

Victrex Automotive

High Performance Materials and Coatings to meet future requirements

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Agenda

- Requirements in the steering / suspension area
- Material comparison
- Latest material developments – Victrex PEEK HMF
- Aging of thermoplastic materials @ 150°C
- Gears made out of plastics
- VICOTE Coatings

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Steering/Suspension - Key requirements

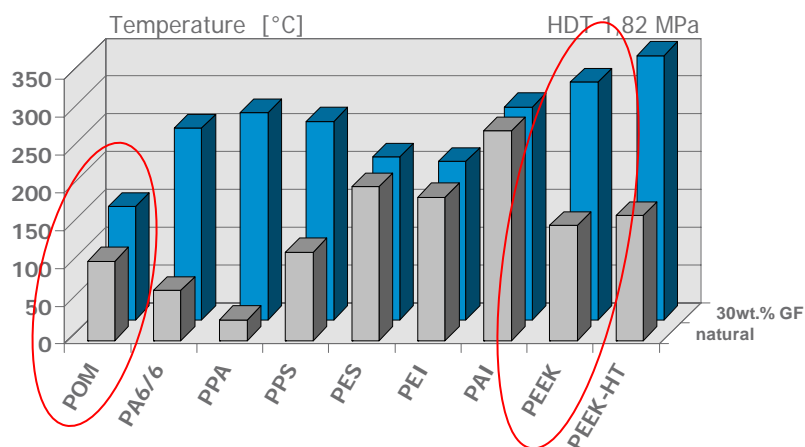
- High mechanical strength at elevated temperatures
- Temperature resistance from -40°C - +120°C
- No aging
- Good wear properties – low Coefficient of friction
- Oil/grease resistance
- Low water absorption – no dimensional change
- tight tolerances – no clearance
- economical processing

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Heat distortion temperature

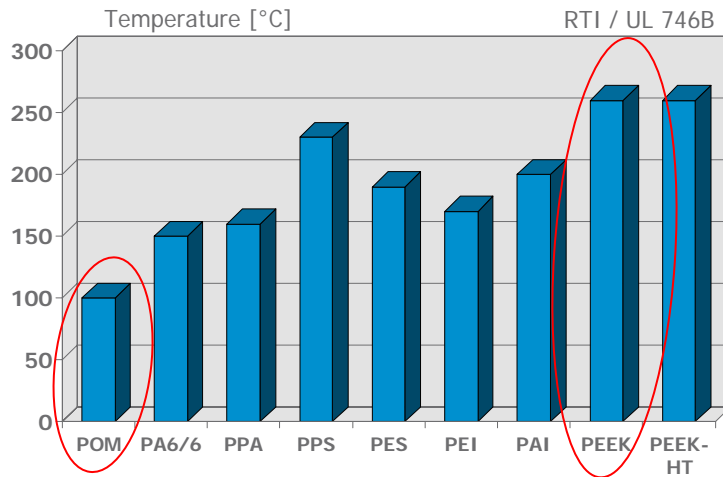


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Relative temperature index



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Mechanical properties

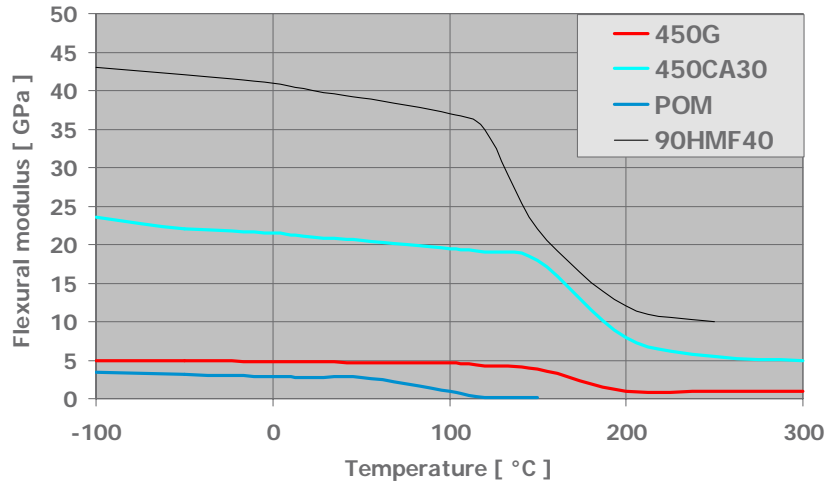
Property	Unit	POM	450G	150CA30
tensile strength	MPa	64	100	224
elongation at break	%	30	100	2
flexural strength	MPa	90	131	355
flexural modulus	GPa	2,7	3,9	20,2
Izod impact strength (notched)	J/m	70	83	90
hardness (Rockwell)	R	98	126	132
thermal expansion	10 ⁻⁵ /°C	11	4,7	1,5
density	g/cm ³	1,41	1,32	1,44
HTD 1,8MPa	°C	106	152	315

