High Temperature Structural Products, Improved Performance at Elevated Temperatures and Harsh Environments

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1:00 p.m.

THERMOPLASTIC ELASTOMERS • STRUCTURAL • WEAR
CONDUCTIVE • COLOR • FLAME RETARDANT

High Temperature Structural Products, Improved Performance at Elevated Temperatures and Harsh Environments

Matt Torosian,
Product Manager, High Temperature Structural Products

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Presentation Overview

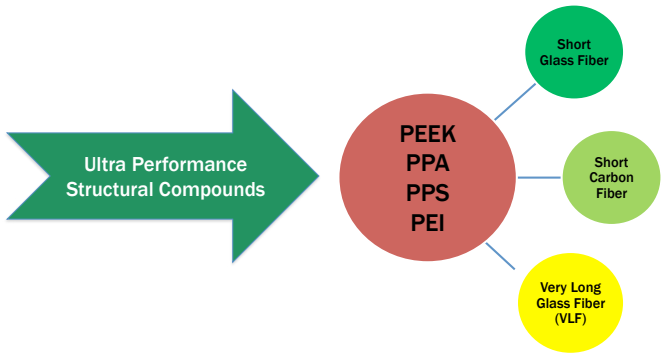
YOUR GLOBAL COMPOUNDER OF CUSTOM ENGINEERED THERMOPLASTICS

- What are Ultra Performance products?
- Highlights
- Review of competing materials
  - Metals
  - Conventional engineering thermoplastics
  - VLF Products
    - Vs. Conventional reinforced TP compounds

Ultra Performance Structural

YOUR GLOBAL COMPOUNDER OF CUSTOM ENGINEERED THERMOPLASTICS

Dictionary: "Ultra" - Very or extreme. (descriptive)



Ultra Performance Structural

YOUR GLOBAL COMPOUNDER OF CUSTOM ENGINEERED THERMOPLASTICS

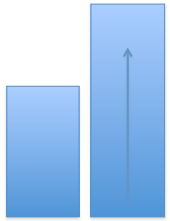
Built upon RTP Company's current standard product portfolio of industry-leading reinforced compounds by

- **Optimizing reinforcement technology**
- **Optimizing process technology**
- *Ultra Performance structural products are in addition to and do not replace our current high temperature structural products*

Ultra Performance Highlights

YOUR GLOBAL COMPOUNDER OF CUSTOM ENGINEERED THERMOPLASTICS

1. **10-30% higher strength and modulus in the RTP Company high temperature portfolio.**
   - Greatest gains in CF compounds
2. **PPA and PPS w/CF demonstrate a 30-40% improvement in room temperature physical properties.**
3. **40%CF PEEK with exceptional properties Vs. Victrex 90 HMF 40, the only other High Modulus PEEK available.**
   - Targeted metal replacement in energy and D&A
4. **VLF products have 3-4 times the impact of short glass products**
   - Improved creep, fatigue and CLTE
5. **Technology is transferable to other polymer systems**



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Ultra Performance Structural Compounds for Greene Tweed, Houston TX

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ISO 9001 CERTIFIED

Ultra Performance Structural

YOUR GLOBAL COMPOUNDER OF CUSTOM ENGINEERED THERMOPLASTICS

Competitive metals

- Die cast aluminum
- Heat treated T-6 aluminum
- Die cast zinc alloy (Zamak 3)

Competitive Materials

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A-380 die cast aluminum and 6061 T-6 heat treated aluminum

- A-380 accounts for over 85% of the Al die cast market

- **Pros**
  - Excellent high temperature performance
  - Very good thermal conductivity
  - Very good EMI shielding capabilities
  - Good corrosion resistance
  - Light: good strength-to-weight ratio (specific strength)
- **Cons**
  - Poor chemical resistance
  - Poor fatigue resistance
  - Subject to attack by galvanic corrosion when in contact with carbon fiber, carbon fiber composites, and other metals

