

DRIVING
INNOVATION
IN **POWERTRAIN**
APPLICATIONS

WITH VICTREX™ PEEK POLYMER SOLUTIONS



PUSHING THE BOUNDARIES TO IMPROVE VEHICLE PERFORMANCE

With increasing demands around CO₂ emissions, safety and electrification, automotive manufacturers are facing pressures to improve fuel efficiencies and vehicle performance without compromising reliability, costs or driving comfort.

Developing next-generation automotive powertrain technology, therefore, is a complex challenge. Design engineers need to translate global demands into cost-effective, innovative solutions and stay ahead of competitors.

For over three decades, Victrex has worked with leading automotive companies to deliver high-performance thermoplastic solutions that improve the reliability, efficiency and cost-effectiveness of powertrain components. VICTREX™ PEEK polymer based solutions are used in the toughest of environments, driving progress time and again.

Combined with our in-depth material, processing and application know-how, we work with customers at each step of the value chain, from conception to production, to help solve current challenges and improve cost-effectiveness using thermoplastics. This enables you to drive your solutions to market faster, safer and with more confidence.

**Find out how we can help you
maximise powertrain efficiency
today and deliver innovative
solutions for tomorrow.**



OUR PRODUCT PORTFOLIO

With over 35 years of PEEK polymer knowledge, we partner with customers to design new solutions to improve performance, reduce manufacturing costs and speed up your time to market.



▲ VICTREX™ PEEK POLYMER

VICTREX PEEK is a viable metal replacement material that can enable optimum performance. Optimise the designs of your next-generation components to improve component performance with our vast portfolio of grades.



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



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



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



▲ 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



▲ ZYEX™ FIBRES

ZYEX PEEK fibre is the thermoplastic fibre of choice for tough environments. Its resistance to high temperatures and a wide range of chemicals, together with its excellent abrasion resistance at high temperatures make PEEK fibres an excellent choice for e.g. rubber reinforcement, filtration applications and composites.

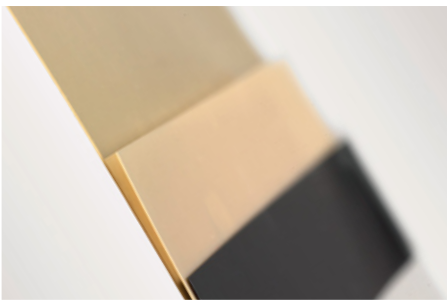


Monofilament, multifilament, staple and cut fibres




Available in diameters from 10 to 2000 microns

POLYMERS, FORMS, PARTS.




▲ APTIV™ FILMS

Take advantage of the properties of VICTREX PEEK in a thin film format for demanding applications. By offering excellent mechanical, thermal and electrical properties, APTIV Film allows for cost-effective, reliable insulation solutions.

 Superior mechanical and dielectric strength


 Excellent thermal conductivity


 Available in thicknesses from 5 to 750 microns



▲ VICTREX GEAR SOLUTIONS

Benefit from a 360° system approach spanning from material selection through gear design to mass production of precision-moulded state-of-the-art gears that meet highest requirements and can deliver a range of benefits.

 Accelerate time to market with integrated process

 68% lighter vs. cast iron gears

 Cost saving potential vs. metal scissor gears

EXPERIENCE THE BENEFITS

We work with automotive customers throughout the value chain to accelerate the development of innovative applications that deliver improved performance and cost-effectiveness in the most demanding environments. Experience the benefits for yourself.



2%

**ENHANCED FUEL
EFFICIENCY**

▲ **REDUCED CO₂ EMISSIONS**

Today, 75% of a car's fuel is lost to inefficiency, most of it due to frictional losses. Our VICTREX PEEK based solutions allow reduced energy losses and functional integration which contribute to the overall fuel efficiency and help reduce CO₂ emissions.



4X

LONGER LIFETIME

▲ **GREATER RELIABILITY**

Reliability is a key requirement for automotive components to avoid costly maintenance and/or recalls. Great performance starts with choosing the right material. Here's where VICTREX PEEK solutions can outperform other polymers or metals and make big contributions in even the smallest parts.



5%

**INCREASED TORQUE
OUTPUT**

▲ **IMPROVED PERFORMANCE**

Knowing the needs of our customers enables us to develop material solutions that allow considerable performance benefits, e.g. in electrical insulation systems where APTIV Film slot liners enable higher torque output and respond to growing electrification demanding higher energy density of electric motors.

Benefits shown are based on customer-specific projects and will vary depending on application-specific environment.