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Flexural modulus / temperature

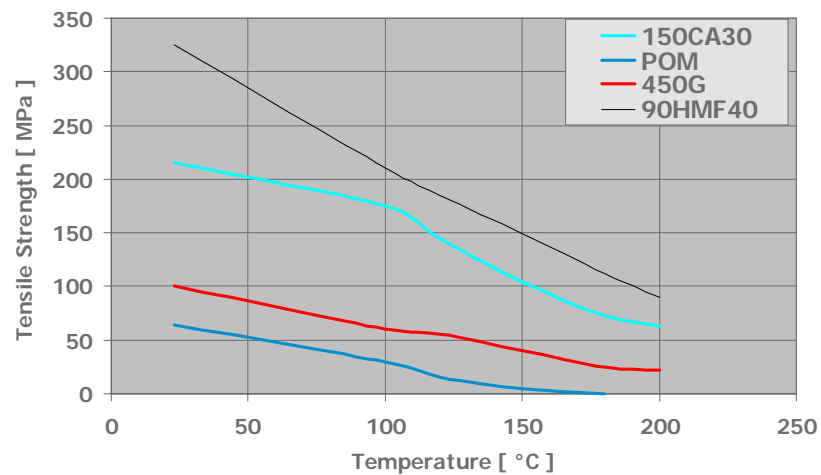


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Tensile strength / temperature

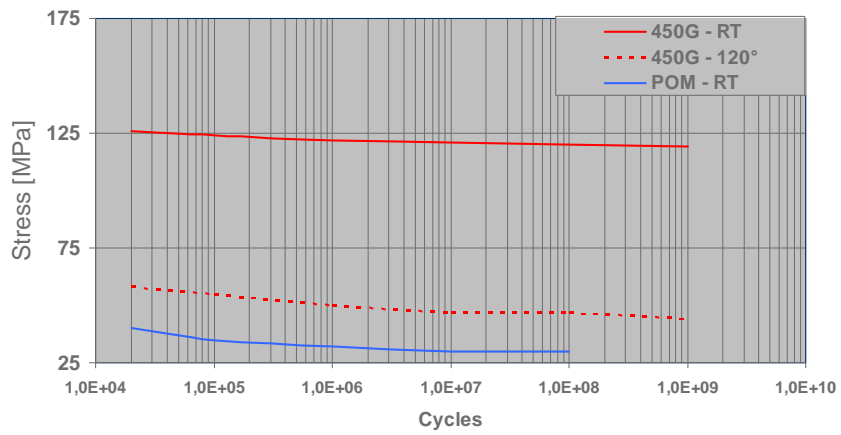


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Flex-Fatigue



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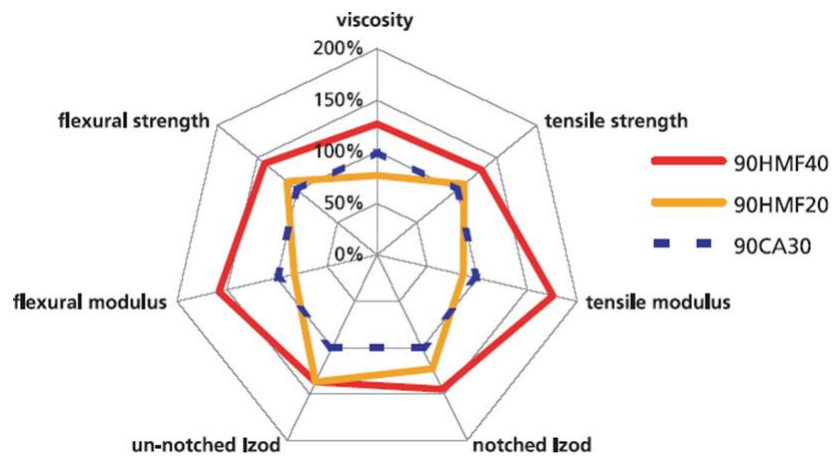
highly innovative products

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Property comparison CA vs HMF (ISO)

