victrex®

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The changing face of VICTREX® PEEK™ Polymer

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General Properties of VICTREX® PEEK™

In most applications, it is a combination of three or more of these properties that dictates the use of VICTREX PEEK polymer.

High & Low Temperature Resistance

Excellent Hydrolysis Resistance

Good Abrasion Resistance

Tribological properties

Good Electrical Properties

High Purity

RadiationResistance

Ease of Processing

FDA Approval

Excellent Chemical Resistance

Good Flame, Smoke and Toxicity

Mech. Properties

			unflilled Polymer	
property	**standard**	**unit**	**PEEK™ 450G**	**PEEK-HT™**
tensile strength	ISO R527	MPa	100	111
elongation at break	ISO R527	%	100	20
secant modulus	ISO R527	GPa	3,6	3,8
flexural strength	ISO R178	MPa	131	185
flexural modulus	ISO R178	GPa	3,9	4,1
Izod impact strength (notched)	ISO 180	kJ/m^2	6,4	7
hardness (Rockwell)	ASTM D785	R	126	108
thermal expansion	ASTM D696	10-5/°C	4,7	4,7
Limiting Oxygen Index		%	35	40
density	ISO R183	g/cm^3	1,32	1,3
HDT	ISO R75	°C	152	165
RTI	UL 746B	°C	260	260
glass transition	DSC	°C	143	157
melting point	DSC	°C	343	373

Mech. Properties

		compounds				
property	**unit**	**450G**	**450GL30**	**450FC30**	**450CA30**	**PEEK-HT CA30**
tensile strength	MPa	100	156	141	224	220
elongation at break	%	100	2,7	2,5	2	2,1
flexural strength	MPa	131	250	210	355	350
flexural modulus	GPa	3,9	10	8,1	20,2	19
notched Izod	kJ/m^2	6,4	10	6,3	9	9
unnotched Izod	kJ/m^2	-	40,3	27,5	41,4	50
hardness (Rockwell)	R	126	124	124	132	125
thermal expansion	$10^{-5}/°C$	4,7	2,2	2,2	1,5	4,7
density	g/cm^3	1,32	1,49	1,48	1,44	1,4
HTD-A (1,8MPa)	°C	152	315	300	315	360

Chemical resistance

- excellent chemical resistance against bases, acids, organic and inorganic reagents even at high temperatures
- excellent hydrolysis resistance
- superior resistance against all automotive fluids, i.e. lubricants, grease, break fluid, coolants, ...

Flammability

- best possible rating for flame retardancy :

  UL94 at 1,45mm with V-0

- limiting oxygen index 0,4mm: 24%

  3,2mm: 35%

- lowest smoke emission of all thermoplastics
- low emission of toxic gases, halogen free
- main combustion products are CO and CO_2
- approved in aeronautical and mass transport applications

Processing

- injection moulding
- extrusion
  - sheets, tubes, rods, 2 dimensional complex shapes
  - mono- and multi-filaments
  - film
  - capillaries
  - wire and cable coating
- compression moulding
- powder coating
  - electrostatic, fluidised bed, dispersion
- foaming

