RTP Company Eco Solutions

Eco-Friendly, Engineered Plastic Solutions

Will Taber, Business Manager–Emerging Technologies

Agenda

• RTP Company
• What are Eco Solutions?
• What is green?
• Bioplastic compounds
• Recycle content compounds
• Cellulose Fiber Reinforced PP
• Future development work
• Economics
• Summary

Profile

• RTP Company is an independent, privately owned custom compounder.
• Global manufacturing and engineering support
• Worldwide sales representation/distribution
• Established in 1982
• 1000+ employees
• $400+ million annual sales
RTP Company Eco Solutions

Custom Solutions

- High-tech specialty compounder
  - 60+ engineering resins
  - 100+ modifiers
- Annual production
  - 6000+ commercial products
  - 1750+ new products each year

Global Manufacturing

United States • Mexico • France • Germany • China • Singapore

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Eco Solutions “Green” Compounds

Our Eco Solutions portfolio consists of compounds that utilize
- Renewable or biobased content
- Recycled content
- Halogen-free additives
- Natural fibers
- Combinations of bioplastic, recycled, halogen-free, natural fiber
What does “green” mean?
• Depends on industry, products, and capabilities
• Infers that a product is more environmentally friendly
  – Examples: less energy consumed, less CO₂ produced, made from a renewable resource etc...
• Eco Solutions are our products (capabilities) we can utilize to help your customers produce a “green” product
“Green” Products

- Product certifications provide credibility
  - USDA BioPreferred, EPEAT (US)
  - Vincotte, C2C (Europe)
  - Japan BioPlastics Association (Japan)
  - BIFMA (Business and Institutional Furniture Mfg. Assoc.)
  - All of the above value and or certify recycle content, biobased content or both

- Certifications provide proof a product meets a set of “green” criteria

Bioplastic Compounds

- Definitions
- Types
- Strategy
- Product portfolio
- Applications
- Information
- Limits of use

Bioplastics – Defined

- Bioplastics are a form of plastics derived from renewable (annually) biomass sources such as corn, wheat, sugar cane, and sugar beets rather than traditional plastics derived from petroleum
- Some, but not all, bioplastics are designed to biodegrade.

Economics, availability, and performance has placed an emphasis on
Polylactic Acid (PLA)
Biobased versus Biodegradable

<table>
<thead>
<tr>
<th>Biobased</th>
<th>Biodegradable</th>
</tr>
</thead>
<tbody>
<tr>
<td>• PLA</td>
<td>• PLA (via industrial composting)*</td>
</tr>
<tr>
<td>• Nylon (11, 6/10)</td>
<td>• PBS</td>
</tr>
<tr>
<td>• PTT</td>
<td>• PHA (via “backyard” composting)</td>
</tr>
<tr>
<td>• PHA</td>
<td>• Thermoplastic starch</td>
</tr>
<tr>
<td>• PE</td>
<td></td>
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<tr>
<td>• PBS</td>
<td></td>
</tr>
<tr>
<td>• Thermoplastic starch</td>
<td></td>
</tr>
</tbody>
</table>

* Not biodegradable in household waste sanitary landfill

How Do We Report Biocontent?

- **Renewable resource content (weight%)**
  - Tells how much of the compound by weight is a renewable or biobased plastic (e.g., 30% PLA and 70% PC)

- **Biobased carbon content**
  - Per ASTM D 6866 – Distinguishes “new” carbon vs “old”
  - Reports renewable carbon content as a % of total carbon content
  - Does not consider product weight
  - Does not measure biodegradability
  - Does not take into account non-organic (carbon) elements such as oxygen, hydrogen or silicon (glass)
  - Can provide different results vs weight%

Where Does RTP Fit?

- **Base Resins**
  - PLA, Nylon 11, Nylon 6/10, PTT, PE.

- **Semi-durable and durable applications**
  - Office furniture, appliance, consumer electronics, niche “green” electronics in controlled environments.

- **Custom Compounds**
  - Structural, impact modified, mineral, FR, conductive, wear, recycled content.

- **Current Focus PLA**
  - Good economics, good supply, easy to modify, advancements in compounding and polymerization.