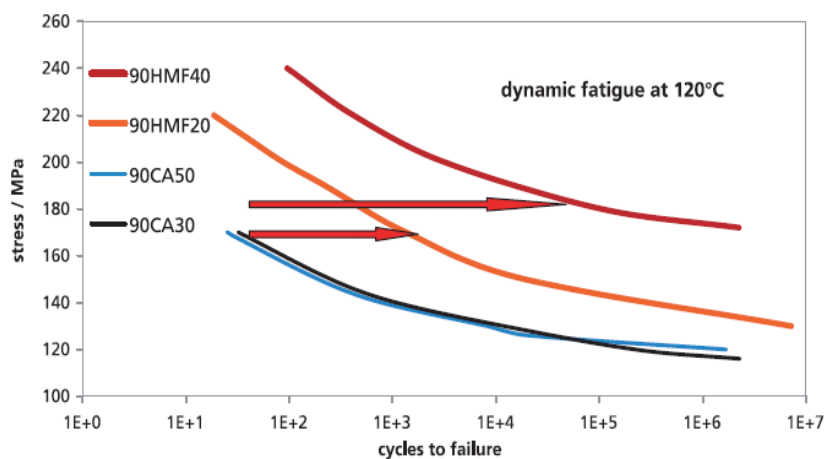


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Dynamic fatigue @ 120°C



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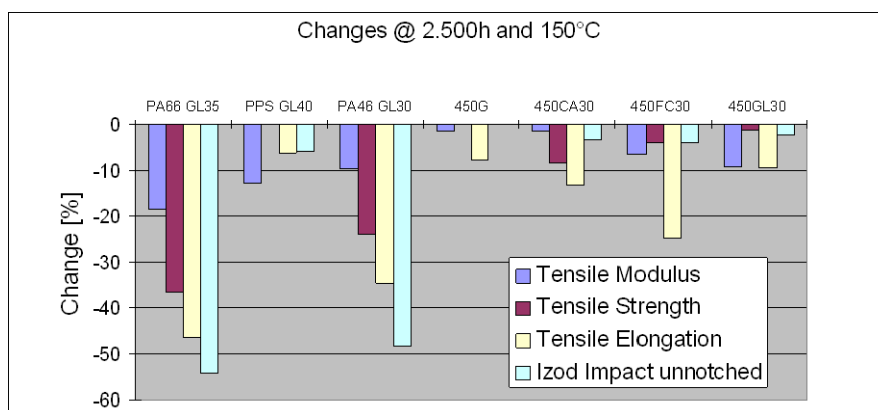
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Data generation – Thermal aging 150°C



Thermal aging 2.500h



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Actuators'

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Metal Replacement - considerations

- Polymer specific design
- thermal expansion
- Anisotropic material behavior
- Properties strongly temperature depending
- Higher creep
- Larger design freedom / integration of multiple functions
- Cost reduction

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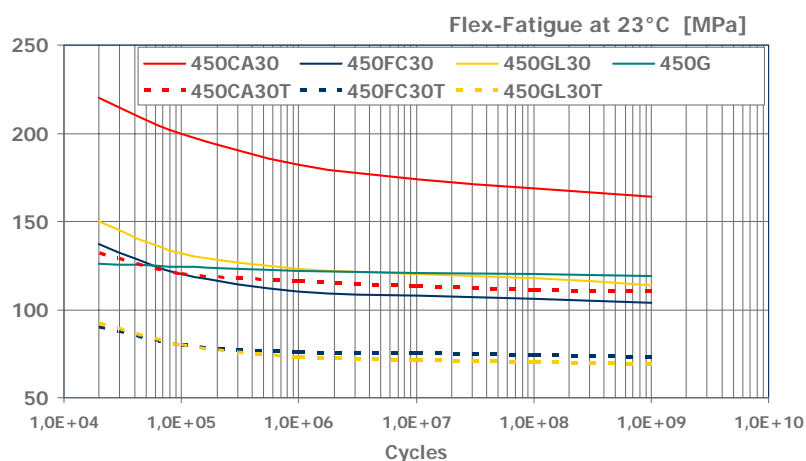
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Gear design recommendations

- Use module >1 for larger teeth and higher load capability
- Contact ratio >1 for more load distribution
- Complementary profile in contact with metal gears
- Make polymer gear stronger, weaken metal gear
- Consider thermal expansion when setting tolerances
- Try to minimise back lash for noise reduction
- For over moulding hubs: rim min. 1,5 times tooth height

Flex Fatigue





VICOTE™ COATINGS

The Next Generation of Coatings for Durability
and Long Life

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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 dft (4-40 mil dft).
- 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 (25-100 dft).
- Typical applications – cookware, irons, engine piston rings, bearings, large parts in chemical plants for corrosion resistance, coating glass and Kevlar™ fabrics.



- **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 – Objects that can't be heated in an oven.

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VICOTE COATINGS – General

Applied to metal substrates as a protective coating. Typically used to improve chemical, corrosion, abrasion and wear resistance.

Thickness Range

Thickness range from 100 - 500 (4 – 20 mils) for electrostatic coating and 25 – 100 microns (1 – 4 mils) for liquid dispersion coating. (In some cases, coating thicknesses as high as 2mm (80mils) have been achieved by multiple passes.

