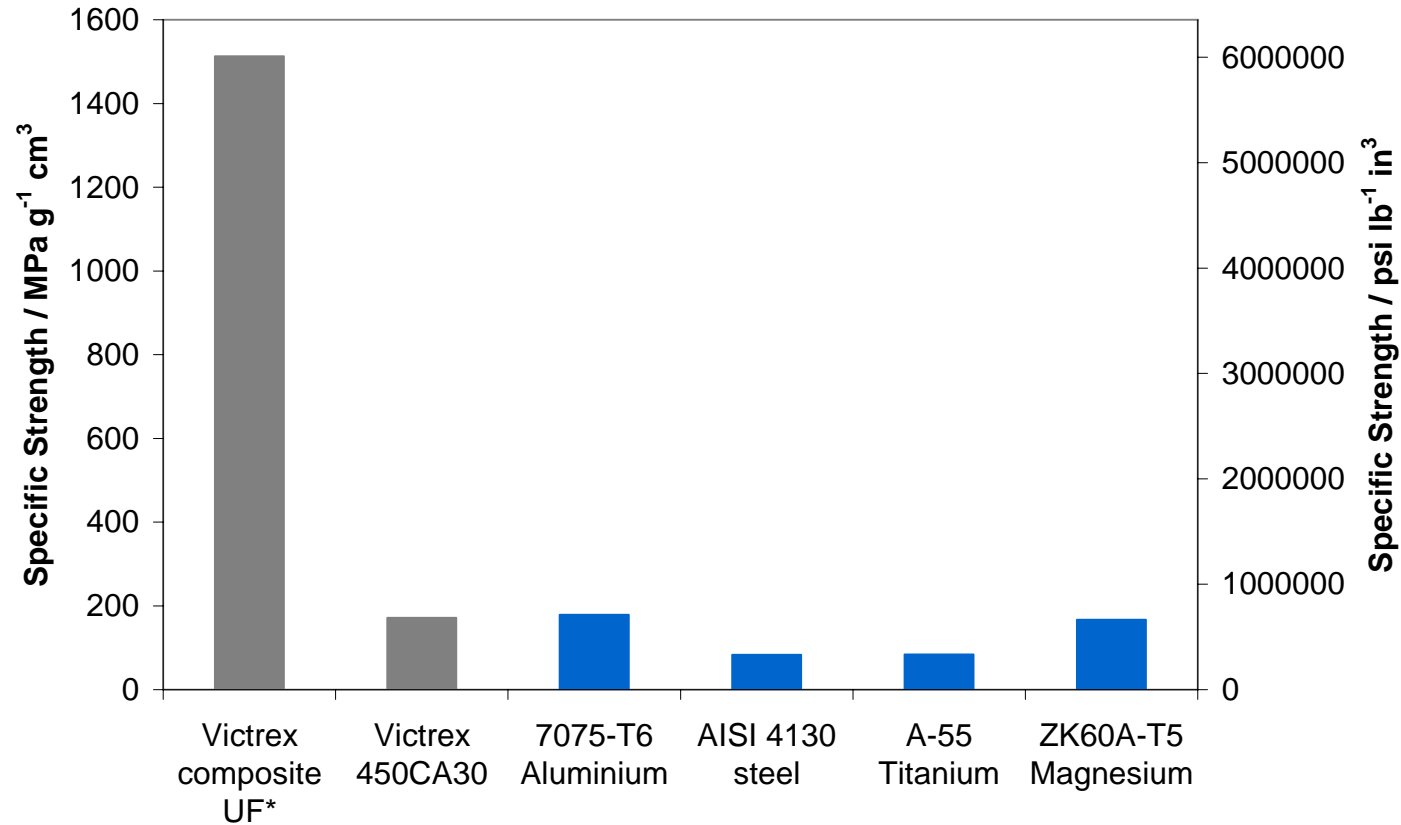
Yield Strength as a Function of Temperature for VICTREX PEEK and Related Compounds



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Specific Strength of Common Aerospace Materials

