Biopolymers for Paperboard Extrusion Coating and Converting

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Introduction

- Sustainable Packaging
- Paper & Bioplastics
- Extrusion Coating & Packaging
- Challenges & Opportunities
- Applications
Linear Economy

Cradle to Grave

Take → Make → Waste
Circular Economy

Cradle to Cradle

make
use
return
Fossil vs. Bio

- Reuse renewable resources
- Reduce carbon footprint
- Enhance sustainability profile
Global Bioplastics Production Capacity

Source: European Bioplastics, Institute for Bioplastics and Biocomposites, nova-Institute, Germany, 2015.
Pulp & Paper

- Natural
- Renewable
- Biodegradable
- Compostable
- Recyclable
The Best of Both Worlds

Paper + Bioplastics = Key Future Packaging Trend

• Sustainable
• Reduced carbon footprint
• Low environmental impact
• Cost effective
• End-of-life options
# Conventional Polymers vs. Biopolymers

<table>
<thead>
<tr>
<th>Biodegradable /Biobased</th>
<th>Non-Biobased</th>
<th>Partially Biobased</th>
<th>Biobased</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biodegradable</td>
<td>PBS, PBSA, PCL, PGA, PVOH</td>
<td>Starch Blends, PLA Blends, PBS, PBAT</td>
<td>PLA, PBS, PHA, PHB, TPS, CA, Starch</td>
</tr>
<tr>
<td>Non-Biodegradable</td>
<td>PE, PP, PET, PBT, PA6, PA66</td>
<td>PBT, PET, PTT, PA6.10</td>
<td>PE, PA11, PA12, PA1010, PEF, PET, PTT</td>
</tr>
</tbody>
</table>
Biodegradable/Compostable Polymers

- ASTM D6400, EN 14995/13432, ISO 17088
- Chemical: heavy metal limits
- Disintegration: <10% larger than 2mm
- Biodegradation: >90% CO2 conversion, 6 months
- Ecotoxicity: no harmful effect on plant growth
- Compostable polymers are biodegradable, but not vice versa.
- Industrial composting
Biobased Polymers

- Derived from plants or other renewable sources
- ASTM D6866, ASTM D7026
- Biobased content determined by carbon-14 dating
- Biobased polymers may or may not be compostable.
Paperboard Extrusion Coating
Challenges

- High process temperature (>290°C/550°F)
- Polymer-to-paper fiber adhesion
- Good melt strength, low neck-in
- Good coat weight profile control
- Low/no smoke, defects, die lip buildups
- Easy to purge, clean up & change over
## Materials

<table>
<thead>
<tr>
<th>Features \ Polymer</th>
<th>Fossil LDPE</th>
<th>Bio-LDPE</th>
<th>PLA</th>
<th>(Bio) PBS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biobased</td>
<td>N</td>
<td>Y</td>
<td>Y</td>
<td>Y*</td>
</tr>
<tr>
<td>Commercially Available</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y*</td>
</tr>
<tr>
<td>Flexible</td>
<td>Y</td>
<td>Y</td>
<td>N</td>
<td>Y</td>
</tr>
<tr>
<td>Heat Sealability</td>
<td>Excellent</td>
<td>Excellent</td>
<td>Fair</td>
<td>Good</td>
</tr>
<tr>
<td>FDA Food Contact</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Liquid Barrier</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Oil Grease Barrier</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Industrial Composting</td>
<td>N</td>
<td>N</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Home Composting</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>Y**</td>
</tr>
<tr>
<td>Marine Degradable</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>?</td>
</tr>
</tbody>
</table>

*Bio version in scale-up to commercial supply  ** Limited grade
Process & Equipment

- All extrusion coating challenges apply.
- PLA poor melt strength, curtain stability, neck-in; narrow process window
- Molecular modification
- Alternate biopolymers
- Proper screw configuration and die design for shear sensitive polymers
Food Contact Regulatory Compliance

- Food packaging and foodservice products require proper food contact compliance and suitable Conditions of Use.

- US FDA 21 CFR 176.170

  A. High temperature heat-sterilized (e.g., over 212°F or 100°C)
  B. Boiling water sterilized.
  C. Hot filled or pasteurized above 150°F (65.5°C)
  D. Hot filled or pasteurized below 150°F (65.5°C)
  E. Room temperature filled and stored (no thermal treatment in the container).
  F. Refrigerated storage (no thermal treatment in the container).
  G. Frozen storage (no thermal treatment in the container).
  H. Frozen or refrigerated storage: Ready-prepared foods intended to be reheated in container at time of use:
     1. Aqueous or oil-in-water emulsion of high- or low-fat.
     2. Aqueous, high- or low-free oil or fat.
Functional & Packaging Performance

- Poly adhesion to paper fiber
- Heat sealability
- Moisture & liquid barrier
- Oil-grease resistance
- Printability
- Mechanical & physical properties
Applications
The Shift

**Trends**
- Urbanization
- Healthy lifestyle, environmental awareness
- Demographic change

**Desires**
- Convenience, on-the-go
- Fresh
- Ready meals

**Needs**
- Smaller package size in bulk
- Shelf-life extension
- Freeze-thaw-microwave-oven
Opportunities

- Fast, small-batch, customized converting
- High heat-resistance biopolymers for microwave and oven cooking
- Compostable biopolymers for liquid packaging
- Moisture & oxygen barrier for shelf-life extension
- Soil, fresh water, marine biodegradable
Eco Economy & Packaging Value Chain

- Brand Owners
- Consumers
- Environmental Assessment
- Government
- NGOs
- Activists
- Communication
- Material Suppliers

Eco Economy

WestRock
Conclusions

- Eco-based circular economy
- Biopolymer innovation and technology
- High-performance biopolymer+paperboard hybrid packaging materials
- Challenges = Opportunities
- Emerging trends and needs
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Thank you!

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