



# Reduzindo NVH e Emissões

## Engrenagens em VICTREX®PEEK

November, 12<sup>th</sup> 2014

Feiplar

Ricardo Ehke`





# Introduction

## Agenda

- Victrex introduction
- Value proposal quantification
- Understanding the Needs
- Successes in Automotive
- Gears - Time to scrap metals
- Properties
- Testimonials
- Outlook



# Your Partner VICTREX

35 Years

PEEK Polymer Innovation + Experience

Technology Centers

Shanghai • Tokyo • Hillhouse

> 650 Employees

In 30 Countries

60 scientists, engineers and technicians

Technical support across 30 countries

4,250 Tons

Production Capacity Increasing to 7,150 tons in 2015

London Stock Exchange



## Global Organisation



UK



China



Japan



# Materials make the difference in CO<sub>2</sub> emissions and Km/l



## Increase fuel efficiency by up to 2%

Less weight, lower moment of inertia, faster response make your components more environmentally friendly

## Smarter fuel management

Only one quarter of the typical vehicle's fuel is used for propulsion, the rest is wasted to parasitic losses. A large portion of that is due to frictional loss. According to the IEA drivetrain technology change will deliver the largest improvement in fuel efficiency Components like rolling bearing elements, bushings, valves, seal rings help enhance your fuel efficiency and improve vehicles' CO<sub>2</sub> emissions.

## Faster response

**68% weight savings** in gears made of VICTREX PEEK, result in **78% lower** moment of inertia operating even under poor lubrication

*Using VICTREX PEEK in modern transmission helps manufacturers meet increasingly challenging emission regulations while at the same time enhancing performance and reducing cost.*

Victrex Confidential



HIGH PERFORMANCE POLYMERS  
HIGH PERFORMANCE POLYMERS



# Re-thinking Technologies for Optimum Passenger Experience



Reliability

Safety

Fuel Efficiency

Driver's Experience

## Precise feedback from the steering system

Reliable transmission of steering forces and speeds - minimal change of angle between actuation and power take-off - no clearance over lifetime