Competitive Materials

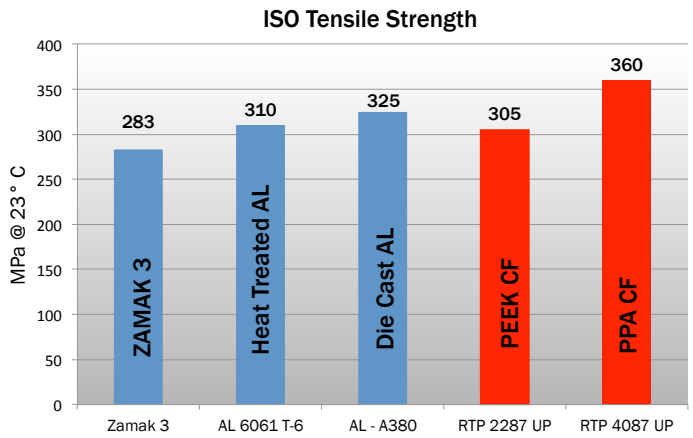
YOUR GLOBAL COMPOUNDER OF CUSTOM ENGINEERED THERMOPLASTICS

ZAMAK alloys are widely used in die casting

- **Pros**
  - Very good EMI shielding
  - Very good conductivity
  - Good strength
- **Cons**
  - Poor creep resistance under load
  - Poor strength-to-weight ratio
  - Difficult to process vs. injection moldable plastics

ISO Tensile Strength

YOUR GLOBAL COMPOUNDER OF CUSTOM ENGINEERED THERMOPLASTICS



Specific Tensile Strength

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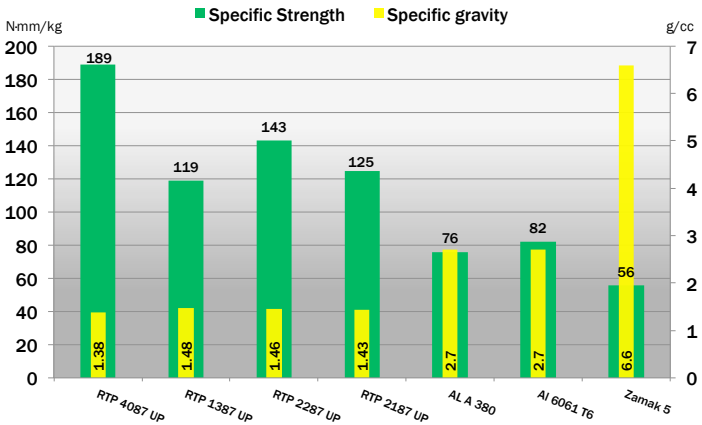

What about Tg and Tm

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- Tg or glass transition temperature is critical when comparing materials for High Temp applications
- **Conventional semi-crystalline thermoplastics are usable above their Tg but physical properties begin to deteriorate quickly**
- **Amorphous materials have defined Tg but have a more gradual drop off in properties bellow the Tg(see graph)**
- Creep and fatigue have increased effects above the TG of thermoplastic materials
  - Crystallinity is critical and affects the Tg
  - End use testing is the best measure of performance

Tensile Strength @ Temperature

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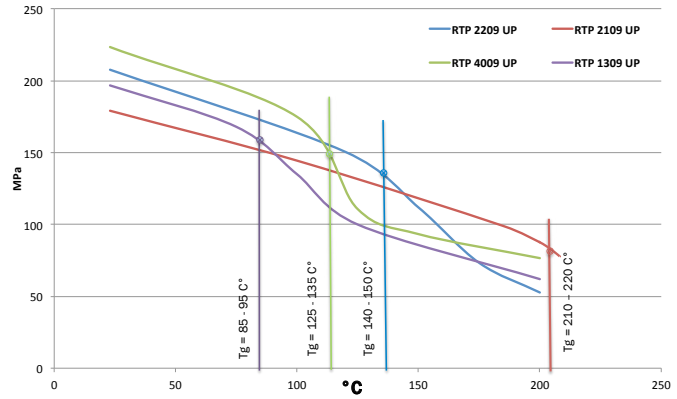

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Ultra Performance Structural Compounds
vs.
Competitive Thermoplastics

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PPA 40%CF Relative Properties

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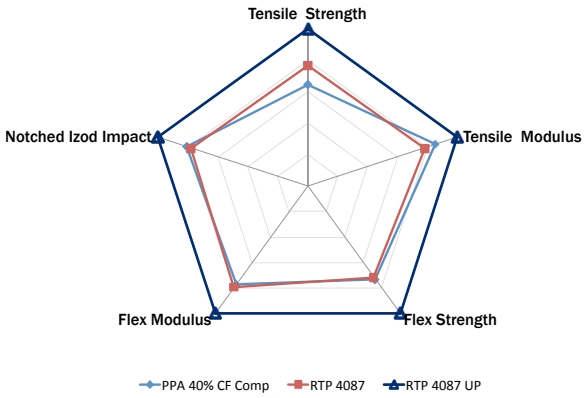