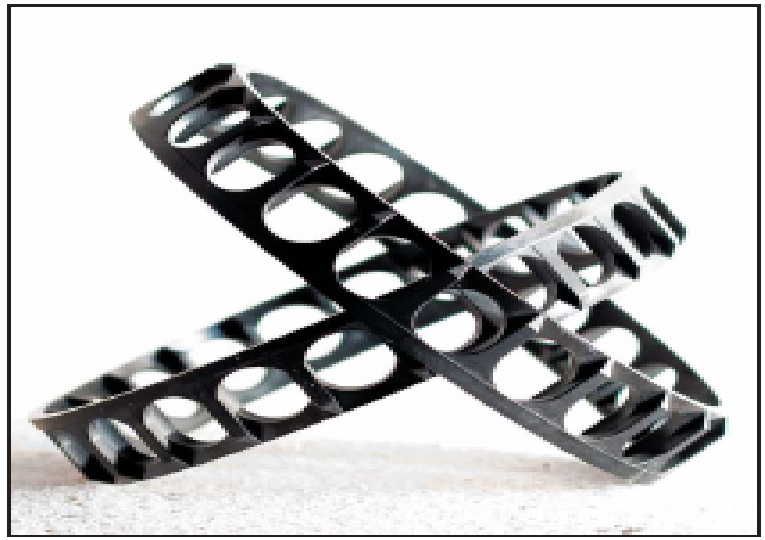
HMF Grades

Victrex introduces its new carbon fibre filled compounds which combine easy processability with superior mechanical performance and improved fatigue performance compared to current high strength grade range of carbon filled PEEK™.

These new products combine Victrex's high flow resins with 20% and 40% carbon fibres utilising a specialised compounding technology.

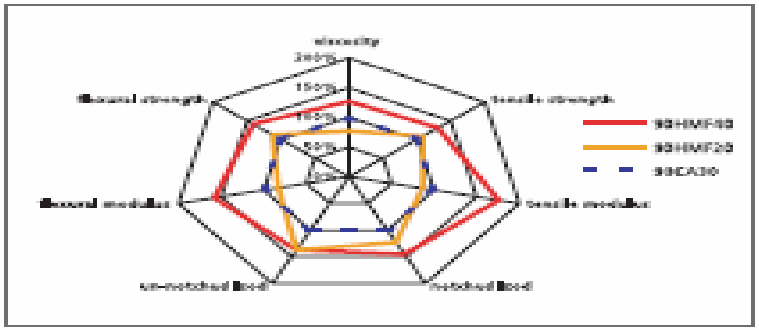
Compared to existing carbon fibre filled high flow compounds the new 90HMF products stand out with several key advantages (Figure 1)

- More than 10-fold improvement in cyclic fatigue performance (compare Figure 3)
- 90HMF20 has improved melt flow and toughness compared to 30% carbon filled standard grade
- 90HMF40 shows about 50% increase in strength, stiffness and toughness compared to 30% carbon filled standard grade
- Maintaining easy processability



Bearing cage

Figure 1: Performance space of VICTREX® 90HMF20 and 90HMF40 compared to standard high strength VICTREX® 90CA30



These new high performance products are targeted at applications

- requiring improved strength and stiffness while retaining easy processability compared to higher filled products of equivalent performance
- where improved ductility is required, i.e. large strains during single assembly procedures as in split seal rings or bearing shells
- where extended endurance in cyclic loadings is required

HMF Properties

Table 1: Typical performance data of VICTREX® 90HMF20 and 90HMF40

PROPERTY	TEST METHOD	TEST CONDITION	UNIT	90HMF20	90HMF40
Melt viscosity / 0.5mm die	Victrex	400°C	Pa.s	200	330
Tensile modulus	ISO 527	23°C	GPa	22	45
Tensile strength	ISO 527	23°C	MPa	290	350
Tensile elongation	ISO 527	23°C	%	1,9	1,3
Flexural modulus	ISO 178	23°C	GPa	19	36
Flexural strength	ISO 178	23°C	MPa	400	500
Izod Impact strength (notched)	ISO 180	23°C	kJ/m²	8,5	10
Izod Impact strength (unnotched)	ISO 180	23°C	kJ/m²	55	55
Heat Distortion Temperature	ISO 75A-1	1,8MPa	°C	347	349
Specific gravity	ISO 1183	23°C	g/cm³	1,36	1,44

Figure 2: VICTREX® 90HMF40 offers superior stiffness compared to similar VICTREX® high strength compounds, especially at temperatures above the glass transition (Tg= 148°C)

