Thermoplastic Technologies for Firearms and Firearm Accessories

Zach Halverson
Product Development Engineer - Structural
RTP Company
• RTP Company
  – Who we are and what we do
  – Why use thermoplastics in firearms

• Firearm Related Technologies
  – Reinforcements
    • Low aspect, short glass, VLF (long fiber), carbon fiber
  – Color
  – Challenging application solutions
  – Lightweighting and Ergonomics

• Review/Questions
RTP Company is an independent, privately owned compounding company.

- Global manufacturing and engineering support
- Worldwide sales representation/distribution
- Established in 1982
- 1300+ employees
- $450+ million annual sales
• **Compounder** → We blend thermoplastic resins with fillers, additives, and modifiers

• **Specialty** → We create engineered formulations tailored to your precise needs

• **Independent** → We are unbiased in our selection of raw materials
YOUR GLOBAL COMPOUNDER OF CUSTOM ENGINEERED THERMOPLASTICS

Worldwide Support

Winona, Minnesota “Corporate Headquarters”

South Boston, Virginia
Fort Worth, Texas
Indianapolis, Indiana
Sauk Rapids, Minnesota
Dupo, Illinois
Monterrey, Mexico
Beaune, France
Ladenburg, Germany
Singapore
Suzhou, China
Shenzhen, China
Global Manufacturing Sites

- Winona, Minnesota
- Sauk Rapids, Minnesota
- Fort Worth, Texas
- Orange, Texas
- Crockett, Texas
- Dupo, Illinois
- Waukesha, Wisconsin
- Gahanna, Ohio
- Indianapolis, Indiana
- South Boston, Virginia
- Richmond, Virginia
- Beaune, France
- Ladenburg, Germany
- Monterrey, Mexico
- Singapore
- Shenzhen, China
- Suzhou, China
Your Global Compounder of Custom Engineered Thermoplastics

Product Families

Comprehensive Product Line

Compounds formulated to meet your needs

Structural

Wear Resistant

Conductive

Thermoplastic Elastomers

Flame Retardant

Color

Film and Sheet
Why Thermoplastics?

- Weight Reduction
- Design Freedom
- Custom Colored
- High Temperature
- Thermal Insulation
- Impact Resistance
- Strong and Durable
- Corrosion Resistance
Our Team of Experts Working With Your Team of Experts

RTP Company is ready to work with your internal design and engineering teams to ensure that we apply key engineering criteria and appropriate regulatory specifications pertinent to your application. By working side-by-side with your team, we help minimize over-specification and are able to provide you with the best custom engineered thermoplastic compound for your application.

ITAR Compliance

RTP Company is ITAR registered with the U.S. State Department and has dedicated export control resources to ensure ITAR compliance. In addition, all relevant employees have received pertinent ITAR control/compliance training. Recurrent training programs are also in place to ensure all employees comply with ITAR requirements.

Your Global Compounder of Custom Engineered Thermoplastics

At RTP Company, we use our 60+ years of independence and expertise in thermosets and engineering thermoplastics to be a materials leader in the defense and aerospace industries. We have accomplished this by forming strategic relationships with defense and aerospace OEMs, processors, and engineering materials suppliers worldwide. We address these industries long (and short) term initiatives using RTP Company's engineering resources and advanced materials technologies.

Our Independence

Our independence permits us to be unbiased as we choose from over 60 engineering resins and hundreds of reinforcements and additives to tailor a specially compound matched to your design requirements. With RTP Company, you won't have to change your expectations to fit an off-the-shelf material.