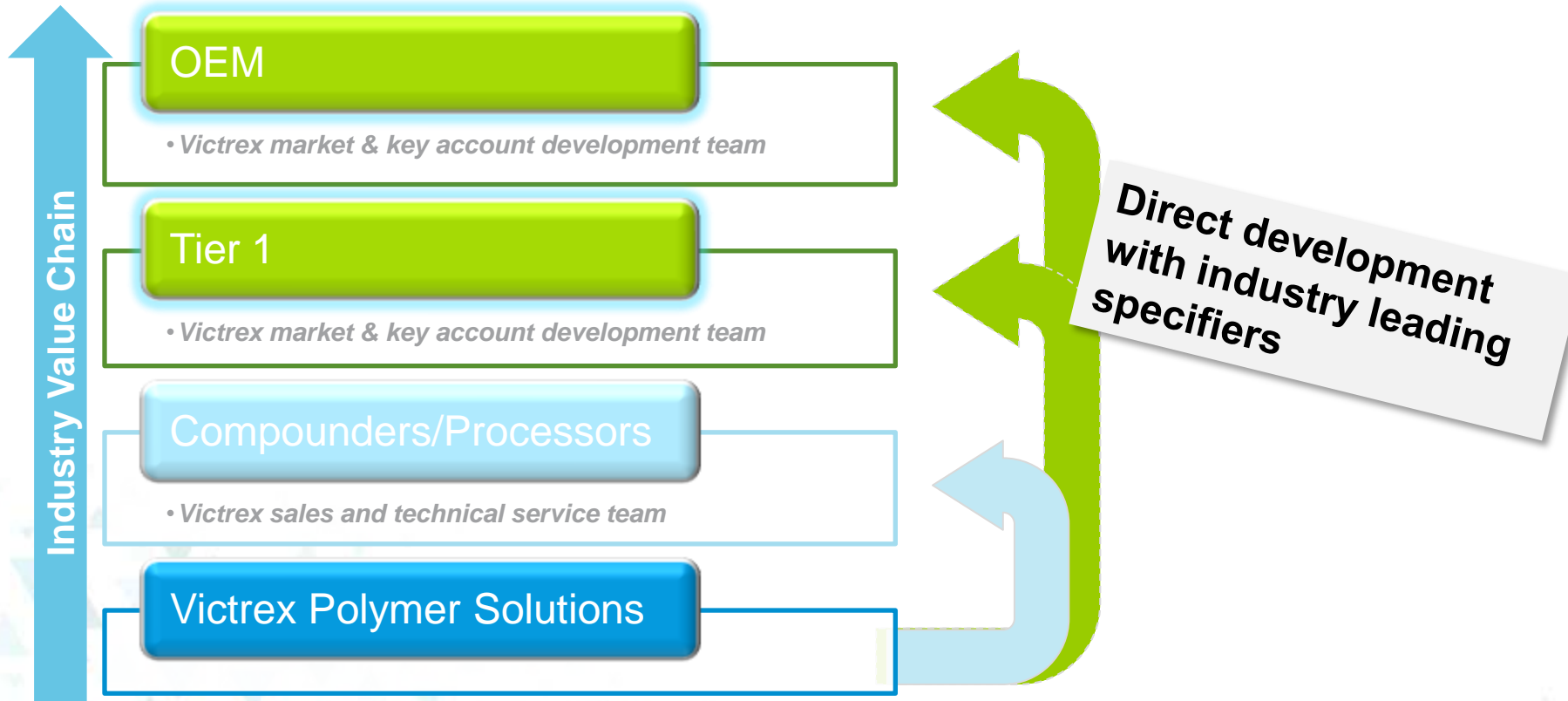
## Smooth running – half the noise

Less high-frequency noises in hydraulic valves or 3dB improvement in NVH compared to grey cast iron gear set – this equals a 50% noise reduction for the human ear

## Rapid, smooth and precise gear shifting

Seals and clutch release components are designed to cope with high torque engines and allow smooth gear shifts under full load

# Understanding the Need



# Victrex Product Portfolio

victrex<sup>®</sup>  
HIGH PERFORMANCE PEEK POLYMERS



Composites  
Made with VICTREX<sup>®</sup> PEEK polymer



victrex pipes<sup>®</sup>



victrex<sup>®</sup>

aptiv.  
VICTREX<sup>®</sup> PEEK FILM TECHNOLOGY



Confidential – Victrex

World Leader in PEEK Polymer Solutions

Victrex Confidential

# Polymer Pyramid

## Thermoplastics

### Commodity Thermoplastics

PE PMMA  
 PVC PVA  
 PP PVDC  
 PS PET  
 ABS etc..

### Engineering Thermoplastics

#### Commodity ETP

PA  
 POM  
 PC  
 PPE  
 PBT

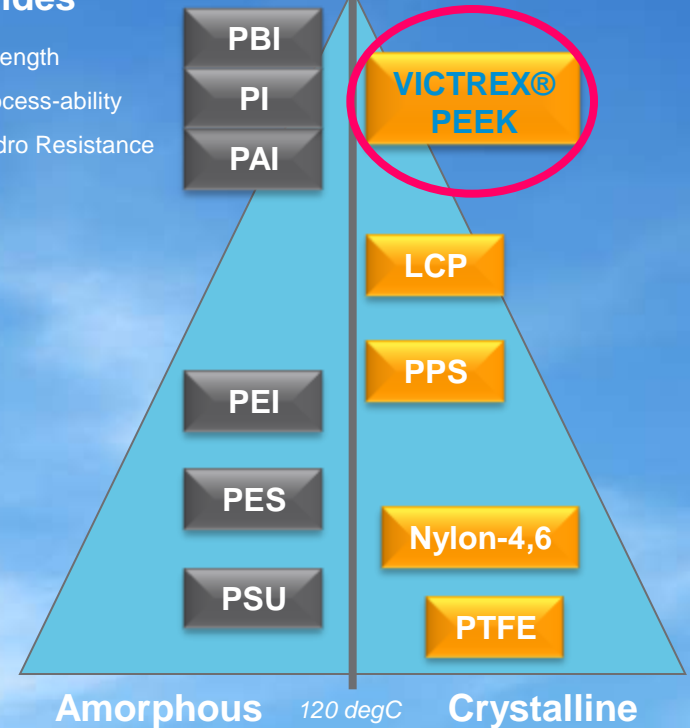
#### Super ETP

PSU  
 PES  
 PPS  
 PAI  
**PEEK**  
 PEI  
 PI  
 LCP

## Polyimides

- High Strength
- Poor Process-ability
- Poor Hydro Resistance

Heat Resistance  
 300 degC +



- Transparency
- Good Formability
- Relatively Poor Chem Resistance
- Poor on Fatigue