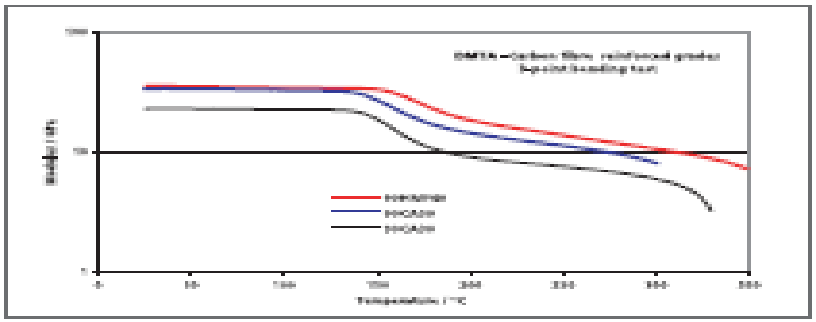
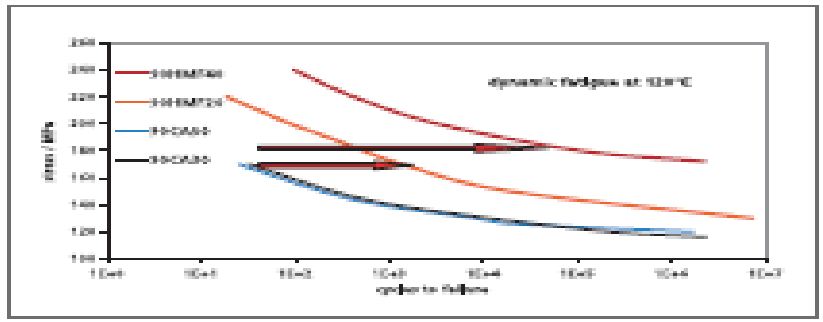
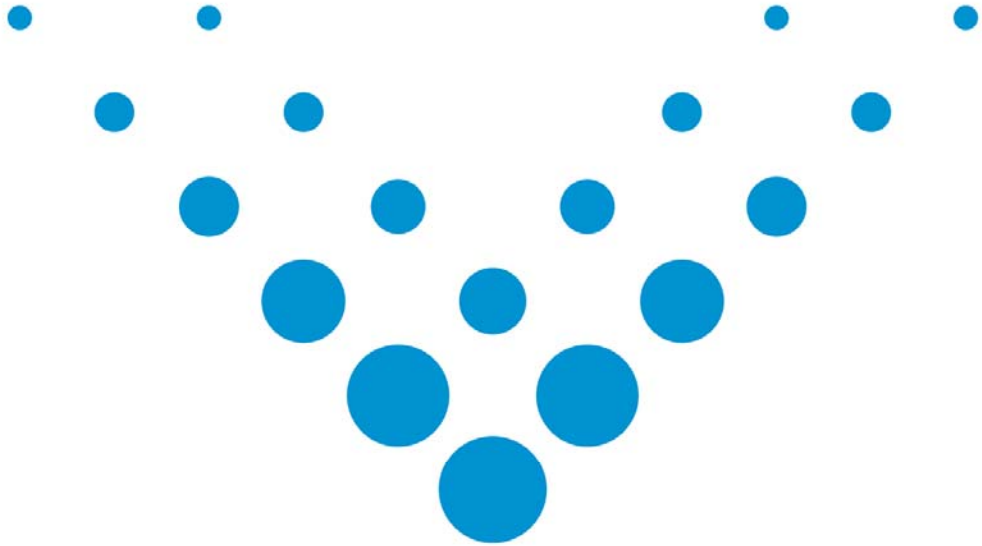


Figure 3: Tensile fatigue performance of 90HMF20 and 90HMF40 is significantly increased at 120°C compared to existing VICTREX® high strength products