50%

REDUCTION IN NVH



80%

REDUCED COST

ENHANCED COMFORT AND SAFETY

We help customers develop smarter product designs that enable enhanced safety. Today more than 200 million drivers rely on VICTREX PEEK based ABS/ESC brake components. VICTREX Gear Solutions help overcome the challenges in NVH reduction and provide a viable and cost-effective alternative to metals.

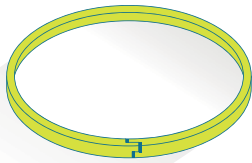
COST SAVINGS POTENTIAL

Cost-effectiveness is a main driver in the industry. Partnering with Victrex not only allows you to design smarter components but also provides further cost savings potential through an economical, environmentally friendly manufacturing process and can accelerate your time to market.

**IMPROVING
VEHICLE
PERFORMANCE**

SHAPING POWERTRAIN APPLICATIONS

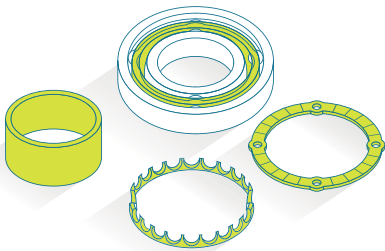
Victrex offers a range of high-performance polymer solutions which have successfully replaced metals and other polymers in a wide range of demanding powertrain applications. VICTREX™ PEEK, VICTREX™ Gear Solutions and APTIV™ Film solutions can meet or exceed performance criteria and enable component cost savings potential by eliminating secondary operations, such as machining, and consolidating a number of metal parts into one injection-moulded component.



▲ CONTROLLED LEAKAGE PERFORMANCE WITHIN TIGHT TOLERANCES

Tight tolerances are a key requirement to ensure controlled leakage in reliable and high-performing seal rings. In this application space, VICTREX PEEK has been found to offer:

- low thermal expansion,
- excellent wear properties
- simple one-shot technology with no need for a time-consuming post-moulding annealing process (e.g. typically 17 days for PAI)
- assembly cost saving potential – due to various PEEK grades for different diameter areas depending on specific requirements (e.g. load, dimension)

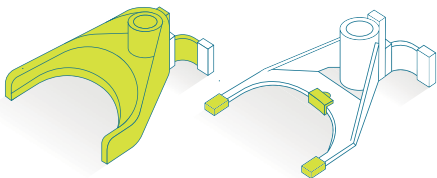


▲ TRIBOLOGICAL PERFORMANCE IN WEAR APPLICATIONS

Tribological performance is essential to efficiency and reliability in bearing applications, particularly in mixed lubrication conditions.

In thrust washers, bushings and bearing cages, VICTREX PEEK has a proven track record in delivering

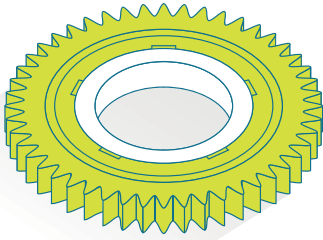
- stable coefficient of friction (CoF) as low as 0.05 in dry conditions
- excellent wear performance across a range of pressure and velocity scenarios
- high compressive strength over a wide temperature range to support component miniaturisation respectively increased loads
- high reliability due to excellent emergency running properties - no sudden blocking of bearing)
- improved NVH in plain bearings without multi-frequency noise and vibration spectrum of rolling element bearings



▲ STRUCTURAL & MECHANICAL STRENGTH IN SHIFT FORK APPLICATIONS

In shift fork applications, VICTREX PEEK has been selected for

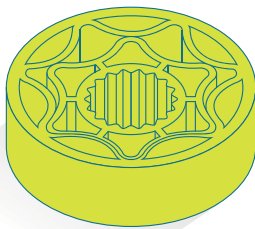
- its excellent combination of dynamic fatigue strength and wear resistance
- enabling functional integration by reducing complexity and supporting total system cost-effectiveness.
- supporting CO₂ targets – with an up to 70% weight reduction potential compared to metal solutions
- offering cost reduction potential by massively reducing conversion steps, low investment in tooling and machines, and accelerating time to market



▲ QUIET AND COST-EFFECTIVE GEAR SOLUTIONS

Compared to metal gears, Victrex Gear Solutions enable a range of benefits in powertrain environments:

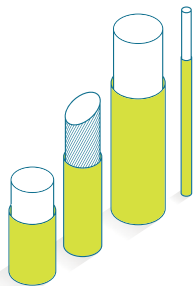
- 50% reduction in NVH for smoother operation and improved driving comfort
- improved responsiveness through up to 80% reduction of inertia
- lower energy consumption due to up to 70% weight savings
- reliable performance through low friction and wear, corrosion resistance and reduced need for lubrication
- reduced part cost by eliminating secondary machining, hardening or finishing operations, all with a 360° integrated approach including shape optimised gear design, prototyping, testing, tooling, inspection and manufacturing