RTP Company R&D Capabilities

- 40+ development engineers located around the world
- Wide range of technical backgrounds
- Prompt & efficient assistance
- Global R&D facilities allow for seamless transfer of formulations

Manufacturing Facilities:

Winona, MN • South Boston, VA • Fort Worth, TX • Indianapolis, IN • Sao Paulo, Brazil • Dupo, IL • Monterrey, Mexico
Beaune, France • Laudenburg, Germany • Singapore • Suzhou, China • Shenzhen, China

F&TA Technical Brief

SPECIALTY THERMOPLASTIC COMPOUNDS
FOR FIREARMS AND TACTICAL ACCESSORIES

High Performance and Weight Reduction with Innovative Materials Technology

Traditional materials such as wood and metal have been used in the manufacture of firearms since the first weapons were produced. While these materials have performed well, they are often heavy, subject to corrosion, and expensive to manufacture. RTP Company's advanced reinforced thermoplastics help alleviate the undesirable traits of wood and metals when it comes to design and manufacture of firearms and tactical accessories.

More than ever, "lightening the load" is an important part of military sustainability. With the help of RTP Company's structural materials, you can now offer soldiers a lighter weapon thereby making them more mobile and less susceptible to fatigue. At the same time, our lightweight materials offer better corrosion resistance in the field and are compatible with all chemicals commonly used with firearms applications.

RTP Company's structural products also offer an opportunity for design freedom when it comes to creating sleek lines and compound curves. While these designs were often cost-prohibitive due to traditional metal manufacturing methods, injection molding only requires you to design one mold which reduces machining costs and improves manufacturing rates compared to conventional materials.

RTP Company has extensive experience developing materials for firearms applications and our engineers understand the demanding environments in which these materials will have to perform. Whether it is an existing RTP Company compound or a new cutting-edge formulation specifically tailored to meet your application needs, RTP Company can support your custom engineered thermoplastic needs from design through production.
## Materials Matrix

This information is intended as a starting point for product development and materials selection. RTP Company can modify and customize materials to meet your requirements for strength, stiffness, impact performance, EMI shielding, color, wear resistance, and other requirements. We also have extensive experience developing and certifying materials to ASTM, ISO, Mil-Spec, and customer specifications.

Listed are the most common base resins that have historic success in firearms and tactical accessory applications. In addition, typical applications for each resin system are shown. While this is by no means a complete list, it does provide a starting point for materials selection.

<table>
<thead>
<tr>
<th>RTP SERIES &amp; BASE POLYMER</th>
<th>APPLICATIONS</th>
<th>TENSILE STRENGTH (ksi)</th>
<th>NOTCHED IMPACT (ft-lb/in)</th>
<th>TENSILE MODULUS (Msi)</th>
<th>SPECIFIC GRAVITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>RTP 200 Series (Nylon 6/6)</td>
<td>Butt Plate, Buttstock</td>
<td>0 10 20 30 40 50</td>
<td>0 4 8 12 16 20</td>
<td>0 1 2 3 4 5 6</td>
<td>1.2 1.4 1.6 1.8</td>
</tr>
<tr>
<td>RTP 200 H Series</td>
<td>Pistol Grip, Trigger Guard,</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RTP 2100 Series (Polyetherimide)</td>
<td>Pistol Frame, Forend</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RTP 2300 A Series</td>
<td>Thermal Weapon Sight,</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RTP 2300 E Series</td>
<td>Night Vision System, Laser</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RTP 4000 Series (Polyphthalamide)</td>
<td>Ammunition Magazine, Pistol Grip</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Case Study: Rifle Magazine

Weight reduction in firearms and tactical accessories has been an increasingly important goal of manufacturers in recent years. The opportunity to replace the existing rifle magazine with an engineered thermoplastic proved to be an excellent solution that reduced weight and improved field performance due to the compound's high impact resistance. This allowed the magazine to survive even when subjected to rough handling in the field. In addition to improving the user experience, the reinforced polyurethane reduced manufacturing costs by eliminating the need to paint the magazine and allowed it to be assembled via ultrasonic welding.

### Tensile Strength:

Tensile strength is used to help determine whether a material can withstand a static load that will be applied to it during use. The stress-strain curves obtained from tensile testing can also be used in finite element modeling of a part.

### Notched Impact:

Notched impact strength can be an indicator of how the product will perform when subjected to rough handling. With our Very Long Fiber (VLF) technology, we have the ability to offer high strength and stiffness while maintaining excellent impact performance, even at low temperatures.