VICOTE®

COATINGS

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Definitions

- Electrostatic (powder) Coating:
  - Powders are sprayed directly onto a heated substrate. Powders melt to form the coating typically 100 – 1000 microns (4-40 mil).
  - Typical applications – Pans, rice cookers, dampers, bushings, cylinder head gaskets, bearings, parts for corrosion resistance
- Dispersion Coating
  - The formulated aqueous based coating is sprayed onto the substrate which is subsequently heated to form a thin film on the substrate.
  - Typical applications – cookware, irons, engine piston rings, bearings, large parts in chemical plants for corrosion resistance
- Thermal Spray
  - Powder is passed through flame to melt and melt the polymer which adheres and solidifies on the cool surface. (Under development)
  - Potential Applications – Marine, large objects that can't be heated.

aptiv™

VICTREX® PEEK™ FILM TECHNOLOGY

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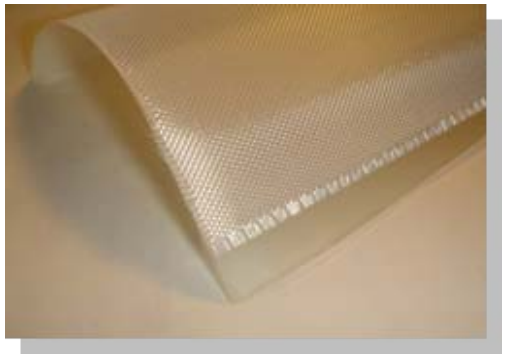
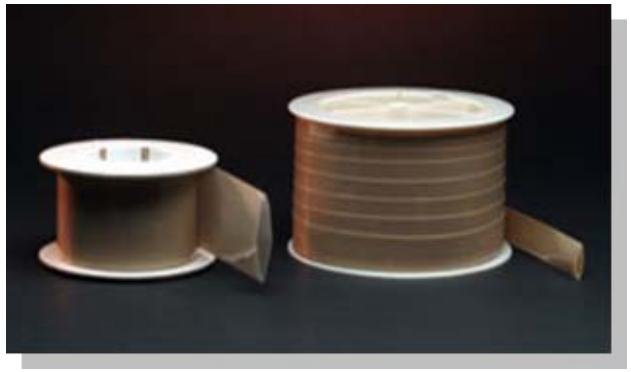
PEEK film secondary conversion processes

- Surface treatment to promote adhesion (plasma, corona, chemical etching, primers)
- Metallization with a variety of metals using lamination, plating, or electro deposition.
- Coat with adhesives for producing tapes
- Co-extrude with other films, and carbon or glass mat fabrics to produce composites
- Extrusion into film tube form
- Laser cutting
- Stamping
- Thermoform to create 3D shapes

PEEK film secondary conversion examples

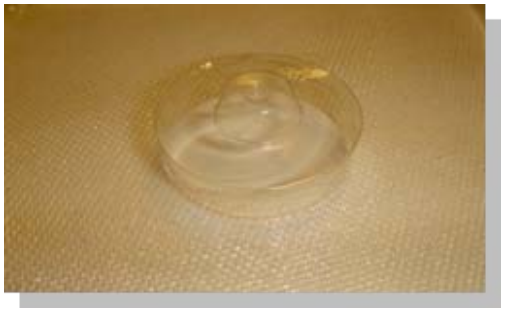


Co-extruded PEEK
Composite Films



Extruded PEEK
Film Tubing

Metalized PEEK film
(5 um to 35 um copper)



Thermoformed PEEK
film 5 mils (125 um)

Ibuki Film Laminated
Directly to Metal

Surface treated, adhesive
coated PEEK films

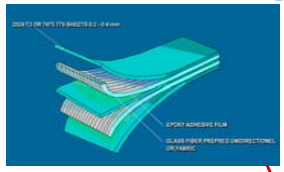
Secondary processing partners Europe

- Arthur Krüger GmbH: www.arthur-krueger.de
- Vacuum thermoforming of PEEK film / sheet
- Signed „NDA agreement“, first successful trials with 625µm film, and trials with 1 and 1,5mm from Ensinger
- Most active in the aerospace industry, transport and traffic, mechanical engineering sector, medical technology sector, chemical industry, electrical engineering sector
- Machine sizes up to 3000 x 2000 x 1000mm
- Provided thermoformed part for the K-Show