PLA Compound Portfolio

- **Glass reinforced**
- **Impact modified – Performance (high HDT)**
- **Impact modified – Translucent**
- **Impact modified – Opaque**
- **Impact modified – FDA compliant**
- **Alloys**
**Glass Reinforced PLA**

**Market:** Consumer  
**Application:** Scissors Handle  
**Problem:** Biobased material to replace glass reinforced PP  
**Solution:** RTP 2000 Series 30% glass reinforced PLA  
**Benefit:** Superior strength and stiffness vs 30% glass PP. Nucleated for improved cycle time. 68% renewable resource content

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**Impact Modified PLA**

- Nucleated  
- Mineral reinforced  
- FDA compliant ingredients  
- Opaque or translucent  
- Colorable and glossy  
- Injection or extrusion  
- Balance cost, properties, biocontent

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**Impact Modified PLA Portfolio**

Extensive portfolio can be modified to meet specific economic and performance targets
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**High Performance PLA**

Increased rate and degree of crystallization yields:

- Reduced cycle time
- Higher HDT with lower cost nucleators
- Improved hydrolysis resistance?

*2099132557A: standard impact mineral reinforced

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**Impact Modified PLA Application**

- **Market:** Sporting Goods
- **Application:** Bicycle Helmet
- **Problem:** High biobased content. Good durability, gloss and color. Option to paint.
- **Solution:** RTP 2000 Series Impact Modified PLA
- **Benefit:** 79% renewable content, excellent balance of strength and toughness. Good flow for thin walls. Glossy and colorable

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**Impact Modified PLA Application**

- **Market:** Sporting Goods
- **Application:** Promotional Divot Tool
- **Problem:** High biobased content. Good durability, gloss and color
- **Solution:** RTP 2000 Series Impact Modified PLA
- **Benefit:** 84% renewable content, excellent balance of strength and toughness. Good flow for thin walls. Glossy and colorable

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**PLA Alloys**

- PLA/PC
- PLA/PC (recycled PC)
- PLA/PC FR (non-hal V-0)
- PLA/PC FR (non-hal V-0, recycled PC)
- PLA/PMMA (clear and impact opaque)
- PLA/PE
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PLA/PC Alloys

• PLA-PC Alloys Balance Renewable Content With High Impact Strength and Heat Deflection Temperature

<table>
<thead>
<tr>
<th>Renewable Resource Content</th>
<th>Notched IZOD (ft-lbs/in)</th>
<th>73F</th>
<th>HDT at 66 psi (F)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ABS</td>
<td>0%</td>
<td>4</td>
<td>206</td>
</tr>
<tr>
<td>PC-ABS</td>
<td>0%</td>
<td>0%</td>
<td>255</td>
</tr>
<tr>
<td>PLA-PC Alloy</td>
<td>32%</td>
<td>16%</td>
<td>230</td>
</tr>
</tbody>
</table>

PLA Compounds Limits of Use

• Suitable for applications requiring:
  – High impact and stiffness
  – High gloss and colorability
  – FDA compliant ingredients
  – Products with renewable/sustainable resource content
  – Moldability in existing tools
  – Use in a controlled environment, ie: home, office

• Not suitable for applications requiring:
  – Extended exposure to high heat and humidity. Consult with R&D to determine limits for your particular application
  – Applications requiring biodegradability in landfill at ambient temps

Market: Consumer Electronics
Application: Portable Electronics Housing
Problem: Biobased content with good balance of stiffness, impact and heat deflection temperature. Moldable in existing tooling
Solution: RTP 2000 Series PLA/PC Alloy
Benefit: 32% renewable resource content. 14 ft-lbs/in notched izod with a 240°F (115°C) HDT. Processed in existing tooling with added benefit of being overmoldable with soft touch elastomer
New PLA Products

- High gravity
- Permanently anti-static
- PLA/acrylic sheet compound
- Improved FR PLA/PC
- Recycle content

PLA Compounds – Information

- Updated bio-compounds innovation bulletin
- Glass reinforced bulletin
- Impact modified bulletin
- USDA product listings
- Processing guide
- Regrind studies
- Sample plaques
- Product data sheets

Biobased PE Compounds

- Advantages
  – Biobased
  – Recyclable
  – Composition same as Petroleum PE
  – Properties, and processing
  – Cost relative to other biobased plastics
- Disadvantages
  – Some unknowns in supply
  – Compostability

Biobased PE Compounds

Glass Reinforced Bio PE vs Glass PP

- Tensile Strength
- Notched Izod ft-lbs/in
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Recycled Content Compounds

• RTP Company Strategy
• Source Certification
• Portfolio
• Considerations

Recycled Content Strategy

• Provide a means for customers to “green” their product via recycle content
• FTC guidelines – type/amount, substantiation
• Utilize pre- and post-consumer:
  – PP, Nylon6, Nylon 6/6, PC, PET
• Pursue “one off” opportunities as presented
• RTP Company is a compounding who can utilize recycled content to add value... not a recycler
Recycled - Source Certification

Recycled Content - Considerations

- Supply and pricing is dynamic
- Can be difficult to verify source
- Post Consumer is more highly valued than Pre Consumer but generally more variable in properties and higher levels of contamination
- Post Consumer compounds limited to black
- Consider tradeoffs between recycle content and performance...RTP can help to overcome limitations!
- Opportunity for cost parity with complex compounds and provide a “green” angle... ie impact modified, FR, wear, conductive.