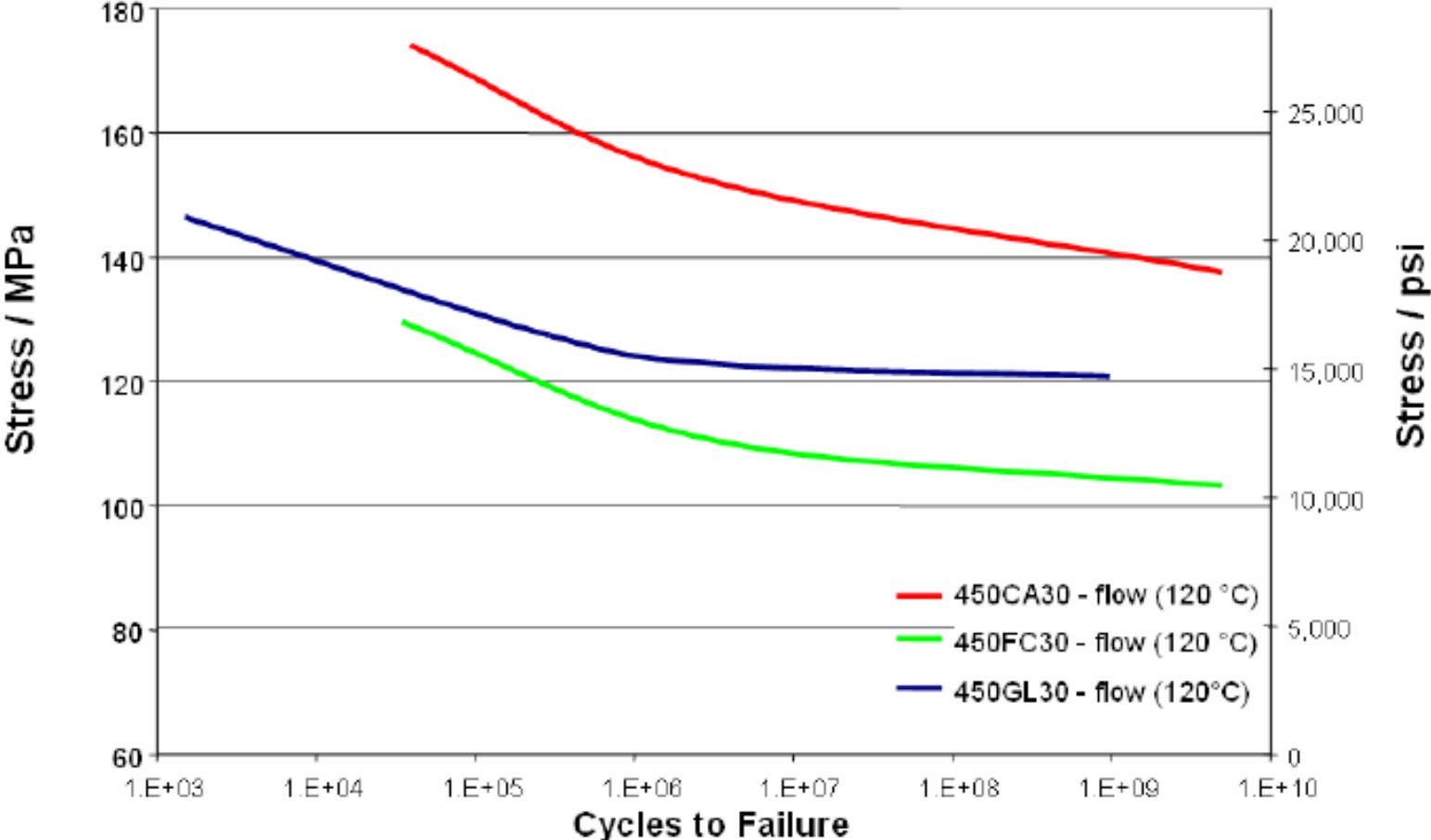


UF* - Unidirectional Fibres

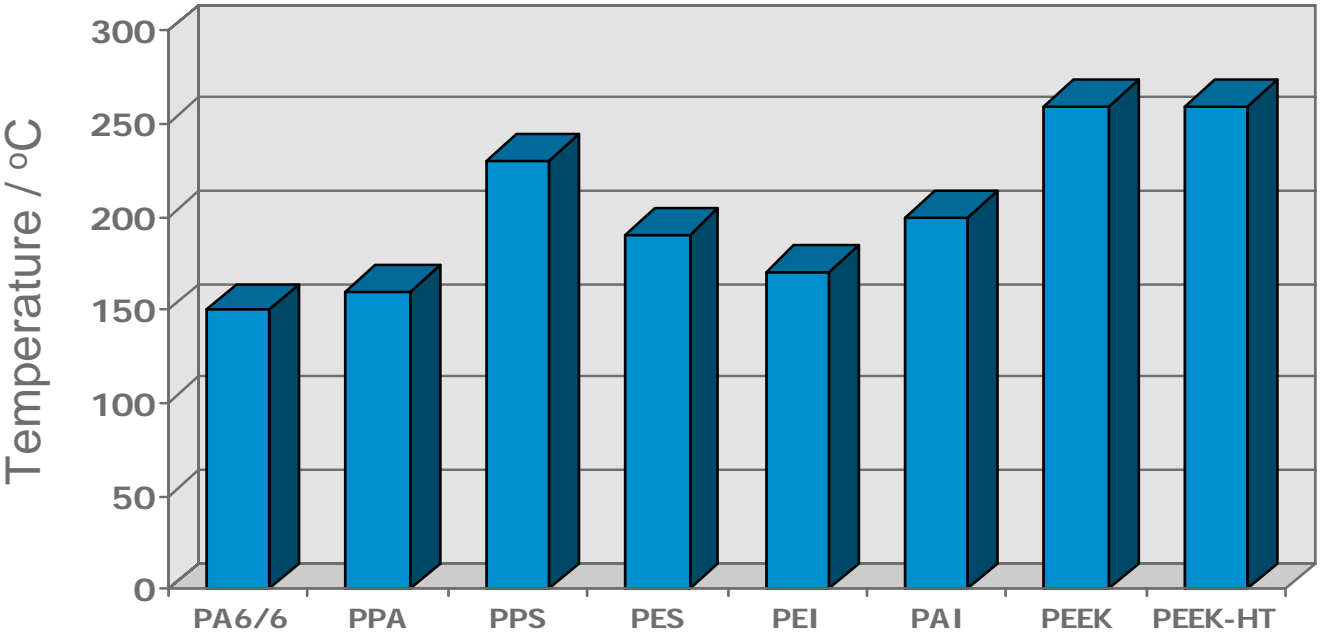
