Introduction to BioPBS™

A GREENER WORLD.
A GREENER YOU.
Agenda

- PTTMCC company profile
- PBS, how it works
Who are we?

A joint venture of PTT and MCC

#84
WORLD’S LARGEST CORPORATION
FORTUNE 500

#1
JAPAN’S LARGEST CHEMICAL COMPANY
• PTTMCC company profile

• PBS, how it works
WE’RE INTRODUCING BioPBS:

BioPBS: A FRIENDLY CATALYST TO HELP YOU BECOME AN ENVIRONMENTALLY FRIENDLIER BRAND.

Bio-based material

A cradle-to-cradle biopolymer that will actualize your brand’s environmental soul.

Your product

CO₂

H₂O

SOIL
1. **Renewable resource**

By using bio-based material,

Compared to plastics made from petroleum, where CO₂ from the ground is brought up, contributing to climate change.

2. **Biodegradability**

Our biodegradability is superior to others. BioPBS degrades at room temperature. So there's no need for special composting facilities.
What is BioPBS™?

PBS is generally produced from Succinic acid and 1,4-BDO.

BioPBS™ Chemical Reaction

\[
\text{Bio-Succinic Acid} + \text{1,4-Butanediol} \xrightarrow{\text{Esterification / Polycondensation, Catalyst, D}} \text{BioPBS} + \text{H}_2\text{O}
\]
Why BioPBS™ is attractive?

Renewable
- BSA providing bio content
- Plan for 100% bio

Compostable
- Fast degradability among biodegradable polymers
- Ambient compostable

Food Contact
- High heat resistance
- Comply to OM-6 condition, EU Directive 10/2011
- JHOSPA
- Applying FCN with U.S.FDA

Recyclability
- PBS-coated paper shows excellent repulpability
- Achieve better recyclability result compared to conventional plastics

Applications:
- Paper Coating
- Flexible Packaging
- Mulch film
- Compost bag
- Fiber composite
- Foaming
- PBS/PLA compound
### BioPBS™ properties

<table>
<thead>
<tr>
<th>Properties</th>
<th>Unit</th>
<th>BioPBS™</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>FZ91</td>
</tr>
<tr>
<td>Melt Flow Rate (190°C/2.16kgf)</td>
<td>g/10min</td>
<td>5</td>
</tr>
<tr>
<td>Density</td>
<td>g/cm³</td>
<td>1.26</td>
</tr>
<tr>
<td>Glass Transition Temp.</td>
<td>°C</td>
<td>-22</td>
</tr>
<tr>
<td>Melting Point</td>
<td>°C</td>
<td>115</td>
</tr>
<tr>
<td>Tensile Stress at break</td>
<td>MPa</td>
<td>30</td>
</tr>
<tr>
<td>Tensile Strain at break</td>
<td>%</td>
<td>160</td>
</tr>
<tr>
<td>Flexural Modulus</td>
<td>MPa</td>
<td>650</td>
</tr>
<tr>
<td>Izod Impact</td>
<td>kJ/m²</td>
<td>7</td>
</tr>
<tr>
<td>Heat Deflection Temp. (0.45MPa)</td>
<td>°C</td>
<td>91</td>
</tr>
<tr>
<td>Rockwell Hardness (R scale)</td>
<td>-</td>
<td>103</td>
</tr>
</tbody>
</table>

Note: These values are typical and not to be construed as specifications.
BioPBS™ for paper coating

- **Excellent processibility** as good as LDPE
- Excellent **adhesion and seal strength**
- Coat **thinner** than other bioplastics
- Excellent **printability**
- Suitable for **hot food serviceware**
- **Compostable*** at ambient temperature
- **Recyclability** in paper mill

* BioPBS™ are being applied for major compostability certificates; AIB-Vincotte and BPI
BioPBS™ Heat Seal Property

Heat-seal temperature (℃)

Heat-seal strength (N/15mm)

FD92

FZ91

LLDPE

[Heat-seal conditions]
- Pressure: 0.2 MPa
- Time: 1 sec.
- Seal width: 5 mm

[Strength measurement conditions]
- Specimen: 20μm thickness film, width in 15mm
- Chuck interval: 60 mm
- Test speed: 300 mm/min.

Excellent heat seal strength even at low temp
BioPBS™ Heat Seal Property

Polymer / Paper

Substrate: Kraft paper
Polymer layer thickness: 20µm
Heat-seal conditions: 0.2 MPa/1 sec.
## Gas Transmission Rate of BioPBS™

<table>
<thead>
<tr>
<th>Material</th>
<th>Gas Transmission Rate</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>H₂O (WVTR)</strong></td>
<td><strong>O₂ (OTR)</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>[g/m²·day]</td>
<td>[cm³/m²·day·atm]</td>
<td></td>
</tr>
<tr>
<td><strong>BioPBS FZ91 (20 μm)</strong></td>
<td>620</td>
<td>770</td>
<td></td>
</tr>
<tr>
<td><strong>PLA 20 μm</strong></td>
<td>680</td>
<td>1,900</td>
<td></td>
</tr>
<tr>
<td><strong>PBAT 20 μm</strong></td>
<td>900</td>
<td>&gt; 2,000</td>
<td></td>
</tr>
<tr>
<td><strong>LDPE 20 μm</strong></td>
<td>26</td>
<td>8,850</td>
<td></td>
</tr>
</tbody>
</table>