### Tensile Modulus:

We have a wide variety of reinforcements to choose from which allows us to tailor the stiffness of a material to meet your needs. By adjusting tensile modulus and wall thickness of a part, we can often offer a material that has similar stiffness to metal parts at lower weights.

### Specific Gravity:

"Lightening the load" is a key goal in almost any new firearms application. We can tailor our filler/reinforcement package to offer the mechanical properties needed while minimizing specific gravity. This allows you to offer a lightweight product that improves mobility and effectiveness.

www.rtpcompany.com
• Fillers and Reinforcements
  – Influence of aspect ratio on mechanical properties
  – Beads, minerals, short glass, long glass, carbon fiber

• Color
  – Critical matches and functional additives

• Application Specific
  – Impact, high temperature, UP, stabilization

• Density Modification
  – High gravity, lightweighting

• Ergonomics
  – Bondable Thermoplastic Elastomers (TPE’s)
Property change determined by:

Aspect Ratio = L/D

- Beads (Glass): Aspect Ratio = 1
- Minerals (Talc): Aspect Ratio = 2-50
- Fibers (Glass): Aspect Ratio = 50-250
- Long Glass Fiber: Aspect Ratio = 300+
• Reusable Plastic Handling Container
  – Tight Tolerance
  – Durable
  – Chemical Resistance
  – Stiffness
  – Cheap

• Solution
  – **Mineral** Filled Polypropylene

• How Solution Satisfies Problem?
  – Materials molds to very tight tolerances and maintains good dimensional stability while keeping very low costs.

• Firearm Crossover Example
  – Gun Cases
Mineral/Beads

Shrink Rate $x = \text{Shrink Rate } y$ → Flat Part
Rifle & Shotgun Stocks & Pistol Grips
- Light Weight
- Durable
- Chemical Resistance
- Good Surface Appearance

Solution
- Nylon 6/6 + **Short Glass Fiber**

How Solution Satisfies Problem?
- Materials demonstrate great durability while maintaining a low specific gravity. Un-deteriorated from typical chemicals such as gun cleaner, deet, & gas and oil...
Non-Uniform Shrink = Warp

Shrinkage X1 & X2 ≠ X3 ≠ Y1 → Warp

Glass Fibers
• Oil Pan
  – Chemical Resistance
  – Excellent Strength, Stiffness, & Impact
  – Good Heat Resistance
  – Moderate Cost
  – Extremely Tight Dimensions & Flat

• Solution
  – ????
Glass Fiber + Mineral Combo

Shrink Rate $x = \text{Shrink Rate } y \quad \rightarrow \text{ Flat Part}$

Common Loading = 15% Glass Fiber & 25% Mineral or Beads
Case Study

• Oil Pan
  – Chemical Resistance
  – Excellent Strength, Stiffness, & Impact
  – Good Heat Resistance
  – Moderate Cost
  – Extremely Tight Dimensions & Flat

• Solution
  – Nylon 6/6 + 15% Glass fiber + 25% Mineral

• How Solution Satisfies Problem?
  – Nylon 6/6 brings good heat and chemical resistance while the glass fibers provide necessary reinforcement and mineral aids in maintaining geometric constraints

Firearms Crossover Example:

Firearm hardware with warping problems
• Requirements
  – High Impact (even at low temps)
  – Chemical Resistance
  – Lightweight
  – Wear Resistant
  – Stiff

• Solution
  – VLF (very long fiber) Nylon or RTPU

• How Solution Satisfies Problem?
  – Materials demonstrate great durability and impact strength to protect the
    magazine from drops even at low temps. Good wear resistance to keep
    the magazine functioning at optimal performance; no shells sticking in the
    magazine.
  – Colorable and won’t dent like metal!
YOUR GLOBAL COMPOUNDER OF CUSTOM ENGINEERED THERMOPLASTICS