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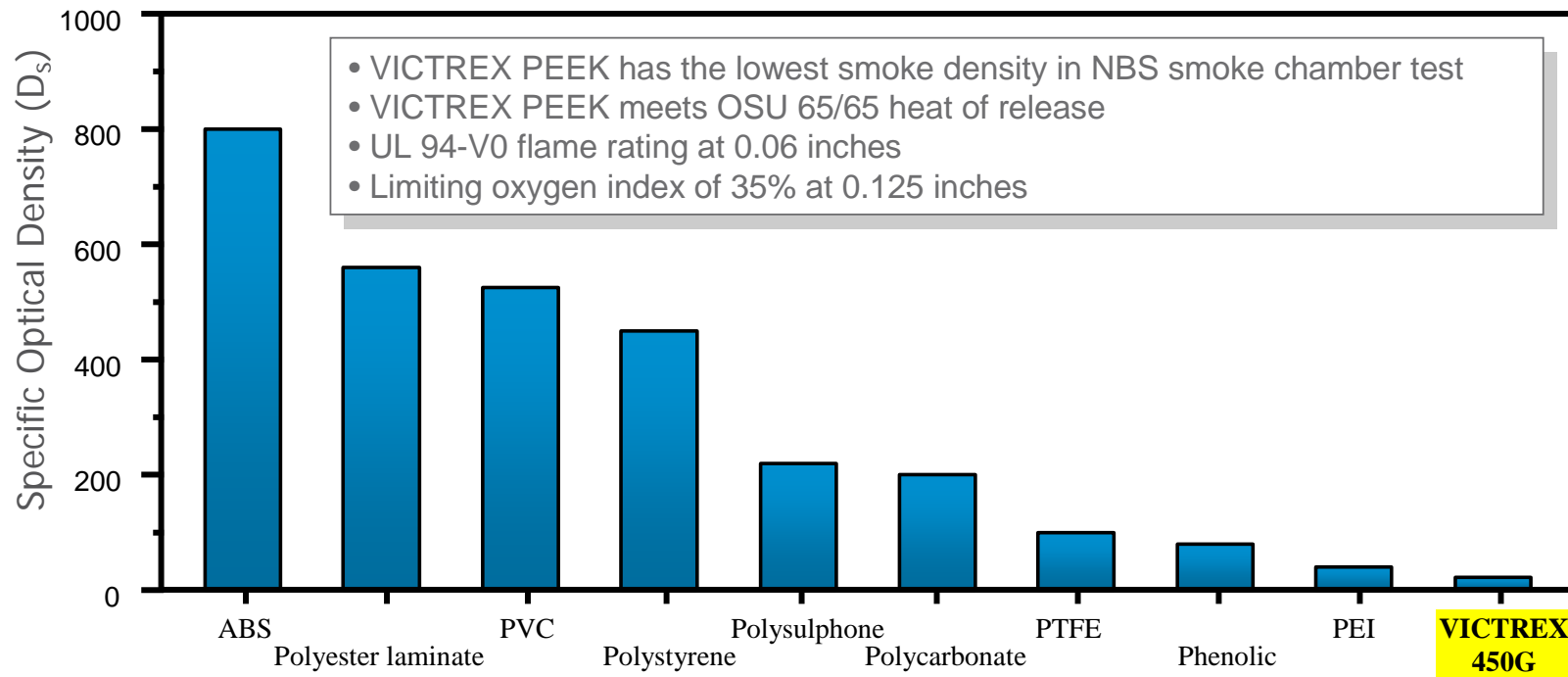
Flex fatigue, 120 °C (248 °F), 25 Hz