Victrex® PEEK™ Composites

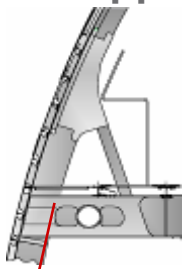
Victrex believe that ultimately High performance Thermoplastics will be the dominant composite material in the Aerospace industry

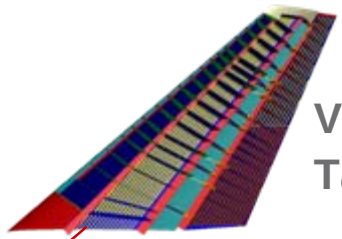
Major monolithic carbon fibre reinforcement thermosets (CFRP) and thermoplastics applications in A380 AIRBUS



GLARE®

Floor Beams for Upper Deck

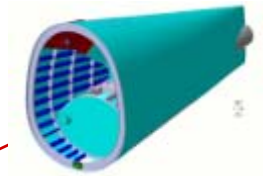




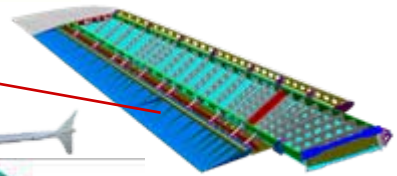
Vertical Tail Plane

Outer Flaps

J-Nose



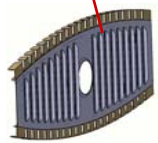
Section 19.1



Horizontal Tail Plane

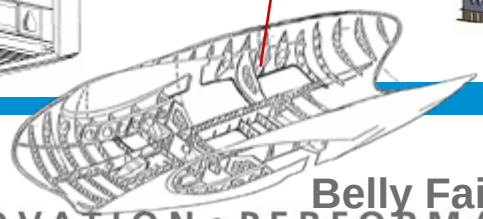
Un-pressurized Solid laminated

Center Wing Box



Wing Ribs

Rear Pressure Bulkhead



Belly Fairing

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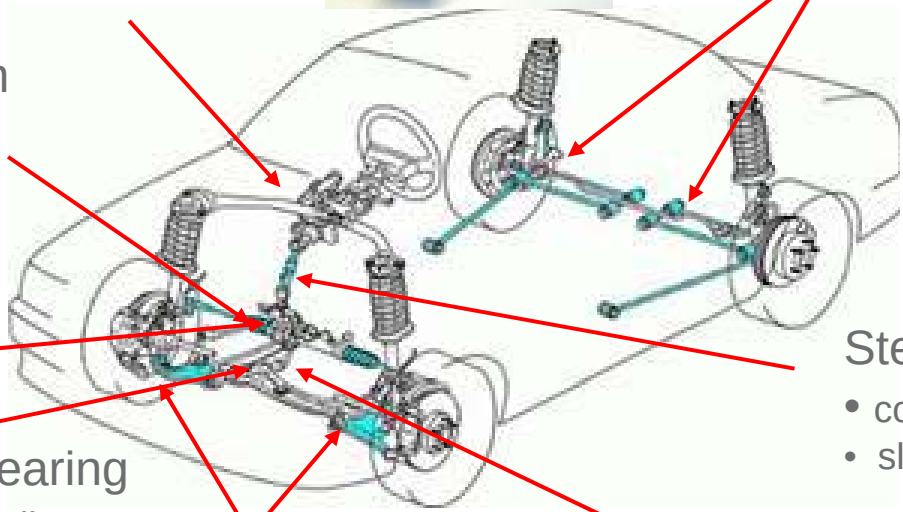
Automotive - Steering/Suspension