- Opaque
- Good Chem Resistance
- Resistant to Stress Cracking
- Good on Fatigue

Confidential – Victrex

World Leader in PEEK Polymer Solutions

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# More than 65% of energy loss occurs within the **Engine**

VICTREX Polymer solutions is focused on developing technologies and materials that help automakers **downsize engines** while **improving fuel economy** and **maintaining performance**



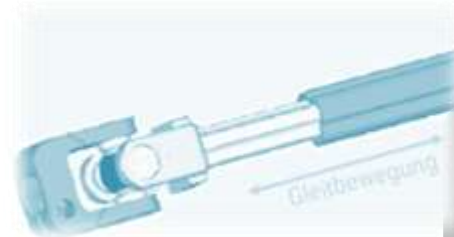
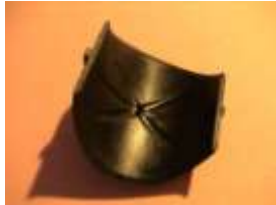


Over **200 million** drivers rely on  
**VICTREX® PEEK** based  
**brake components**





# Precise and Reliable transmission of **Steering** angles and torques with VICTREX PEEK



IT'S TIME TO SCRAP METAL GEARS





# Delivering the gear value



**Material Training**

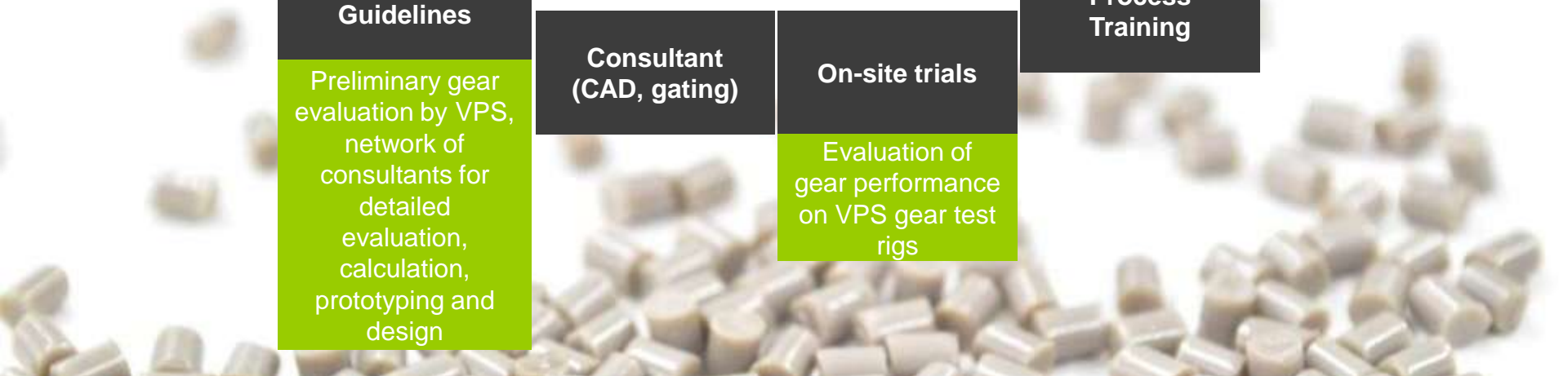
**Design Guidelines**  
Preliminary gear evaluation by VPS, network of consultants for detailed evaluation, calculation, prototyping and design