Extreme Aspect Ratio

Short Fiber

Fiber Length

~ 1-2 mm

Long Fiber

12 mm
PA 66 + 60% VLF
Seat Belt Tensioner Housing
Drop Impact Test

YOUR GLOBAL COMPOUNDER OF CUSTOM ENGINEERED THERMOPLASTICS

Short Fiber Nylon

Increasing impact load

VLF Nylon
<table>
<thead>
<tr>
<th>RTP Series</th>
<th>Resin</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>Polypropylene</td>
</tr>
<tr>
<td>200</td>
<td>Nylons (Polyamides)</td>
</tr>
<tr>
<td>300</td>
<td>Polycarbonate</td>
</tr>
<tr>
<td>400</td>
<td>Polystyrene</td>
</tr>
<tr>
<td>600</td>
<td>ABS</td>
</tr>
<tr>
<td>700</td>
<td>HDPE</td>
</tr>
<tr>
<td>800</td>
<td>POM</td>
</tr>
<tr>
<td>1000</td>
<td>PBT</td>
</tr>
<tr>
<td><strong>1300</strong></td>
<td><strong>PPS</strong></td>
</tr>
<tr>
<td>1400</td>
<td>PES</td>
</tr>
<tr>
<td><strong>2100</strong></td>
<td><strong>PEI</strong></td>
</tr>
<tr>
<td><strong>2200</strong></td>
<td><strong>PEEK</strong></td>
</tr>
<tr>
<td>2300</td>
<td>RTPU</td>
</tr>
<tr>
<td>4000</td>
<td>PPA</td>
</tr>
</tbody>
</table>

* RTP *Ultra Performance* Products
• Kayak Paddle
  – Strength
  – Stiffness
  – Lightweight
  – Aesthetics

• Solution
  – Nylon + **Carbon Fiber**

• How Solution Satisfies Problem?
  – Carbon fiber provided excellent reinforcement and weight savings over glass fiber in a nylon compound while maintaining acceptable aesthetics to the customer while also increasing marketability.

**Firearms Crossover Example:**

*High-end firearm components where increased performance and lightweight are crucial.*
<table>
<thead>
<tr>
<th>Fiber</th>
<th>E-Glass Fiber</th>
<th>Standard Modulus Carbon Fiber</th>
</tr>
</thead>
<tbody>
<tr>
<td>Typical Diameter, µm</td>
<td>10-17</td>
<td>5-10</td>
</tr>
<tr>
<td>Density, g/cm³</td>
<td>2.55</td>
<td>1.81</td>
</tr>
<tr>
<td>Est. Tensile Strength, MPa</td>
<td>3400</td>
<td>4100</td>
</tr>
<tr>
<td>Est. Tensile Modulus, GPa</td>
<td>73</td>
<td>240</td>
</tr>
</tbody>
</table>
## Fillers and Reinforcements

**RTP 200 SERIES NYLON 6,6 COMPOUNDS**

<table>
<thead>
<tr>
<th>Filler / Reinforcement</th>
<th>RTP 200</th>
<th>RTP 227</th>
<th>RTP 207</th>
<th>VLF 80207 EM HS</th>
<th>RTP 287</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Filler / Reinforcement</strong></td>
<td>0 Unfilled</td>
<td>40% Talc Mineral</td>
<td>40% SGF Short Fiber</td>
<td>40% VLF Very Long Fiber</td>
<td>40% CF Carbon Fiber</td>
</tr>
<tr>
<td><strong>Mold Shrinkage, in/in</strong></td>
<td>0.014</td>
<td>0.007</td>
<td>0.004</td>
<td>0.002</td>
<td>0.001</td>
</tr>
<tr>
<td><strong>Specific Gravity</strong></td>
<td>1.14</td>
<td>1.50</td>
<td>1.46</td>
<td>1.46</td>
<td>1.31</td>
</tr>
<tr>
<td><strong>Tensile Strength, psi</strong></td>
<td>11,000</td>
<td>11,000</td>
<td>32,000</td>
<td>33,000</td>
<td>40,000</td>
</tr>
<tr>
<td><strong>Flexural Modulus, Mpsi</strong></td>
<td>0.4</td>
<td>1.0</td>
<td>1.7</td>
<td>1.8</td>
<td>3.7</td>
</tr>
<tr>
<td><strong>Notched Izod Impact, ft-lb/in</strong></td>
<td>1.0</td>
<td>0.9</td>
<td>2.6</td>
<td>6.5</td>
<td>2.0</td>
</tr>
<tr>
<td><strong>HDT @ 264 psi, °F</strong></td>
<td>160</td>
<td>400</td>
<td>480</td>
<td>490</td>
<td>485</td>
</tr>
</tbody>
</table>
Color
• Rifle Body
  – Strength
  – Stiffness
  – Impact
  – Lightweight
  – Critical Color Match