Relative Thermal Index (RTI) Values as Measured by UL 746

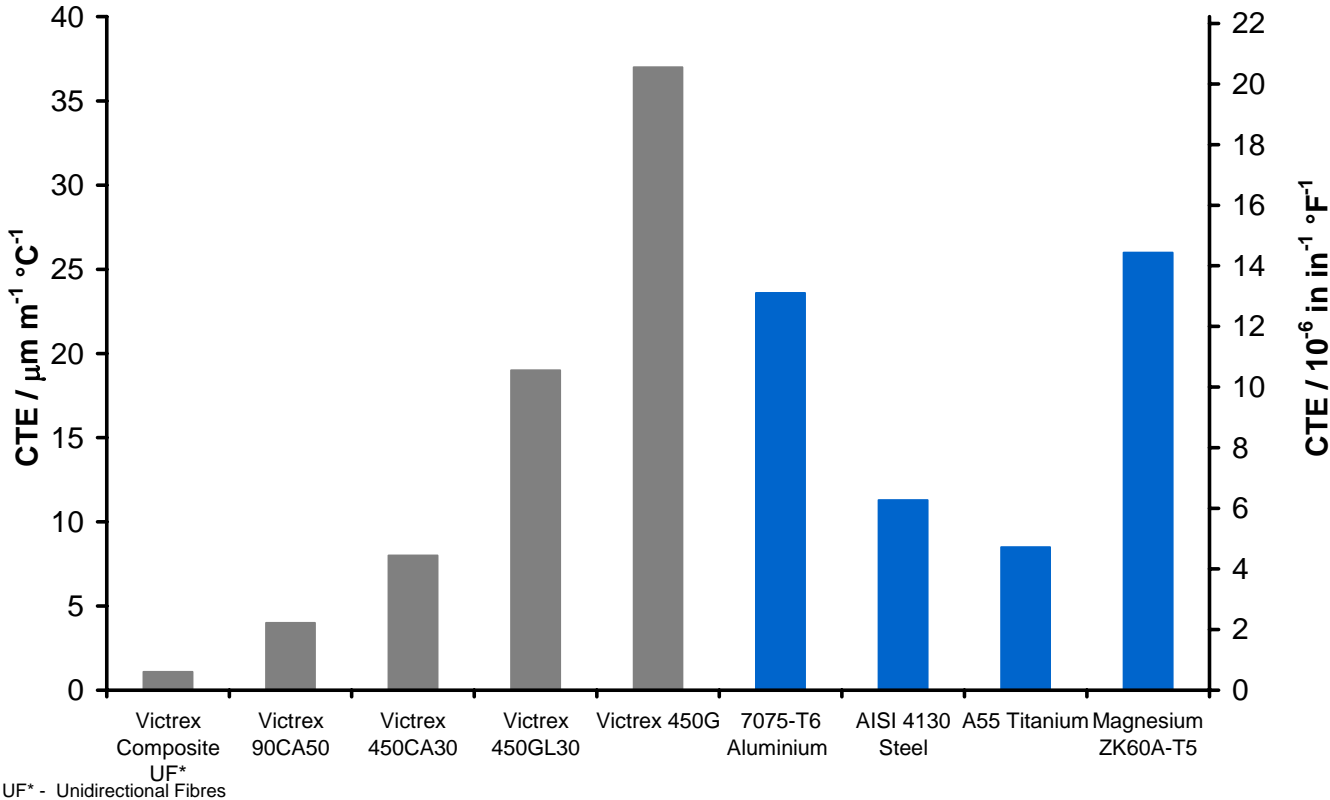


Forced Combustion Chamber Smoke Data for a Range of Polymers



Specific Optical Density ASTM E662 Flaming mode for a 3.2 mm thick sample

Coefficient of Linear Thermal Expansion for Common Aerospace Materials



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Specifications

Victrex® PEEK™ Polymer Specifications and Approvals. Victrex® PEEK™ polymer and compounds are recognised or approved by the following bodies:

Aerospace/Military	
FAR25-25853B	Victrex® PEEK™ 381G & 450G meet the fire, smoke and toxicity standard FAR 25-25853 for aircraft cockpit use.
ATS 1000.001	Victrex® PEEK™ 381G & 450G meet the fire, smoke and toxicity standard ATS 1000.001 for optical density and toxicity of fumes from burning.
SP-R-0022A	Victrex® PEEK™ 450G meets the NASA standard SP-R-0022A for vacuum stability of polymeric materials in spacecraft applications.
BMS 8-317A	Victrex® PEEK™ unfilled glass and carbon filled polymers can be supplied to Boeing specification BMS 8-317A for use in aircraft applications.
MIL-P-46183	Victrex® PEEK™ polymer and compounds can be supplied to the military specification MIL-P-46183.
Staining Test	Victrex® PEEK™ 381G complies with the Boeing Aircraft staining test.
#DMSRR 1018	Victrex® PEEK™ CA30 complies with the Rolls Royce standard #DMSRR 1018.
75-T-2-3007-4-1	Victrex® PEEK™ CA30 meets the Deutsche Aerospace/Airbus standard 75-T-2-3007-4-1.
MS29.02.03	Victrex® PEEK™ 450GL30 complies with the Sundstran Aerospace materials specification MS29.02.03.