**Consultant (CAD, gating)**

**On-site trials**  
Evaluation of gear performance on VPS gear test rigs

**Process Training**

**Failure Analysis, Troubleshooting**





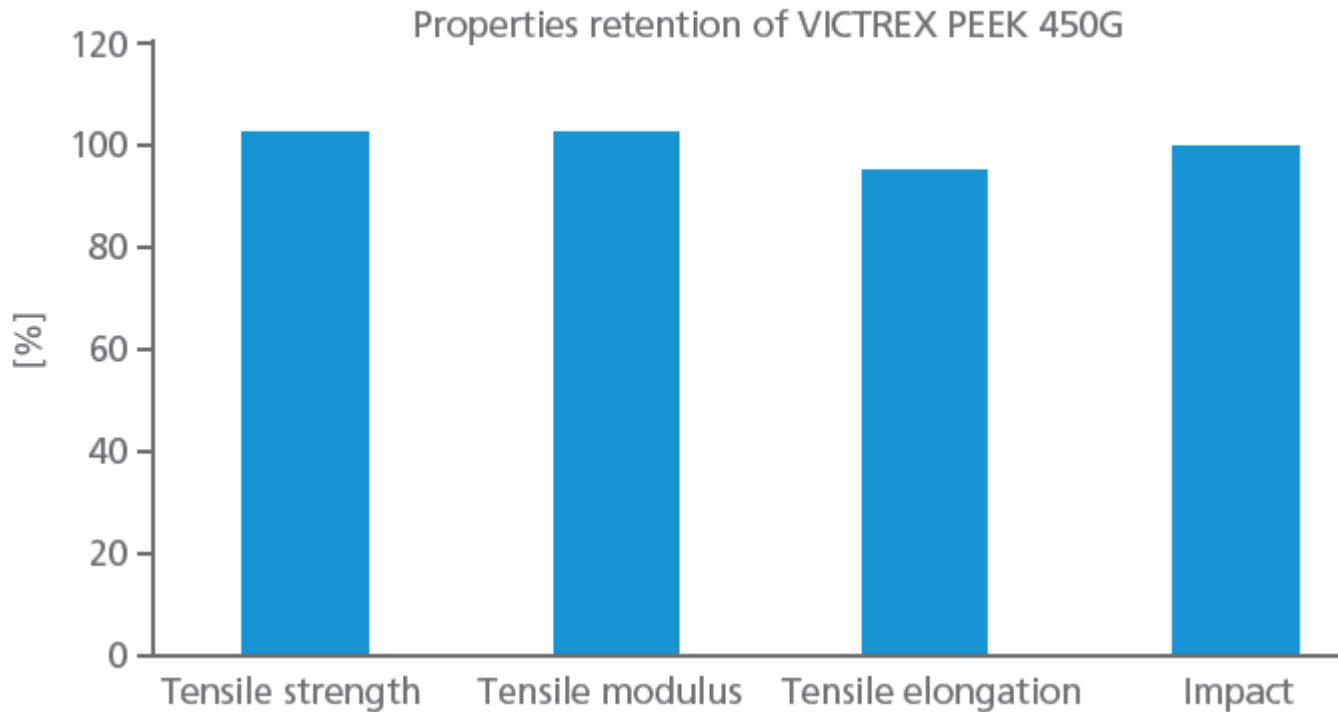
# Capabilities and Competencies

- **PEEK Polymer** - core competencies are material science and engineering we understand material properties and performance
- **Processing of PEEK Polymer** - injection moulding, extrusion, compression moulding.....
- A history of **application successes** in a wide range of industrial sectors
- Unique **gear test rigs**
- A growing bank of **data on PEEK gear performance**
- **'Simple' gear calculations** for initial feasibility calculations and design observations:
  - KISSsoft
  - OSU Gear Lab Consortium