Data Table of Ultra Performance PPA

YOUR GLOBAL COMPOUNDER OF CUSTOM ENGINEERED THERMOPLASTICS

Material	RTP 4087	RTP 4087 UP	Comp. PPA 40% CF	
Tensile Strength	275	360	232	MPa
Tensile Modulus	32500	41500	35500	MPa
Flexural Strength	415	580	425	MPa
Flexural Modulus	27500	34500	26600	MPa
Notched Izod Impact,	7.0	9.0	7.0	KJ/m²

Note: Properties tested using ISO test methods

PPS 40%CF Relative Properties

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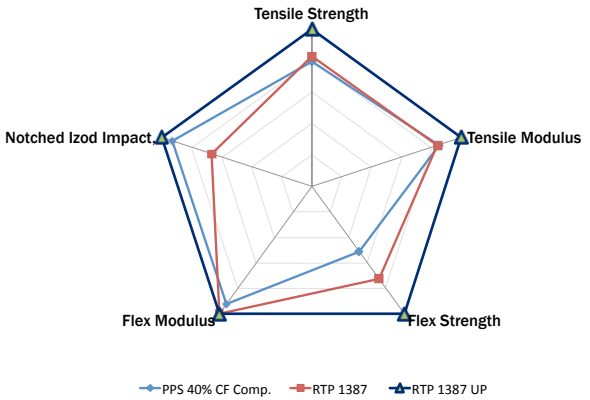


Data Table of Ultra Performance PPS

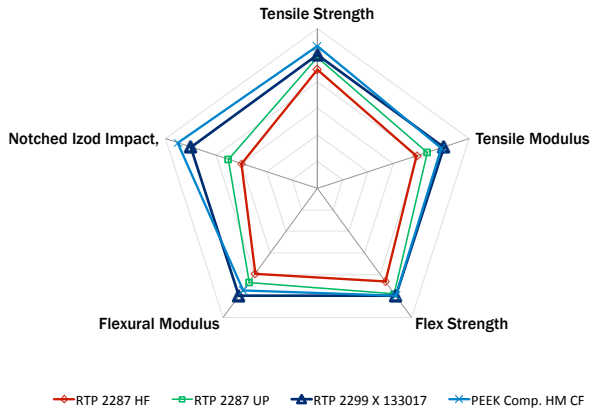
YOUR GLOBAL COMPOUNDER OF CUSTOM ENGINEERED THERMOPLASTICS

Material	RTP 1387	RTP 1387 UP	Comp. PPS 40% CF	
Tensile Strength	215	260	207	MPa
Tensile Modulus	34000	40500	34500	MPa
Flexural Strength	295	405	209	MPa
Flexural Modulus	32500	32500	30000	MPa
Notched Izod Impact,	5.0	7.5	9.0*	KJ/m²

Note: Properties tested using ISO test methods
* Competitive material is a PPS alloy (no other 40% CF PPS competitive data available)

PEEK 40%CF Relative Properties

YOUR GLOBAL COMPOUNDER OF CUSTOM ENGINEERED THERMOPLASTICS



Data Table of Ultra Performance PEEK

YOUR GLOBAL COMPOUNDER OF CUSTOM ENGINEERED THERMOPLASTICS

Material	RTP 2287 HF	RTP 2287 UP	RTP 2299 X 133017	Comp. PEEK 40% CF	
Tensile Strength	270	275	310	330	MPa
Tensile Modulus	27500	36000	46200	45000	MPa
Flexural Strength	385	415	480	480	MPa
Flexural Modulus	24000	31000	39300	37000	MPa
Notched Izod Impact,	6.5	6	10	11	KJ/m²

Note: Properties tested using ISO test methods

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An Introduction to VLF – Very Long Fiber Composites in High Temperature Materials

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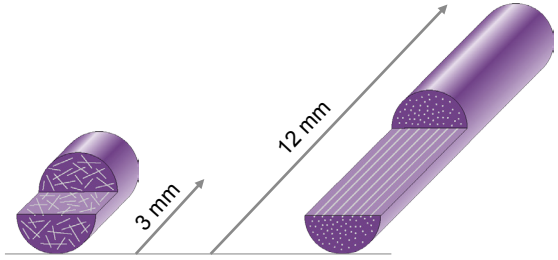
Typical Long Fiber Pellets