▲ EFFICIENT AND RELIABLE PERFORMANCE IN PUMP APPLICATIONS

In a range of pump applications VICTREX PEEK polymer has been chosen for

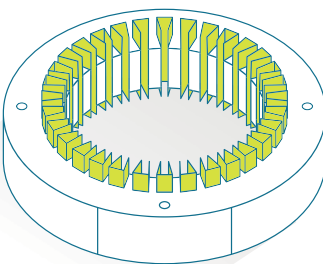
- reliable performance over lifetime due to wear resistance at required load and temperature levels
- improved leakage performance at elevated temperature due to thermal expansion characteristic, supporting up to 10 % higher pump efficiency vs. metal pump internals
- meeting CO₂ demands – by up to 75% weight saving potential vs. metal based pumps
- enabling optimised pump designs that allow for increased efficiency and lower component cost vs. metal solutions



▲ RELIABLE INSULATION IN THE MOST DEMANDING ENVIRONMENTS

VICTREX PEEK polymer has successfully been used in wire insulation applications where it has been found to offer

- improved retention of electrical properties in elevated temperature environments cooled by ATF or rich in moisture
- stable dielectric constant over a wide range of electric machine operating temperatures
- a reliable, lightweight combination of wear and chemical resistance, and electrical insulation



▲ EFFICIENT AND COST-EFFECTIVE ELECTRICAL INSULATION

In high power density electric motors, when compared to traditional multi-layer Meta-Aramid/PET laminates, APTIV Film based slot liners* enable

- motor downsizing resulting in a \$6 reduced cost per e-motor while maintaining the power density, or
- 5% increased continuous torque output and 2% increased copper density in a same size motor due to 40% thinner film format providing superior tear and puncture resistance whilst maintaining electrical insulation properties and improving thermal conductivity

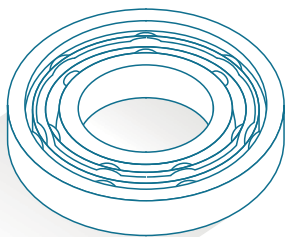
*replacing a 250 µm laminate with a 125 µm APTIV Film

OUR AUTOMOTIVE PHILOSOPHY

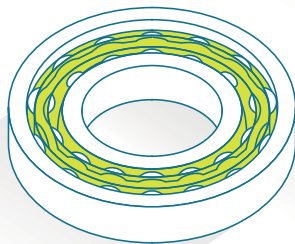
Direct development with industry leading specifiers

With unmatched experience and knowledge in PEEK material, we always thrive on improving the status quo – working with our customers and finding new ways to solve complex design requirements that address the challenges of today and the megatrends affecting tomorrow. Working together from concept stage to product launch, we can go beyond small measures and truly create solutions that will give our customers real competitive advantage. That's future performance!

- ▲ Taking cost out through innovation
- ▲ Accelerating time to market
- ▲ Improving efficiency



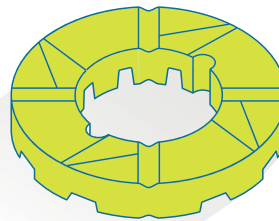
METAL BEARING WITH PA CAGE



METAL BEARING WITH PEEK CAGE

Replacing a PA bearing cage with PEEK allowed

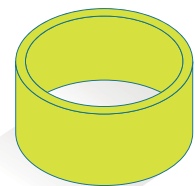
- a higher number of balls, thus
- higher loads in smaller spaces



FULL PEEK BEARING

Designing a full plastic bearing as a running change enabled

- reduced weight and
- lower part cost at same loads in the same space



OPTIMISED FULL PEEK BUSHING

Partnering with Victrex at early concept stage supports optimised part design and allows maximum benefits, e.g.

- reduced system space
- lower part cost while maintaining the same load

We understand the characteristics and behaviours of PEEK right through the manufacturing process - help our customers achieve new ways of solving complex challenges – true innovation.

MAXIMISE YOUR BENEFITS!

Our dedicated team of experts would be thrilled to work with you on the development of your next powertrain application,

contact us now: automotive@victrex.com

THE FOUNDATION OF VICTREX INNOVATION

VICTREX™ PEEK polymer

PEEK is widely regarded as one of the highest performing polymers in the world. VICTREX PEEK polymers are ideally suited to extreme and demanding environments. Whilst alternative materials can meet specific needs, PEEK can support multiple requirements at once.