JAR 25.853	Victrex® PEEK™ 381G meets the fire, smoke and toxicity standard JAR 25.853 for flame resistance.
S26 4625	Victrex® PEEK™ 381G meets the fire, smoke and toxicity standard S26 4625 for non-flaming smoke generation.
VPRM85-10A	Victrex® PEEK™ 381G meets the fire, smoke and toxicity standard VPRM85-10A for peak and total heat release when heated.
299-947-362	All grades of Victrex® PEEK™ polymer meet Bell Helicopter specification 299-947-362.
P6240	All grades of Victrex® PEEK™ polymer meet General Dynamics specification P6240.
HS13534	Victrex® PEEK™ 450FC30 meets Hamilton Standard (United Technologies) specification HS13534.
Flammability Rating	
Underwriters Laboratories V-0	Victrex® PEEK™ 450G and compounds 450GL30 and 450CA30 have an Underwriters Laboratories V-0 rating at .067 in. (1.45mm) thickness

Process Update

Injection Molding

- High production volumes
- Tight tolerances
- Easy processing
- Many different grades
- No secondary operation
- Parts consolidation



VICTREX PEEK Extrusion

- Usually for small volumes of production
- Good solution for machining parts
- Many standard dimensions in rods, tubes and plaques
- Different grades available
- No investments in prototype tooling in concept phase



VICOTE™ PEEK Coatings

- Liquid dispersions and powder coatings
- Many additive options
- Key Benefits:
 - Corrosion protection
 - Abrasion resistance
 - Lubricity (non-stick)
- Applications:
 - Landing gear
 - Galley / lavatory
 - Bearings, bushings



