Long Fiber Composites

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Thanks to Karl Hoppe
Presentation Overview

• Very Long Fiber (VLF) Intro
• Property comparisons
• Metal replacement
• Case studies
Standard Compounding Process

Raw Materials → Extruder → Cooling → Pelletizer → Classifier → Finished Product
VLF Manufacturing Process

- Fibers
- Extruder
- Pelletizer
Pellet Comparison

Fiber Length

Short Fiber
~1-2 mm

Long Fiber
12 mm
Fiber Retention

PA 66 + 60% VLF
Seat Belt Tensioner Housings
Advantages of Long Fiber

- Improved impact
- Safer impact mode
- Reduced warpage
- Improved creep resistance
Drop Impact Test

Short Fiber Nylon

Increasing load

Long Fiber Nylon
End User: Red Wing Shoes
Material: VLF Polyurethane
Applied Technology: impact modification

Benefits of stamped metal replacement
• Molded net shape
• Thermal insulation
• Non-permanent deformation
Application: Side Block Plates

End User: Harken, Inc.

Material: VLF nylon 6,10

Applied Technology: deep, rich, pre-colored black extra UV protection

Benefits of stainless steel replacement

- Cost reduction
  - eliminate machining
- Prohibit corrosion from sea water
Molding Considerations

General guidelines:

1. General purpose screw OK (low compression preferred)
2. Reduce shear: low back pressure and rpm’s
3. Reverse barrel profile

preferred:
# Combining Technologies

<table>
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<tr>
<th>Polymers</th>
<th>Additives</th>
<th>Long Cut dry blends</th>
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<tbody>
<tr>
<td>PEEK</td>
<td>Your color – Your way™</td>
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<td>PPS</td>
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<td>PBT</td>
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<td>TPU</td>
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<td>PP</td>
<td>Heat stabilizers</td>
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<td>PA</td>
<td>Nano particles</td>
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<td>PA</td>
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<td>PC</td>
<td>Conductivity</td>
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<td>Taggants</td>
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<td>Spheres</td>
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<td></td>
<td>Anti-stat</td>
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<tr>
<td>Property</td>
<td>Short Fiber Reinforced</td>
<td>Long Fiber</td>
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<tr>
<td>-------------------</td>
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<td>------------</td>
</tr>
<tr>
<td>Tensile Strength</td>
<td>13,000 psi</td>
<td>17,500 psi</td>
</tr>
<tr>
<td>Flexural Modulus</td>
<td>1.00 x10^6 psi</td>
<td>1.20 x10^6 psi</td>
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<tr>
<td>Notched Izod</td>
<td>2.0 ft*lbf/in</td>
<td>5.0 ft*lbf/in</td>
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<tr>
<td>HDT @ °F</td>
<td>264 °F</td>
<td>285 °F</td>
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</tbody>
</table>
Nylon 6/6 – 40 Glass Fiber%
Application: Auto Shifter Base

**End User:** Honda, GM, Toyota

**Material:** VLF Polypropylene

**Benefits of replacing short glass nylon**

- Cost reduction
- Weight reduction
- Designed for the environment  
  – more commonly recycled
Low Temperature Impact

50% Long Glass Compounds

Notched Izod Impact (ft*lb/in)

- PP
- PA 6/6
- RTPU
- PPA

73°F
-40°F
Metal Replacement
Metal Replacement Objectives

- Reduce cost
- Design freedom
- Environmental concerns
- Corrosion and chemical resistance
- Sound and vibration dampening
Application: Brake Cylinder

End User: Demco-Dethmers
Material: VLF nylon 6/6

Benefits of die cast metal replacement

- Cost reduction
  - eliminate painting
  - eliminate machining

- Prohibit Rust

- Increased functionality
  - molded in fluid sight window
ZAMAK alloys are the designer's first choice when considering die casting.

- Z for Zink (zinc)
- A for Aluminum
- MA for magnesium
- K for Kupfer (copper)

ZAMAK 3: This is the most widely used general purpose zinc die casting alloy.
## Instantaneous Properties at 23 °C

<table>
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<th></th>
<th>Zamak 3</th>
<th>60% VLF PA6/6</th>
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<tbody>
<tr>
<td><strong>Specific Gravity</strong></td>
<td>6.6</td>
<td>1.7</td>
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<tr>
<td><strong>Tensile Strength (MPa)</strong></td>
<td>282</td>
<td>275</td>
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<tr>
<td><strong>Flexural Modulus (GPa)</strong></td>
<td>85.5</td>
<td>19.3</td>
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</table>
**Application: Fastening Tool**

**End User:** Vertex Fasteners  
**Material:** VLF Nylon

Benefits of metal replacement:
- Molded net shape
- Lighter
- Faster
Summary

• Increase impact, keep stiffness

• Combine technologies

• Take advantage of plastic design
Application...Shield
Application...Pistol Body
Application...Textile Wheel
Application...Cycle Support
Ladenburg

Equipment

4.... VLF Lines

2.... 58 mm Mega Compounders

2..... 40 mm Mega Compounders
<table>
<thead>
<tr>
<th>VLF Materials</th>
<th>Polypropylene</th>
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<tbody>
<tr>
<td>Glass %</td>
<td>Nylon 6, 66</td>
</tr>
<tr>
<td>Compounds</td>
<td>30, 40, 50 &amp; 60</td>
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<tr>
<td></td>
<td>High Volume</td>
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<tr>
<td></td>
<td>Polypropylene</td>
</tr>
<tr>
<td></td>
<td>Nylons</td>
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VLF Concentrate Masterbatch

- 60% VLF Concentrate
- Neat polypropylene, other
- Blend at the press
- Big parts
VLF PP Concentrate Market Success

Platform: 2009 Dodge Journey
Letdown: 20% long glass PP

Benefits of using VLF PP

- Designed for the environment
- Easily recyclable, use of regrind
- Lightweight

6.6 lbs/part
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