• Solution
  – Nylon + VLF (long glass reinforcement) + Color Masterbatch (MB)

• How Solution Satisfies Problem?
  – VLF provides strength, stiffness, and good impacts in custom matched colors – even at very low temperatures!
• Precolors
• Masterbatches
• Cube blends
• Functional Additives
• Laser Marking
• Glow-in-the-dark
• Spray Colors
  – Camo colors (certain resins)
• Edge Glow
• Thermochromatic
• Photochromatic
• Light-diffusing
• Antibacterial
Application Specific Technologies
• Trail Camera
  – Impact
  – Abrasion
  – Durability
  – Aesthetics

• Solution
  – **Impact Modified** Nylon

• How Solution Satisfies Problem?
  – Improved ductility in low-cost, lightweight material with good abrasion resistance and great aesthetics.
Impact Modifiers

- Increased Impact Properties
- Decreased Strength and Stiffness
• **Automatic Rifle Hand Guard**
  – High Temperature Resistance
  – High Strength
  – Impact Resistance

• **Solution**
  – VLF (long glass reinforced) PPA

• **How Solution Satisfies Problem?**
  – PPA provides high temperature capabilities with VLF reinforcement providing excellent impact resistance, strength and stiffness.
## Comparative Properties for High Temperature Compounds

**Heat Deflection Temperature**
- **264psi (1.82MPa)** with 40% glass fiber

**Continuous Use Temperature**

<table>
<thead>
<tr>
<th>RTP SERIES NUMBER</th>
<th>POLYMER</th>
<th>GLASS TRANSITION TEMPERATURE °F (°C)</th>
<th>CONTINUOUS USE TEMPERATURE °F (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1300</td>
<td>Polyphenylene Sulfide (PPS)</td>
<td>SC 198 (92)</td>
<td>400-450 (204-232) 500 (260)</td>
</tr>
<tr>
<td>2200</td>
<td>Polyetheretherketone (PEEK)</td>
<td>SC 290 (143)</td>
<td>450-500 (232-260) 600 (316)</td>
</tr>
<tr>
<td>2200A</td>
<td>Polyetherketone (PEK)</td>
<td>SC 329 (165)</td>
<td>500-550 (260-288) &gt;600 (&gt;316)</td>
</tr>
<tr>
<td>4000</td>
<td>Polyphthalamide (PPA)</td>
<td>SC 274 (135)</td>
<td>350-400 (177-204) 535 (279)</td>
</tr>
<tr>
<td>4000A</td>
<td>Hot Water Moldable Polyphthalamide (PPA)</td>
<td>SC 239 (115)</td>
<td>300-350 (149-177) 535 (279)</td>
</tr>
<tr>
<td>4100</td>
<td>Polyetherketoneketone (PEKK)</td>
<td>SC 330 (166)</td>
<td>450-500 (232-260) &gt;600 (&gt;316)</td>
</tr>
<tr>
<td>4200</td>
<td>Polyimide (TPI)</td>
<td>SC 482 (250)</td>
<td>500-550 (260-288) 630 (332)</td>
</tr>
<tr>
<td>4400</td>
<td>High Temperature Nylon (HTN)</td>
<td>SC 257 (125)</td>
<td>300-350 (149-177) 500 (260)</td>
</tr>
<tr>
<td>900</td>
<td>Polysulfone (PSU)</td>
<td>A 374 (190)</td>
<td>300-340 (149-171) 365 (185)</td>
</tr>
<tr>
<td>1400</td>
<td>Polyethersulfone (PES)</td>
<td>A 435 (224)</td>
<td>350-400 (177-204) 420 (216)</td>
</tr>
<tr>
<td>2100</td>
<td>Polyetherimide (PEI)</td>
<td>A 415 (213)</td>
<td>350-400 (177-204) 410 (210)</td>
</tr>
<tr>
<td>3400</td>
<td>Liquid Crystal Polymer (LCP)</td>
<td>LC ---</td>
<td>400-450 (204-232) 610 (321)</td>
</tr>
</tbody>
</table>
Dictionary: "Ultra" - Very or extreme. (descriptive)
# Carbon Fiber Reinforced PPA Comparison