# Thermal properties retention

Thermal aging – 5.000 h @ 150°C in air

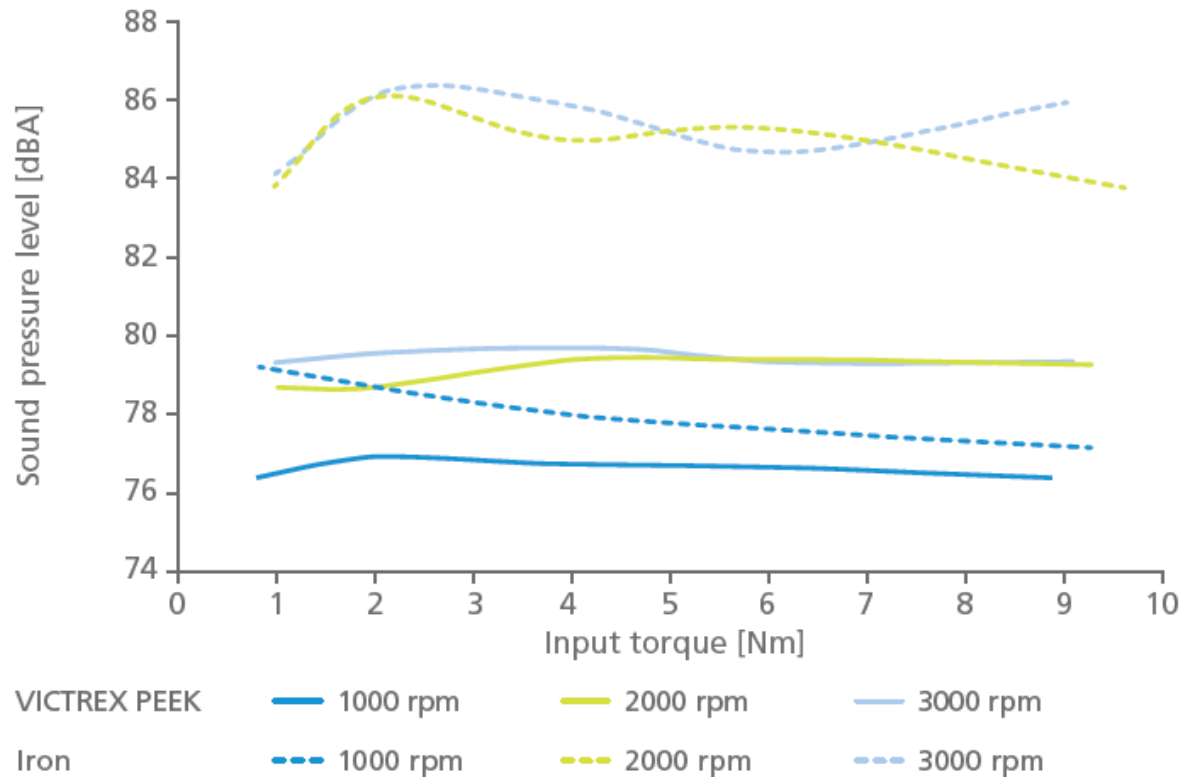






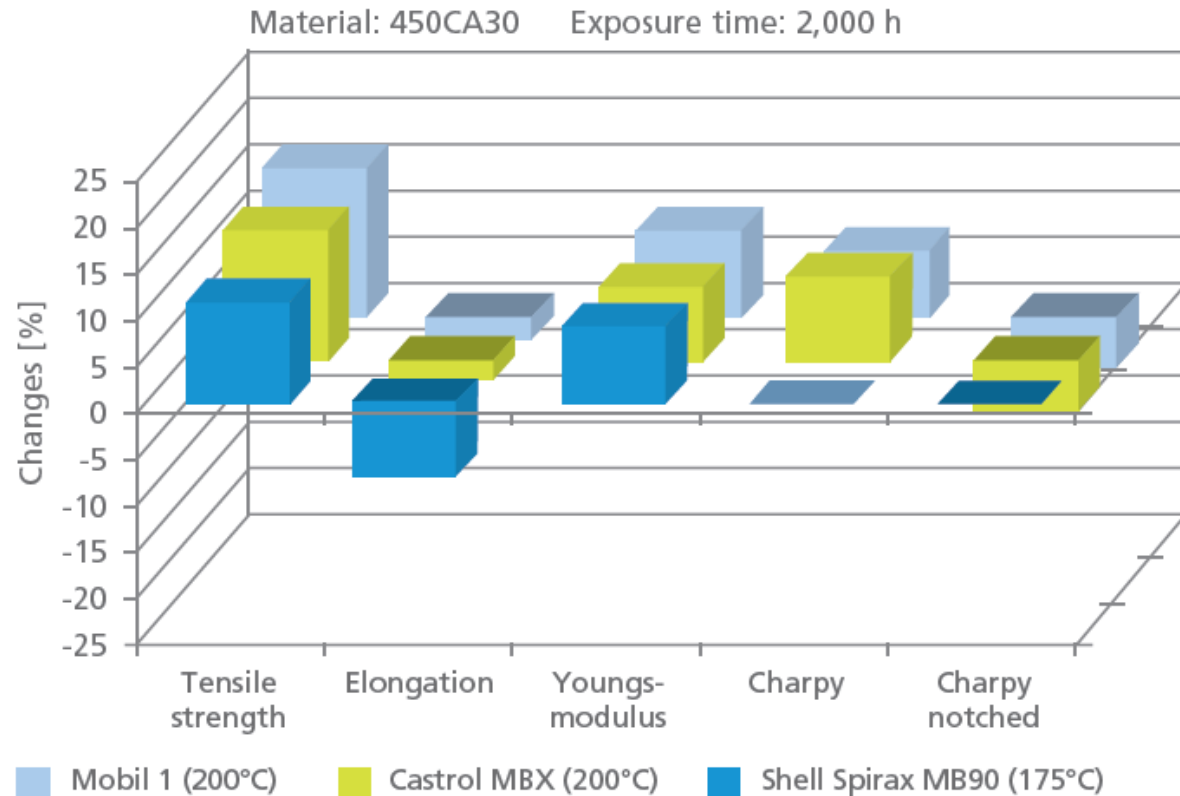
# Sound level comparison

Sound level