APTIV™ PEEK Film & Tape

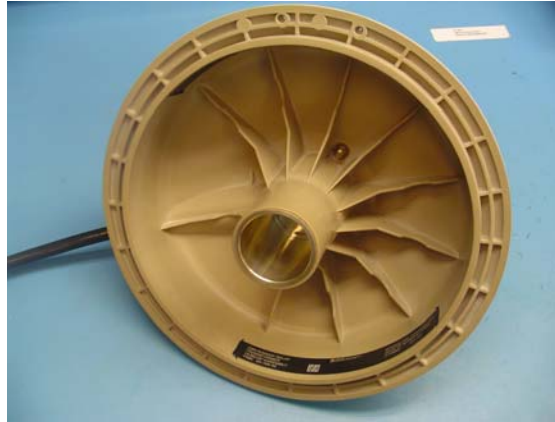
- Extruded PEEK 381G, 450G
- Amorphous, Crystalline
- Key benefits:
 - Electrical insulation
 - Thermal/acoustic insulation
 - Moisture stability
- Applications:
 - Insulation cover films
 - Lighting, transformers
 - Duct wrap
 - Wear surfaces



Application Case Studies

- Exterior – unpressurized zone
- Interior – pressurized zone
- Complementary systems

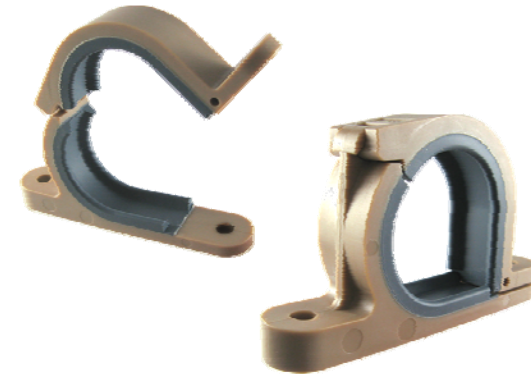
Landing Gear Hubcaps



Benefits of VICTREX PEEK 450GL30 *(courtesy of Crane Aerospace & Electronics)*

- weight reduction
- wide temperature range of operation (-54°C at altitude, $> 200^{\circ}\text{C}$ on braking)
- mechanical properties to resist repeated hard landings
- resistance to impacts from flying debris
- chemical resistance to jet fuel, hydraulic fluid, and de-icing solution
- resistance to ozone
- paintable for appearance and enhanced UV resistance

Electric Wire Bundle and Tubing Clamps



Benefits of VICTREX PEEK 150GL30

(courtesy of Amphenol PCD)

- weight reduction by a minimum of 20%
- part count is reduced by consolidating parts
- standardising on a consistent design throughout
- VICTREX PEEK is completely non-corrosive and non-conductive
- scalable design available in a range of sizes: 15 P-clamps, 12 Omega clamps
- compatible with wire bundles or tubes from 6 mm to 50 mm diameter

Electrical Installation Stand-offs



(courtesy of Amphenol PCD)

Benefits of VICTREX PEEK 150GL30

- non-conductive
- non-corrosive
- weight saving minimum of 20%
- chemical resistance
- fatigue properties
- mechanical properties

Thermal Acoustic and Burn-through Insulation Cover Films



Benefits of APTIV Film made with VICTREX PEEK polymer

- Polyester films originally used to encapsulate fiberglass batting
- Polyester did not meet the fire performance required by FAR 25.856(a)+(b)
- Polyester replaced with PVF which has increased thickness and weight
- Victrex introduces 6 micron PEEK film: APTIV 2000-006
- APTIV based cover film offers 50-60% weight reduction versus PVF
- In qualification for both TAB and Burn-through insulation, sealing tapes