Steering adjustment
- worm gear height adjust

Ball joints
- bearing shells

EPS System
- worm gear
- yoke bearing



Hydraulic pump
- pump coupling

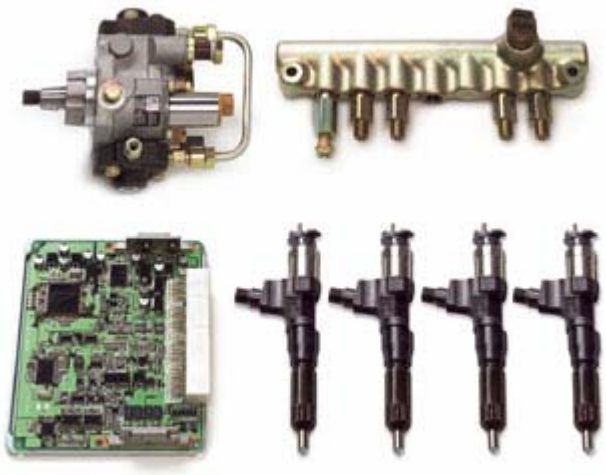
Steering column
- column sleeve
- slider bearing

Yoke bearing
- sliding foil

Ball joints
- bearing shells

Active Front Steering System
- worm gear

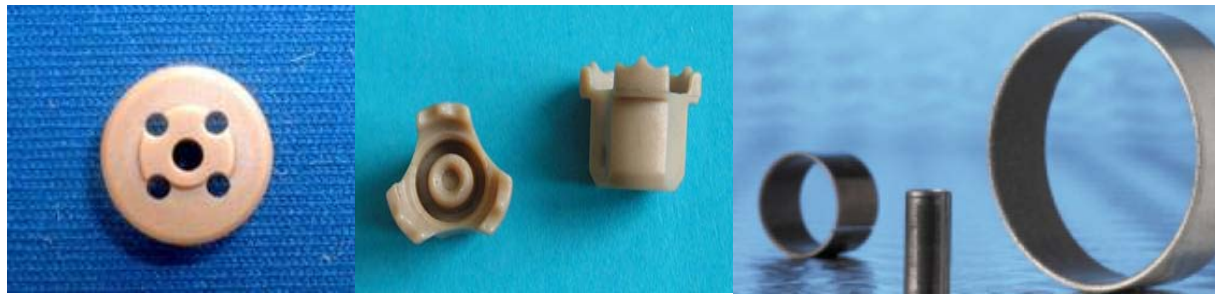
Fuel injection



PEEK™ Benefits

- mechanical properties
- wear properties
- creep performance
- toughness
- cost reduction

- Injector valve seats
- Pump bushing
- Back-up ring
- Membrane guide



Sensors

PEEK™ Benefits

- temperature performance
- mechanical properties
- chemical resistance
- processability
- cost reduction