High-Temperature Performance

Allowing continuous operation temperatures of 260°C (short term up to 300°C).



Environmentally Friendly

Fully recyclable, halogen-free and RoHS and REACH compliant. The majority of our products comply with the GADSL Reference List dated February 2017



Wear Properties

High abrasion and cut through resistance combined with a low coefficient of friction



Chemical Resistance

Resistant to aggressive automotive fluids (ATF, AdBlue®, oils, etc.), excellent ageing resistance to additives used in automotive lubricants



Easy Processing

1-shot injection moulding process allows for optimised part design and eliminates the need for secondary processing steps and saves labour, space, machine invest



Hydrolysis Resistance

Low moisture absorption, resistant to steam, with low permeability



Electrical Properties

Maintained over a wide frequency and temperature range, improved dielectric strength vs. PI/PTFE



Mechanical Strength

Excellent strength, dimensional stability and stiffness as well as long-term creep and fatigue properties



Light Weight

Enabling reduced mass and MOI, lower energy consumption, improved CO₂ efficiency and system cost reduction

From our beginnings as the first company to commercialise PEEK, we have continually pioneered new materials and created new markets. We are proud to be responsible for many world-leading firsts that have shaped the polymers industry.



Confidence Through Reliable, Proven
and Cost-Effective Material Solutions



HEADQUARTERS

Victrex plc
Hillhouse International
Thornton Cleveleys
Lancashire FY5 4QD
United Kingdom

TEL + (44) 1253 897700
FAX + (44) 1253 897701
victrexplc@victrex.com

AMERICAS

Victrex USA Inc
300 Conshohocken State Road
Suite 120
West Conshohocken, PA 19428
USA

TEL + (1) 484 342 6001
FAX + (1) 484 342 6002
americas@victrex.com

EUROPE

Victrex Europa GmbH
Langgasse 16
65719 Hofheim/Ts.
Germany

TEL + (49) 6192 96490
FAX + (49) 6192 964948
customerservice@victrex.com

JAPAN

Victrex Japan, Inc.
Mita Kokusai Building Annex
4-28, Mita 1-chome
Minato-ku
Tokyo 108-0073
Japan

TEL + 81 (0)3 5427 4650
FAX + 81 (0)3 5427 4651
japansales@victrex.com

ASIA PACIFIC

**Victrex High-Performance
Materials (Shanghai) Co Ltd**
Part B Building G
No. 1688 Zhuanxing Road
Xinzhuang Industry Park
Shanghai 201108
China

TEL + (86) 21 6113 6900
FAX + (86) 21 6113 6901
scsales@victrex.com

As a global high-performance polymer solutions provider, Victrex serves more than 40 geographies worldwide across the automotive, aerospace, medical, electronics, industrial and energy markets. VICTREX™ PEEK is regarded as one of the highest performing engineering thermoplastics in the world, and is used by leading companies to develop fuel-efficient automobiles and aeroplanes, advanced medical devices, next generation technology and tools for the harshest environments.

Follow us on social media!



www.victrex.com

©Victrex plc - December 2017

Victrex plc and/or its group companies ("Victrex plc") believes that the information contained in this document is an accurate description of the typical characteristics and/or uses of the product or products, but it is the customer's responsibility to thoroughly test the product in each specific application to determine its performance, efficacy, and safety for each end-use product, device or other application. Suggestions of uses should not be taken as inducements to infringe any particular patent or a confirmation as to fitness for use. The information and data contained herein are based on information we believe true. Mention of a product in this document is not a guarantee of availability.

Victrex plc reserves the right to modify products, specifications and/or packaging as part of a continuous program of product development. Victrex plc makes no warranties, express or implied, including, without limitation, a warranty of fitness for a particular purpose or of intellectual property non-infringement, including, but not limited to patent non-infringement, which are expressly disclaimed, whether express or implied, in fact or by law.

Further, Victrex plc makes no warranty to your customers or agents, and has not authorized anyone to make any representation or warranty other than as provided above. Victrex plc shall in no event be liable for any general, indirect, special, consequential, punitive, incidental or similar damages, including without limitation, damages for harm to business, lost profits or lost savings, even if Victrex has been advised of the possibility of such damages regardless of the form of action.

Any performance or comparative claims in this document can be supported by data which are available on request.

VICTREX™, APTIV™, VICOTE™, ZYEX™ Fibres, VICTREX™ Gear Solutions, VICTREX WG™ and the Triangle (Device), are trade marks of Victrex plc or its group companies.