comparison between iron and VICTREX® PEEK gears at various loads and speeds



# Chemical x Thermal aging

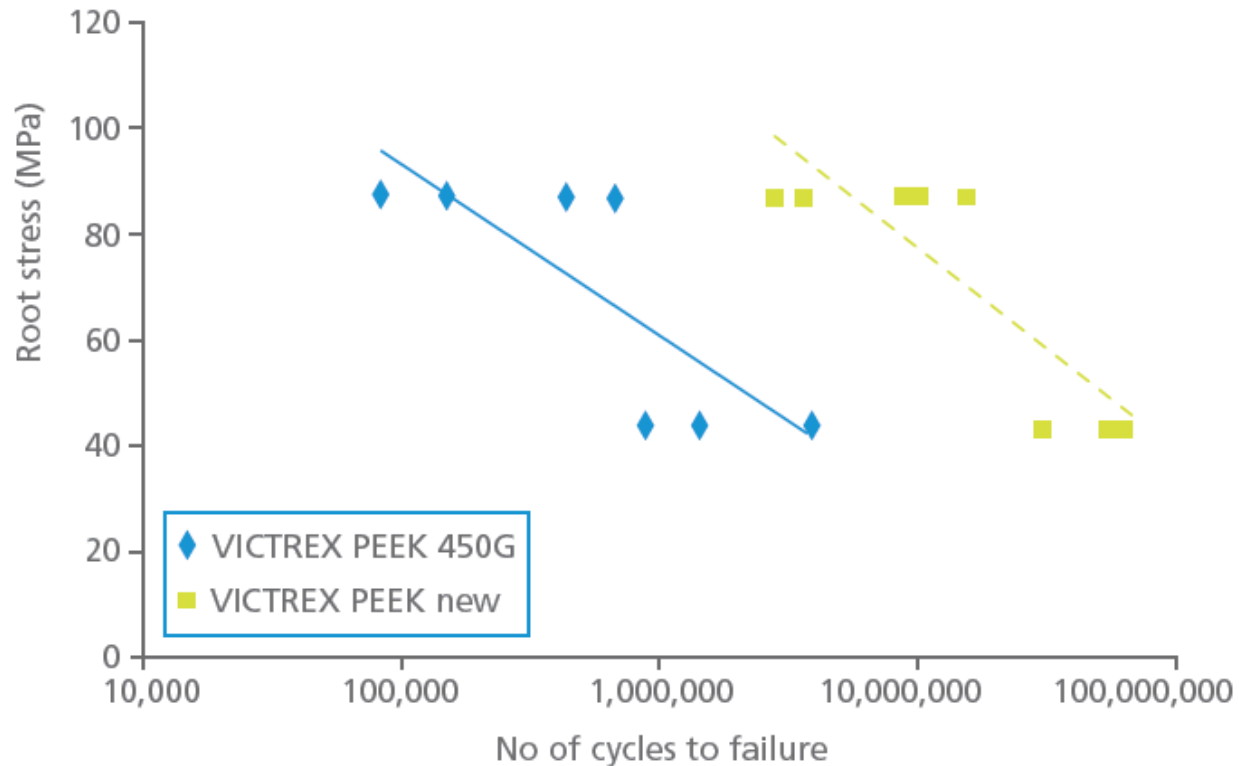
## Thermal aging – Automotive lubricants