<table>
<thead>
<tr>
<th></th>
<th>RTP 4087</th>
<th>RTP 4087 UP</th>
<th>Competitor PPA 40% CF</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Tensile Strength, MPa (psi)</strong></td>
<td>275 (39885)</td>
<td>360 (52215)</td>
<td>232 (33650)</td>
</tr>
<tr>
<td><strong>Tensile Modulus, MPa (psi*10^6)</strong></td>
<td>32500 (4.7)</td>
<td>41500 (6.0)</td>
<td>35500 (5.1)</td>
</tr>
<tr>
<td><strong>Flexural Strength, MPa (psi)</strong></td>
<td>415 (60190)</td>
<td>580 (84120)</td>
<td>425 (61640)</td>
</tr>
<tr>
<td><strong>Flexural Modulus, MPa (psi*10^6)</strong></td>
<td>27500 (4.0)</td>
<td>34500 (5.0)</td>
<td>26600 (3.9)</td>
</tr>
<tr>
<td><strong>Notched Izod Impact, KJ/m^2</strong></td>
<td>7.0</td>
<td>9.0</td>
<td>7.0</td>
</tr>
</tbody>
</table>

Note: Properties tested using ISO test methods.
• Heat stabilizers come in many forms
  – Slow down the degradation reactions of the polymer caused by heat
  – Can be for process stability or Long Term Heat Aging (LTHA)

• UV Stabilization
  – HALS: Protects polymer by stopping degradation reactions once they have started
  – UV Absorbers: Protects polymer by absorbing harmful UV light before the degradation reaction has started
40% VLF PP
1000 Hour Heat Aging

<table>
<thead>
<tr>
<th>Temperature</th>
<th>Tensile Retention</th>
<th>Izod Impact Retention</th>
</tr>
</thead>
<tbody>
<tr>
<td>140°C</td>
<td>+5.7%</td>
<td>+9.9%</td>
</tr>
<tr>
<td>150°C</td>
<td>-4.7%</td>
<td>-11.3%</td>
</tr>
</tbody>
</table>

Typical Automotive requirements are ~+/- 25%
• High Gravity Materials
  – Density of 2.0 to 11 g/cm³
  – Metallic and non-metallic additive options

• Lightweighting
  – Down to .7 g/cm³ density
  – Reinforcements
  – Resin changes
  – Chemical foaming agents
  – Glass Bubble
Specific Gravity Range

- Lead
- Nickel
- Tungsten
- Copper Alloys
- Steel Alloys
- Titanium
- Ferrous minerals
- Barium Sulfate
- Glass Bubbles
- Water

High Gravity Compounds

Low Gravity Compounds
• Why add weight?
  – Sound/vibration damping
  – Polymer based projectiles
  – Balancing
  – Perceived value
  – Productivity increase
Applications

- Projectiles
  - Frangible
  - Jacketed or unjacketed
- Casings
- Dummy rounds

Benefits

- 100% lead free
- Up to same density as lead
- Customized grades to fit application
- Colorable