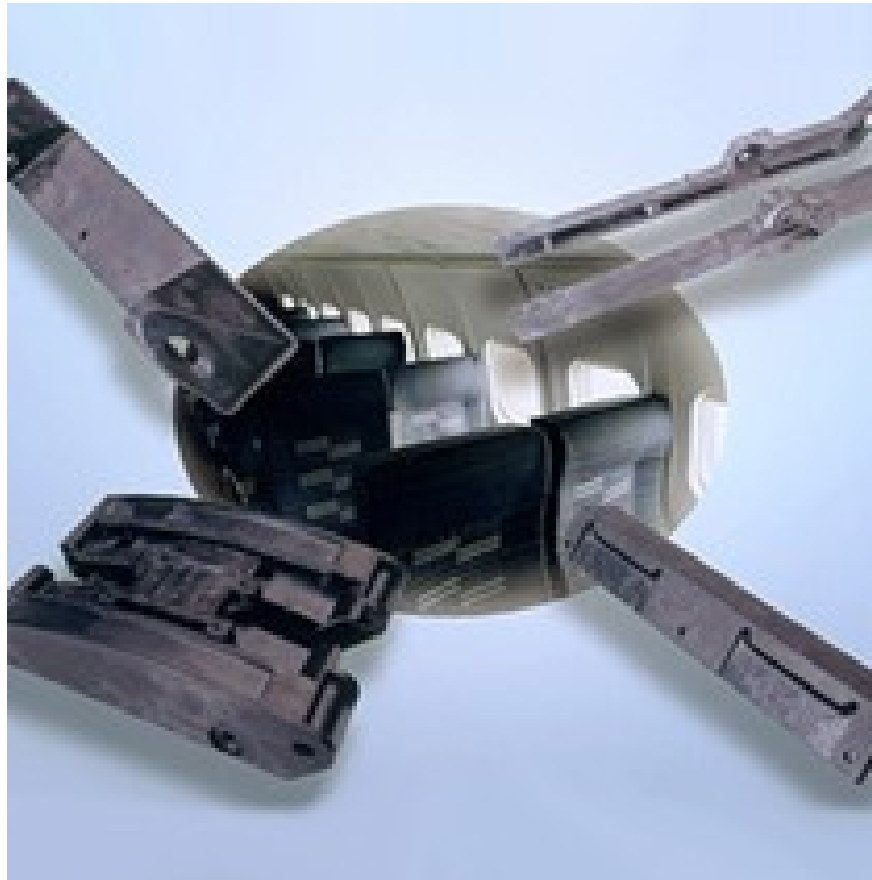
Door handles



(courtesy of KTR)

Benefits of VICTREX PEEK 150CA30 and 150GL30

- Compliance with Aircraft safety standards
- Outstanding mechanical strength, creep and fatigue resistance
- Low specific weight
- Replacing metal die cast
- Easy processing
- Extended service life
- Cost reduction



Details

**System: seat
application:**

**head rest, lumbar support, guide for
safety belt**

grade:

PEEK™ 450CA30/GL30

substitutes:

Mg-alloy

requirements

- highest elastic recovery after crash
- thermal performance
- flammability

PEEK™ benefits

- passenger safety
- weight reduction
- easy processing
- cost reduction



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PEEK COMPOSITE



THERMOPLASTIC COMPOSITE - WHAT IS IT?

DEFINITION

•A thermoplastic composite prepreg is made of carbon, glass, aramid long(>10 mm) or **continuous fibers** reinforcing a wide range of thermoplastic resin matrix, including PEEK, PEI, PPS, PA, PP, PE, PMMA, among others. These are introduced following different main products forms in the market:

- Unidirectional tape
- Dry fabrics
- Multiaxial fabrics (NCF: Non-crimp fiber)
- Braid
- Tow
- Laminated sheets

Main mechanical properties

PROPERTIES @ 23°C < T < 120°C	PEEK UD Carbon Tape	PEEK Carbon Fabric	PEEK UD glass Tape
Tensile Properties			
Tensile Strength	>2000 MPa (280 ksi)	> 1900 MPa (275 ksi)	> 1100 MPa (160 ksi)
Tensile strain at break	>1,35 %	> 1,2 %	> 1,5 %
Tensile Modulus	>135 GPa (20 Msi)	>120 GPa (18 Msi)	> 60 GPa (9 Msi)
Compressive Properties			
Compressive Strength	>1150 MPa (165 ksi)	> 1000 MPa (145 ksi)	> 1000 MPa (145 ksi)
Compressive Modulus	> 120 GPa (18 Msi)	> 110 GPa (16 Msi)	> 55 GPa (8 Msi)
Flexural Properties			
Flexural Strength	> 1750 MPa (250 ksi)	> 1700 MPa (245 ksi)	> 1500 MPa (220 ksi)
Flexural Modulus	> 120 GPa (18 Msi)	> 110 GPa (16 Msi)	> 55 GPa (8 Msi)
<p><i>The figures contained in this table are given for guidance purpose only . VICTREX PLC reserve themselves the right to proceed to any modification aiming to improve the quality of their information .</i></p>			