Tolerances

Typical tolerances of +/- 10 microns (0.5 mil) on thinner coatings and +/- 50 microns (2 mils) on thicker coatings. Coatings can be machined.

Application Techniques

VICOTE 700 Series powders are mainly applied electro statically. Fluidized bed, thermal and plasma spraying are other potential techniques.

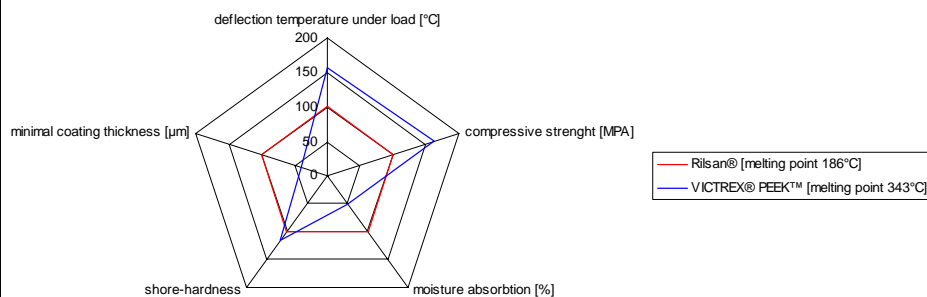
VICOTE COATINGS – Performance

Lubricity	Low coefficient of friction. Will not gall metals. Coating is very smooth when applied correctly.
Abrasion Resistance	3X plus wear resistance versus PTFE and 5x better than PFA, 7x better than PPS. Virtually no particle sloughing.
Mechanical Properties	4X strength of fluoropolymers.
Heat Resistance	For use up to 260°C (500°F).
Electrical Insulation	Consistent over wide range of temperature, frequency and humidity.
Chemical Resistance	Inert in most chemical environments. Not affected by steam. Low moisture absorption.
Purity / FDA Status	Extremely low extractable. Contact Victrex plc for current FDA compliant coatings.

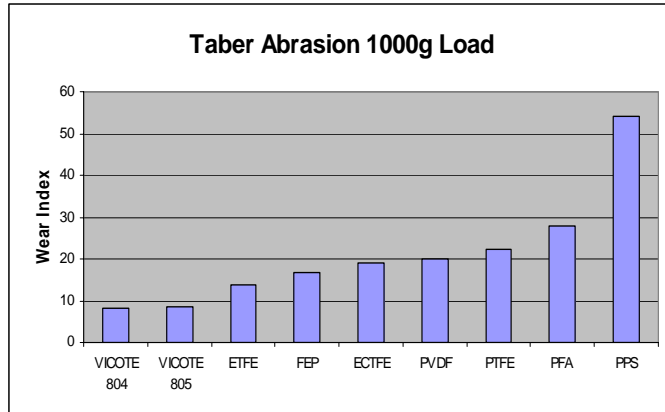
VICOTE COATINGS – Property Comparison vs. Fluor polymer Coatings

- High performance, specialty coatings are dominated by the Fluor polymers. i.e., PTFE, PFA, ECTFE
- Fluoropolymers are known for chemical resistance, low coefficient of friction and excellent release properties.
- Limitations include drop in mechanical performance at elevated temperatures resulting in poor wear, abrasion and cut-through.
- Release properties of Fluor polymers can have an adverse effect on the adhesion of the coating to the substrate. Primer systems may be necessary to achieve satisfactory adhesion. N.B. No primer required for VICOTE products.

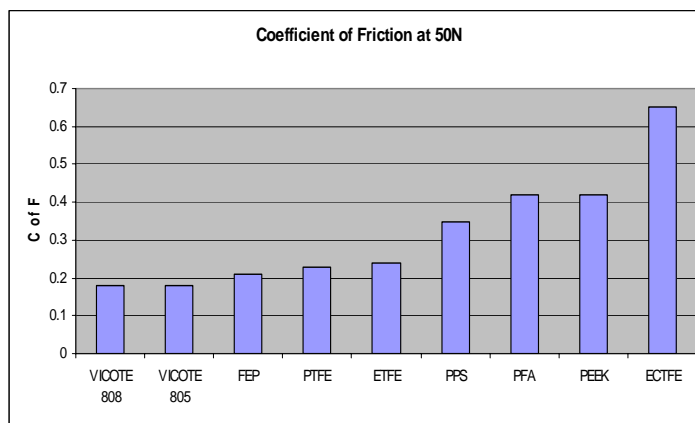
Property Comparison vs. RILSAN™



Taber Abrasion of VICOTE vs Other Coating Materials at 1000g Load



Coefficient of Friction VICOTE vs Other Coating Materials at 50N



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