Short Fiber & VERY LONG FIBER

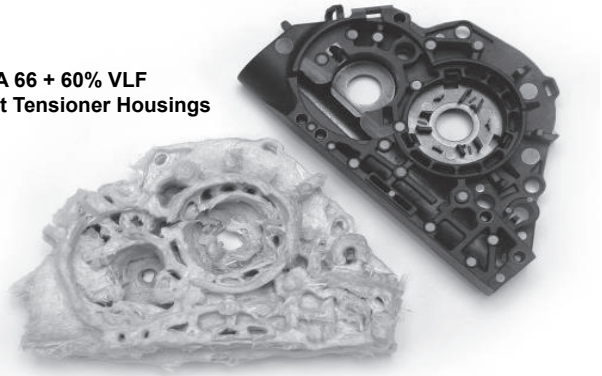


Fibers: ~2 mm 12 mm

The Structural Skeleton

YOUR GLOBAL COMPOUNDER OF CUSTOM ENGINEERED THERMOPLASTICS

PA 66 + 60% VLF
Seat Belt Tensioner Housings



Masterbatch VLF Technologies

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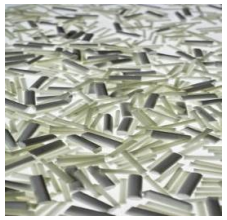
Steel Carbon Glass

Polymers	Additives	"Long Cut" technology
PEEK PPS PBT TPU PP PA	Your color – Your way™ Flame retardants Wear & lubricity Heat stabilizers Nano particles UV resistance Conductivity Anti-stat	

PEI 40%GF Relative Properties

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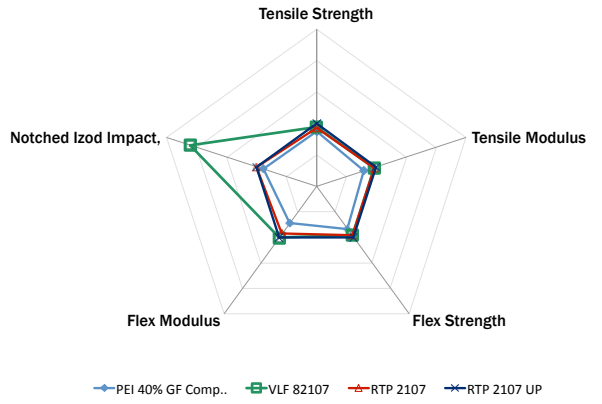

PPS 50%GF Relative Properties

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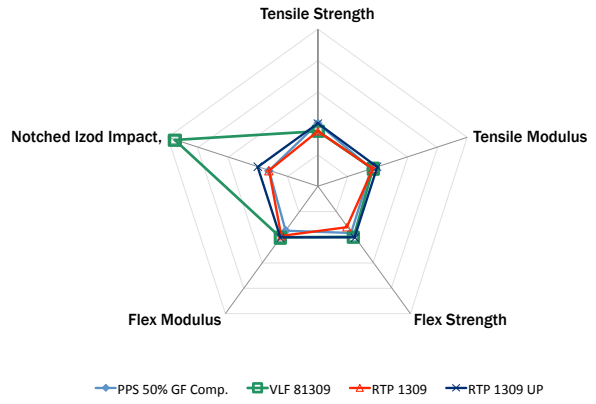

PPA 50%GF Relative Properties

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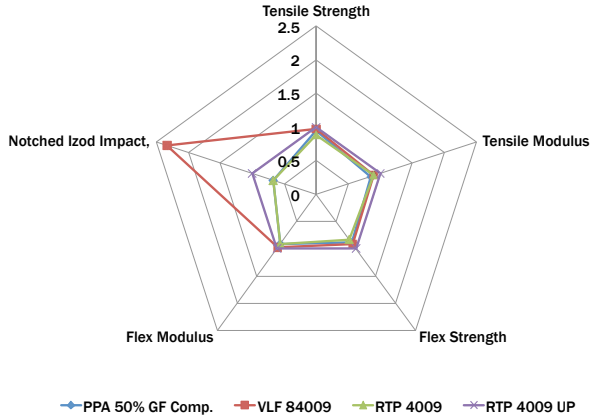

PPA 50%GF Actual Properties

YOUR GLOBAL COMPOUNDER OF CUSTOM ENGINEERED THERMOPLASTICS

	PPA 50% GF Competitive	VLF 84009 50% VLF GF	RTP 4009 50% GF	RTP 4009 UP 50% UP GF	Units
Tensile Strength	270	275	250	285	MPa
Tensile Modulus	17000	18000	18000	20000	MPa
Flex Strength	390	400	370	440	MPa
Flex Modulus	17000	18000	17000	18500	MPa
Notched Izod Impact,	10	35	10	15	KJ/m²

Note: Properties tested using ISO test methods

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Questions?

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