Comparison to Metals

Figure 1: Density Comparison

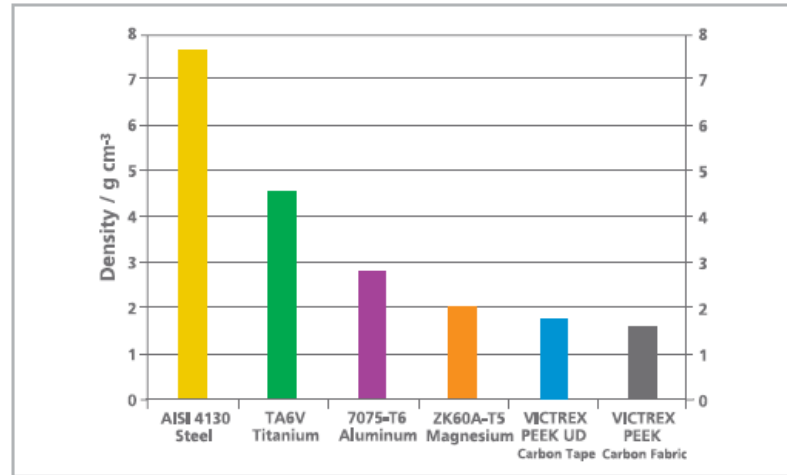
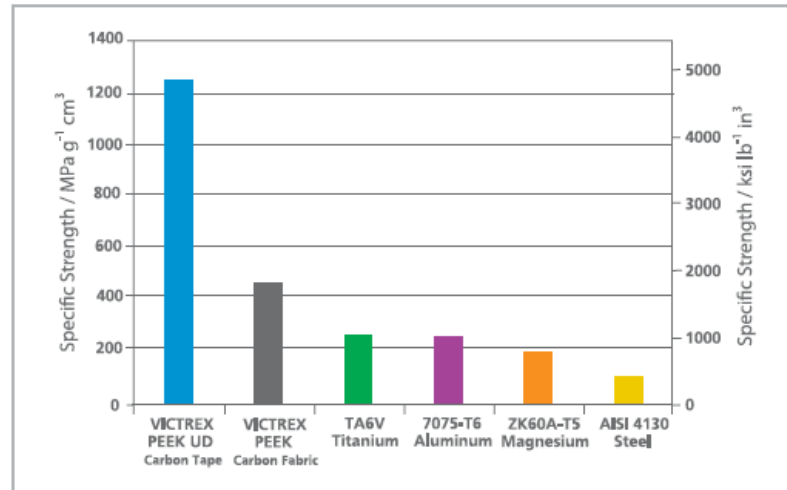
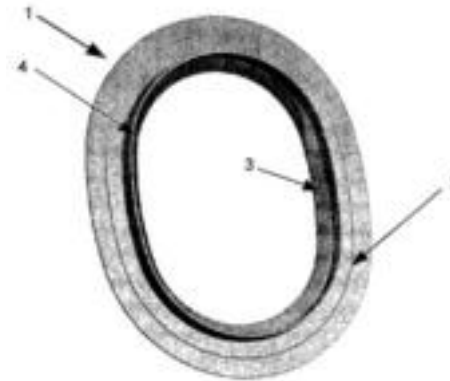


Figure 2: Specific Strength



VICTREX® PEEK composites

- VICTREX PEEK matrix for composite prepregs
- Material Forms:
 - Unidirectional tape, ribbon
 - Fabrics
 - Consolidated sheet
- Key Benefits:
 - Stiffness-to-weight ratio
 - Hoop & shear strength
 - Toughness
- Applications:
 - Aircraft structures
 - Bearings, bushings, washers
 - Drive shafts



Prepregs

Standard Composite Material available

- **UD Carbon or glass tape/ VICTREX PEEK**
 - Width to 300 mm
 - Area fiber weight: 145 to 220 g/m²
 - Weight resin content: 30-50%

- **Fabric carbon or glass tapes (balanced or UD)**
 - Width to 1600 mm
 - Area fiber weight: 100 to 400 g/m²
 - Weight resin content: 30-50%

Conclusion

- Victrex has over 25 years accumulated experience in the application and processing of Poly(Aryl Ether Ketones)
- Comprehensive material qualifications and over 20 years in service in both military and commercial aircraft have proven VICTREX PEEK performance
- History of working closely with endusers and channel partners to ensure design process is successful and the product is manufactured to the highest standards



Thank you!

victrex[®]

ONE TEAM
NO LIMITS!