# Product Development

Root stress versus no of cycles to failure  
(30°PA, 3000 rpm, lubricated)



New product delivers up to 10x gear lifetime

# Engine - Mass Balancer Gear



- ❖ Less than half the noise - **3 dB improvement** in NVH compared to grey cast iron gear set
- ❖ **69% weight reduction** resulting in **78% reduction in inertia** compared to grey iron gear
- ❖ **9% reduction** in torque required to operate
- ❖ **2% reduction** of CO<sub>2</sub>



Source Pictures: Metaldyne

So smoother running and higher operation efficiency

## FEATURES

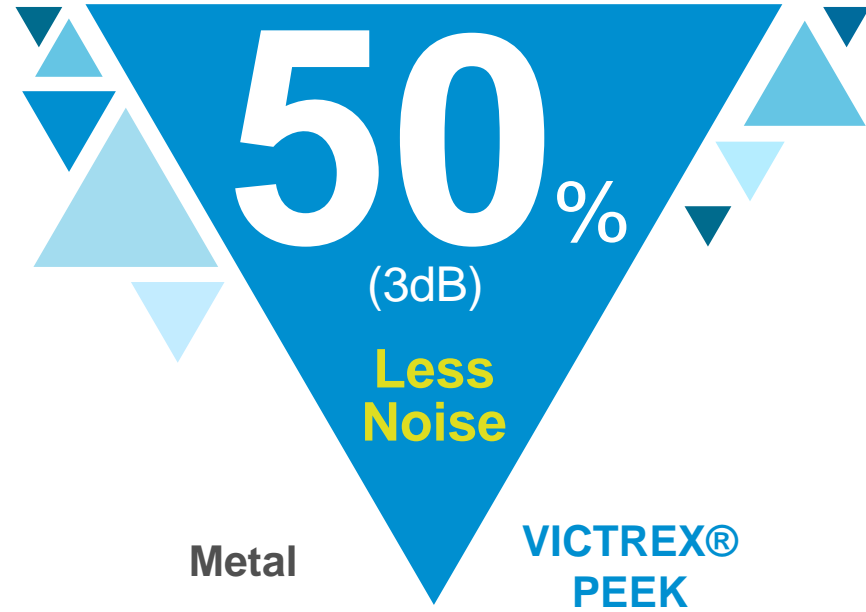
- ❖ high mechanical strength and compressive creep resistance at temperatures of -40°C and 150°C
- ❖ resistance against automotive fluids, specific engine oil 5W-20
- ❖ dimension stability – CLTE and no swelling in humidity
- ❖ excellent dynamic fatigue resistance
- ❖ less pitting generation over lifetime
- ❖ high wear resistance in sliding applications ( up to 12.000 rpm)



# Mass balance system gears



Mass Balance gear made with VICTREX® PEEK



Fuel Efficiency

Safety

Reliability

Electrification

Cost

# Engine – Oil Pump Gear



- ❖ Equivalent efficiency up to 100°C vs. aluminium
- ❖ 30% weight reduction compared to aluminium gears
- ❖ 15% reduction in torque required to operate
- ❖ 5% cost savings with further potential by part integration

So significant weight reduction and higher operation efficiency

Source Pictures: Scherzinger

## FEATURES

- ❖ high mechanical strength and compressive creep resistance at temperatures of -40°C and 150°C
- ❖ resistance against automotive fluids, specific engine oil 5W-20
- ❖ dimension stability – CLTE and no swelling in humidity
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# Engine - Turbo Charger Actuation