### Projectile Materials

<table>
<thead>
<tr>
<th>Product</th>
<th>Resin</th>
<th>SG</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>RTP 299 A X 106739</td>
<td>Nylon 6</td>
<td>5.75</td>
<td>Jacketed/Unjacketed</td>
</tr>
<tr>
<td>RTP 299 A X 92682 J</td>
<td>Nylon 6</td>
<td>11.0</td>
<td>Jacketed/Unjacketed</td>
</tr>
<tr>
<td>RTP 2099 X 106722 C</td>
<td>Alloy</td>
<td>11.0</td>
<td>Jacketed</td>
</tr>
</tbody>
</table>
• Glass Bubbles
  – Reduce density in many resins
  – Some property loss
  – Good aesthetics possible

• Chemical Foaming
  – Up to 20% density reduction
  – Added as masterbatch
  – Poor aesthetics
  – Limited resin selection
Over 20% reduction possible depending on resin used.

Specific Gravity (ASTM D 792)

- Unfilled Nylon 6/6: 1.14
- Nylon 6/6 with Glass Bubbles: 0.89
- High-Impact Nylon 6/6 with Glass Bubbles: 0.85
Elastomers
• **Axe Handle**
  – Strong
  – Durable
  – Soft grip
  – Colorable

• **Solution**
  – Black VLF Substrate + Colored Bondable TPE

• **How Solution Satisfies Problem?**
  – VLF brings required mechanical properties and durability while the overmolded bondable TPE provides comfortable grip and shock absorption in an aesthetically pleasing design.

**Firearms Crossover Example:**

Rifle butt pad or ergonomic pistol grip.
**ThermoPlastic Elastomer**

“...Having the property of softening or fusing when heated and of hardening again when cooled...”

“...Any of various elastic substances resembling rubber...”

---

**Thermoplastic Elastomer (TPE) Bondability**

The products listed below are offered across a broad hardness and flexibility range. Please contact your local RTP Company representative to inquire about application suitability or to request detailed product data.

<table>
<thead>
<tr>
<th>Rigid Substrate Material</th>
<th>ABS</th>
<th>PA 6</th>
<th>PA 6/6</th>
<th>PBT</th>
<th>PC</th>
<th>PC/ABS</th>
<th>PBT/PC</th>
<th>PET/PC</th>
<th>PC/PMMA</th>
<th>PP</th>
<th>RTPU</th>
</tr>
</thead>
<tbody>
<tr>
<td>RTP 2700 S</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RTP 2740 S</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RTP 2800 B</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RTP 6091</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RTP 6042</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>RTP 6003</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
• **Bondable TPE’s**
  – Many substrates possible (high-temp problematic)
  – RTP 6091 TPV for nylon – top notch chemical resistance
  – Multi-shot molding for creativity and mfg. efficiency

• **Applications**
  – Overmolded stocks and forearms
  – Stand-alone grips
  – Energy absorption/damping

• **Customizable**
  – Hardness
  – Vibration and damping qualities
  – Density

<table>
<thead>
<tr>
<th>Bondable TPE SERIES</th>
<th>Shore A HARDNESS RANGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>RTP 2700 S</td>
<td>30 A - 90 A</td>
</tr>
<tr>
<td>RTP 2740 S</td>
<td>30 A - 90 A</td>
</tr>
<tr>
<td>RTP 6042</td>
<td>40 A - 70 A</td>
</tr>
<tr>
<td>RTP 6003</td>
<td>45 A – 75 A</td>
</tr>
<tr>
<td>RTP 6091</td>
<td>55 A - 85 A</td>
</tr>
</tbody>
</table>
• RTP – Global Specialty Independent Compounder
• Technologies
  – Reinforcement : Aspect Ratio Dependent
    • Glass Bead, Mineral, Chopped Glass, VLF, Carbon Fiber
  – Color
    • In-house Expertise Color Development and Functional Additives
  – Solutions tailored for application specific needs
    • Impact Modifiers
    • High Temperature
    • Ultra Performance
    • Density Modification
  – Bondable TPE’s
• Questions??

Contact Info:

Zach Halverson
Product Development Engineer
(507) 474-5393
zhalverson@rtpcompany.com
www.rtpcompany.com