Recycled Content Product Portfolio

- Post-consumer content
- Limited to black
- Can provide lot COA with type and amount of recycle
- Directed at applications where PCR recycle content is key
- Not necessarily lowest cost
- Limited feedstock availability in Europe/Asia

<table>
<thead>
<tr>
<th>Post-Consumer Recycle Content Compounds</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>PP</strong></td>
</tr>
<tr>
<td>20% glass</td>
</tr>
<tr>
<td>30% glass</td>
</tr>
<tr>
<td>40% glass</td>
</tr>
<tr>
<td>60% glass</td>
</tr>
<tr>
<td>60% glass</td>
</tr>
<tr>
<td>glass/monomer 70/30</td>
</tr>
<tr>
<td>glass/monomer 50/50</td>
</tr>
<tr>
<td>glass/monomer 30/70</td>
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<tr>
<td>glass/monomer 10/90</td>
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<tr>
<td>glass/monomer 50/50</td>
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<td>glass/monomer 50/50</td>
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</tbody>
</table>

Recycled Content Application

- Market: Sports and Recreation
- Application: Kayak Paddle
- Problem: Very high strength and rigidity with good surface finish
- Solution: RTP 200 A Series carbon fiber reinforced compound
- Benefit: Excellent balance of properties and surface finish while utilizing recycled carbon fiber content
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Cellulose Fiber Reinforced PP

Benefits vs Glass Reinforced PP

Benefits vs Other Natural Fillers

Cellulose Fiber Reinforced PP vs Glass Fiber PP

Cellulose PP vs Talc PP
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Cellulose Fiber PP Compounds

- **Base Resin**
  - Homopolymer (standard and high flow)
  - Copolymer
  - Recycle content
- **Fiber**
  - Cellulose (5% - 40%)
  - Cellulose + glass
- **Other**
  - Color (precolor or concentrate)
  - Elastomer overmold

Cellulose Fiber PP Application

- **Market:** Furniture
- **Application:** Chair
- **Problem:** Produce an eco-friendly product with that has mechanical properties similar to 20% glass reinforced PP that can be molded via gas assist
- **Solution:** RTP 100 Series 30% Cellulose fiber reinforced Homopolymer PP
- **Benefit:** Superior properties and processing versus wood flour PP with equivalent stiffness to glass reinforced PP and good colorability. Molded via gas-assist with improved cycle time versus glass PP

- **Market:** Lawn and Garden
- **Application:** Weeding Tool
- **Problem:** Produce an eco-friendly product with that has good mechanical properties and “natural” look
- **Solution:** RTP 100 Series Cellulose fiber reinforced PP
- **Benefit:** Superior properties and processing versus wood flour PP with good colorability
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**Development Work**

- Higher HDT (crystallinity) PLA
- Lower cost nucleators
- Improved stabilization of PLA
- Biobased olefin compounds
- PCR feedstreams
- Lower cost FR PLA/PC

**Eco-Friendly Compound Economics**

- Cost
- Bio-based Nylon/PTT
- PLA Alloys Nucleated PLA
- Impact PLA
- Cellulose Fiber PP
- Recycle Content
- Economics
- Summary
Economic Fits

Yes:
- Recycle content
- PLA compounds
  - (antistatic, lubricated, precolor)
- BIO PE compounds
- Cellulose PP vs Glass PP

No:
- Commodity PP, HIPS, ABS

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Summary

- The “green” movement is approaching a “tipping point”
  - Knowledge of “green” products and benefit
  - Technical feasibility
  - Economic viability
  - Visibility via first movers

- RTP Company has many hard to replicate assets that can be used to achieve your “green” initiatives
  - Formulation and compounding knowledge
  - Key supply relationships
  - Worldwide mfg., tech service, and R&D
  - An entrepreneurial spirit
  - How can we help you meet your sustainability objectives?
Questions?

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