**Gas Transmission Standard**

- **H₂O (WVTR)**: ASTM E96/E96m-10  → Temp. 38 °C / 90% RH
- **O₂ (OTR)**: ASTM D3985-05     → Temp. 23 °C / 0% RH
BioPBS decomposes into H₂O and CO₂ by microorganism in soil. The decomposition rate is more rapid than PLA and PBAT.
BioPBS™ is biodegradable in Soil

Buried in soil. No controlled conditions.
Western Michigan University is an independent third party testing and certifying source per Federal Trade Commission guidelines.

Objective: To certify BioPBS-coated paper as recyclable and repulpable within the corrugated stream in paper mill.

Example: Starbucks adopted “EarthSleeve” certified by Western Michigan University.

Certified Material: BioPBS-coated cup stock paper, 2-sided coating

- Repulpability Test: Pass Repulped fiber > 96%
- Recyclability Test: Pass
Certification & Compliance Status

**REACH Compliance**

Ready!

**Biodegradability & Compostability Certification**

All under progress, tentatively to finish by
OK Compost, OK Compost Home, GreenPla Mark, BPI Mark
November, 2015*

**Food Contact Compliance**

EU No.10/2011 & JHOSPA
Tentatively to finish by
December, 2015

FCN
Under progress, tentatively to finish by
October, 2015

* Only FZ91 grade will be certified first from BPI
Current scope of FCN:

Application: All article types.
Food type: All foods types, except alcoholic foods.
Condition of use: FZ grade – B to H. FD grade – C to G.
Time line: Submitted FZ FCN application to FDA – in June. FZ FCN will be approved by FDA – in October.

Note:
Condition B = Boiling water sterilized
Condition H = Frozen or refrigerated storage:
    Ready-prepared foods intended to be reheated in container
Condition C = Hot filled or pasteurized above 150 deg.F
Condition G = Frozen storage (no thermal treatment in the container)
BioPBS™ for Flexible Packaging

- Excellent process in existing LDPE extrusion coating machine
- Excellent **seal strength**
- Compostable without composting facility
- Excellent printability without pre-treatment
- Good to **retain aroma** such as limonene
- Suitable* for packaging such as weak acidic, fatty and oily food

<table>
<thead>
<tr>
<th>Metallized - cellulose film</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bio-PBS as sealing layer</td>
</tr>
</tbody>
</table>

* not actual film structure
BioPBS™/ PLA Compound

PBS/PLA composite can improve the heat resistance of PLA and performance balance.
Property comparison of BioPBS™ vs PLA


* in soil at 30°C, 50%RH
Dispersion of BioPBS™ with PLA

BioPBS / PLA

75 / 25

50 / 50

25 / 75

Compound of BioPBS™ with PLA shows good dispersion
## Properties of BioPBS™ compound with PLA

<table>
<thead>
<tr>
<th>Properties</th>
<th>Test method</th>
<th>Unit</th>
<th>FZ91 / PLA [wt./wt.]</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>100/0</td>
</tr>
<tr>
<td>Density</td>
<td>ISO 1183</td>
<td>g/cm³</td>
<td>1.26</td>
</tr>
<tr>
<td>Flexural</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Modulus</td>
<td>ISO 178</td>
<td>MPa</td>
<td>650</td>
</tr>
<tr>
<td>Strength</td>
<td></td>
<td>MPa</td>
<td>40</td>
</tr>
<tr>
<td>Tensile</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stress at yield</td>
<td>ISO 527-2</td>
<td>MPa</td>
<td>40</td>
</tr>
<tr>
<td>Stress at break</td>
<td></td>
<td>MPa</td>
<td>30</td>
</tr>
<tr>
<td>Strain at break</td>
<td></td>
<td>%</td>
<td>160</td>
</tr>
<tr>
<td>Izod impact</td>
<td>ISO180</td>
<td>kJ/m²</td>
<td>7</td>
</tr>
<tr>
<td>(23 °C)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heat deflection temperature</td>
<td>ISO 75-2</td>
<td>°C</td>
<td>91</td>
</tr>
<tr>
<td>(0.45 MPa)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rockwell hardness</td>
<td>ISO 2039-2</td>
<td>-</td>
<td>100</td>
</tr>
<tr>
<td></td>
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</table>
**Notes:** These values are typical ones and are not to be construed as specifications.
BioPBS™ Affinity to Natural Fiber and Fillers

Cellulose

Strong adhesion between the polymer and filler due to *chemical* and *physical* interactions

Polybutylene succinate

Polypropylene

Weaker adhesion between the polymer and filler due to *physical* interaction only
How can you use BioPBS™?

The opportunities are endless.
How can you use BioPBS™?

Potential Applications
Thank You