Universal Turbo  
Actuator (UTA)

LUVOCOM®  
1105-XXXX

- ❖ Optimized gear system for **reduced consumption**
- ❖ **Smooth operation** from – 40 ... + 125°C / 160 °C
- ❖ **Highly accurate** over a range of temperatures
- ❖ Superior level of **reliability** in a very robust design
- ❖ Position control with HELLA CIPOS® technology **accuracy**

So enables high accuracy of +/- 1% over lifetime and temperature range

## FEATURES

- ❖ PEEK enabled high temperature use up to +160° C
- ❖ Dimension stability – now influence of moisture and low thermal expansion over temperature range
- ❖ Reliable transmission of high torques
- ❖ Low wear rate over lifetime



# Actuator – Electrical Seat Adjustment



PEEK based seat comfort adjustment gears are one of the **enablers to complex requirements** in terms of weight, safety, size, comfort and costs

- ❖ providing **reliable transmission** of required loads (driver + seat) at reasonable speeds
- ❖ **minimal change of angle** between actuation and power take-off
- ❖ **lower radial clearance** over lifetime than other polymers tested
- ❖ combining comfort, light weight, and durability in a cost effective package - also **complies to the NCAP standards**

Source Pictures:  
IMS Gear / Brose

So enables high accuracy of +/- 1% over lifetime and temperature range

## FEATURES

- ❖ smoother operation than metals
- ❖ transmits higher torque than other plastics such like POM
- ❖ resists to grease without stress cracking as recognized with PEI
- ❖ more economical to produce than metal gears
- ❖ better wear resistance– plastic component and counter part
- ❖ higher ductility than PPS for crash reasons
- ❖ less sensitive for misuse than POM



# Actuator - HVAC



- ❖ Noise reduction inside cabin
- ❖ Fuel saving - weight and component reduction
- ❖ Extreme accurate flap positioning
- ❖ Superior performance in all climate conditions

So enables high accuracy of +/- 1% over lifetime and temperature range

## FEATURES

- ❖ No performance drop up to 80°C
- ❖ Dimension stability – now influence of moisture
- ❖ Tight tolerances
- ❖ Cost efficient production
- ❖ Wear and creep resistant over lifetime



# Actuator - Electrical Parking Brake



- ❖ **Less space** requirements - positioning right at brake caliper possible
- ❖ **Fuel saving** - weight and component reduction
- ❖ Enables multiple system **function integration**

So enables high accuracy of +/- 1% over lifetime and temperature range

## FEATURES

- ❖ No performance drop up to 120°C
- ❖ Dimension stability – now influence of moisture
- ❖ Tight tolerances
- ❖ Cost efficient production
- ❖ Wear and creep resistant over lifetime

# Customer Testimonials



Image: ©Metaldyne

Metaldyne and Victrex have been working quite closely for the past nine years designing and developing gearing applications for balance shaft and balance shaft modules in three- and four-cylinder internal combustion engines. This partnership has resulted in significant benefits in weight, inertia and manufacturing costs.

These benefits, in conjunction with noise vibration and harshness (NVH) improvements, have provided our customer base with a viable alternative to traditional metal gear designs in balance shaft and balance shaft module applications. Victrex's support in the design and development process has been critical to the advancement of this technology.

**Steve Chevalier, Engineering Director, Metaldyne LLC**

With their expert know-how and their focus on solutions, Victrex has been a valuable partner to ElringKlinger Kunststofftechnik for many years. We work together to push application boundaries and receive expert support to develop technologically-sophisticated components for drive systems that offer greater efficiency and better performance in the toughest conditions.

**Dr. Claudia Stern, Product Manager High Performance Polymers, ElringKlinger Kunststofftechnik**

Victrex are a trusted innovation partner in our pursuit of solutions to tomorrow's automotive challenges.

**Peter Luff, Purchasing Director, BOSCH**



- Value proposition quantification
- Performance envelope development
- New material development
- Focus in automotive engines and actuation
- Assessment of new application spaces
- Channel development



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# Questions?

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