- EGR sensor
- Throttle body sensor
- Tire pressure sensor
- Oxygen sensor

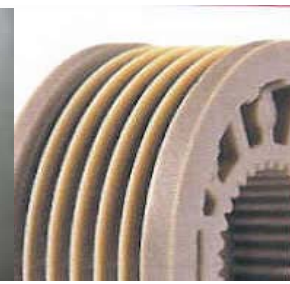



Door modules

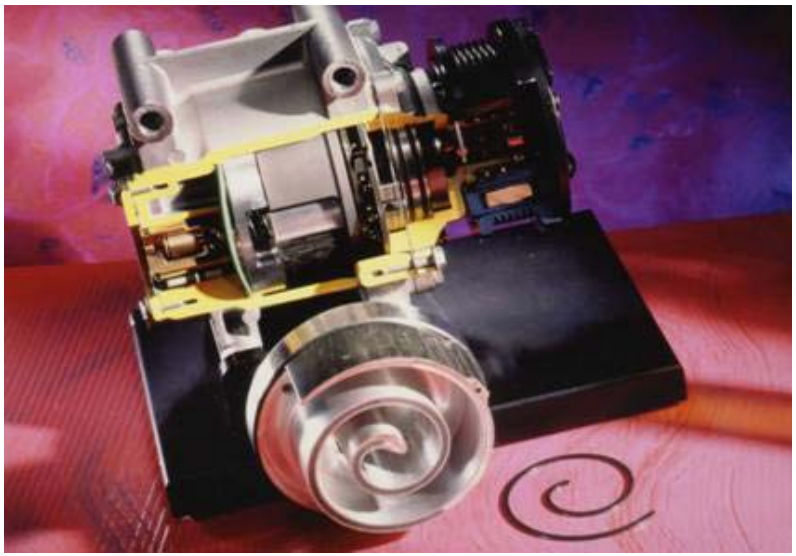
PEEK™ Benefits

- mechanical properties
- creep performance
- toughness
- weight reduction
- cost reduction

- Worm gear window lift
- Thrust pin electric motor
- Cable roller window lift



HVAC



PEEK™ Benefits

- mechanical properties
- higher efficiency
- chemical resistance
- longer lifetime
- weight reduction
- cost reduction

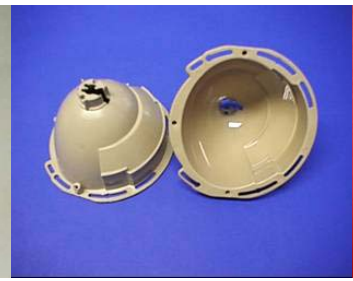
- Scroll seals
- Swash plates
- Gear mode door control
- Piston shoes

Lighting

PEEK™ Benefits

- mechanical properties
- thermal performance
- outgassing properties
- weight reduction
- cost reduction

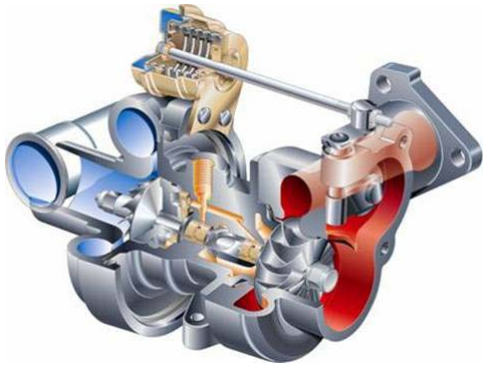
- Reflector housings
- Lamp socket
- Xenon light adjustor
- HB LED‘s

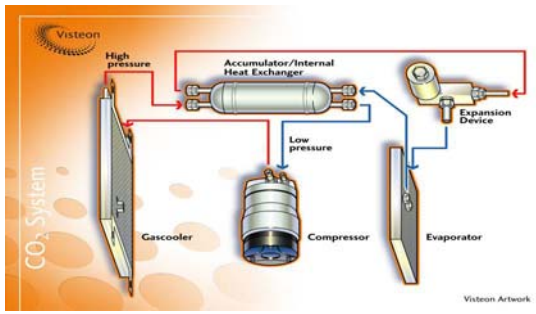


Emerging areas

Hybrid

Turbo





CO_2

Actuator

Connector/Sensor

Film

Coating

Exhaust

Steering

Details

System: Electrical power steering
Application: gear
Material: PEEK™ 450G

Requirements

- temperature max. 140°C
- high impact 1.000°/s
- no dimensional changes
- low temperature resistance

PEEK™ Benefits

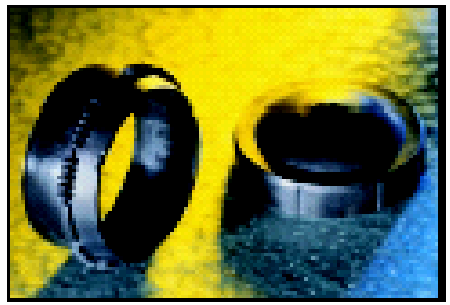
- wear resistance
- noise reduction
- high ductility
- no moisture absorption

Ball joints

MAYBACH

Mercedes-Benz

smart



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