Green Technology
For Barrier Coatings

Presented by:
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Vice President of Research & Development
Mantrose-Haeuser Co., Inc.
Agenda

- Company background
- Coatings on food and pharmaceuticals
- Barrier coatings
- Opportunities for “green” barrier coatings
- Design & formulation of “green” barrier coatings
- Coatings for food trays
- Coatings to replace LDPE coated paper
- HELP! Can we take this technology to other types of packaging
Core Competencies

- Functional Edible Film Formers
- Confectionery Surface Finishing Agents
- Pharmaceutical Controlled Release and Surface Finishing Agents
- Agricultural Coatings and Surface Treatments
- Industrial Coating Applications
Barrier Coatings
Barrier Coating Properties

Oil and Grease Resistance

- Usually a measure of a coating's ability to resist a change in appearance when in contact with cooking oil or grease
- 3M testing protocols
- Customer specific tests
Barrier Coating Properties

Odor
- Keep them out or keep them in
Not Just Barrier

- Easy to apply
- No pin holes
- Non-blocking
- Heat resistant
- Known and reproducible COF
- Gloss
- Flexibility
How Do Barrier Coatings Work?
How Do Barrier Coatings Work?

No barrier
Easy passage through the coating

Limited barrier
Slightly difficult passage through the coating

Barrier
Tortuous path through the coating
What Effects Barrier Properties of Coatings?

- Temperature: Up
- Humidity: Up
- Orientation: Up
- Heat Treatment: Up
- Thickness: Up
- Area: Up
- Solubility: Up

O2 Barrier: Down
System Ingress / Egress

Leaks / Holes

Residual Head Space

Scalping?
Flavor Loss?

Permeation
Through Package Wall

Headspace + Permeation + Integrity/Leaks

SLIDE BY MOCON
A material’s permeation rate will vary from 5% to 10% per degree C.

In real life: A material’s permeation rate will vary from 5% to 10% per degree C.
Permeation Variables

In real life: *typical plot for EVOH

SLIDE BY MOCON
Barrier Coating Properties

Gases – Mainly oxygen but also carbon dioxide and nitrogen

- Expressed as g/ 100 sq inches/24 hours
- Expressed as cc/ 100 sq inches/24 hours
Barrier Coating
Properties

MVTR – moisture vapor transmission rate

- Measures the rate of transmission of water vapor – usually expressed as g/100 sq inches/24 hours at fixed humidity and temperature
Comparison of Barrier Resins

- PET
- BOPP
- HDPE
- PVDC
- EVOH
- AN
- Nylon
- PS

OTR

MVTR

VTR
Typical Barrier Coating Polymers

- Fluorocarbons
- Waxes
- Acrylics
- PVDC
- EVOH
Typical Barrier Coating Polymers

Fluorocarbons – banned in 2015
Waxes – hard to recycle
Acrylics – hydrocarbon based
PVDC - contains chlorine
EVOH – has to be inside a laminate
The Opportunity

Barrier Coatings that are:
- Not from hydrocarbon feedstock
- Recyclable
- Compostable
- Biodegradable
- Are from sustainable and renewable resources
- Suitable for direct food contact
Design & Formulate

Functional Barrier Coatings: Properties desired

- Direct Food Contact approved
- Film forming resins & polymers
- Functional proteins
- Carbohydrates
- Lipids, Fatty Acids
- Food Grade Solvents & Water
- Functional Additives, i.e., pigments, plasticizers, etc.
Design & Formulate

Functional Barrier Coatings: Properties desired

- Direct Food Contact approved
- Derived from “renewable” resources
- Biodegradable & Compostable
- Low Oxygen Permeability (meats)
- Lipid & Grease Resistant (meats, fatty foods)
- Resistance to Liquid Water (coffee, and beverage)
- Low Moisture Vapor Permeability (cut produce)
Barrier Coating Examples

Food Tray Coatings
Food Tray Coatings
Food Tray Coatings

Barrier Properties
- MVTR – 25g/24 hours/sq meter
- COBB - < 1g/sq meter
- Oil and Grease resistance
  - Passes customer 90°C corn oil test
- Salt water resistance
  - Passes customer 60°C 2% sodium chloride test
Coating Comparison: WVTR

Food Tray Coatings

LDPE
Dry Film 0.35 mil (8.2 g per sq meter)

GN-2
Dry Film 0.75 mil (18.8 g per sq meter)

GN-1
Dry Film 0.4 mil (11.7 g per sq meter)

GB
Dry Film 0.4 mil (11.5 g per sq meter)

Control (Uncoated)

WVTR Values:
- LDPE: 25.6 g/24Hr/sq.m
- GN-2: 24.4 g/24Hr/sq.m
- GN-1: 42 g/24Hr/sq.m
- GB: 108 g/24Hr/sq.m
- Control (Uncoated): 389.2 g/24Hr/sq.m
Barrier Coating
Properties

Water – Cobb value

- Measures the amount of water absorbed by the substrate per unit of time
- Usually expresses as g absorbed per 100 sq inches or per sq meter for 2 minutes, 10 minutes or 20 minutes
Food Tray Coatings

Coating Comparison: Cobb

- LDPE: Dry Film 0.35 mil (8.2 g per sq meter)
- GN-2: Dry Film 0.75 mil (18.8 g per sq meter)
- GN-1: Dry Film 0.4 mil (11.7 g per sq meter)
- GB: Dry Film 0.4 mil (11.5 g per sq meter)

Control (Uncoated): 35.9 g/sq.m
Barrier Coating Examples

Food Wrap Coatings
Extruded LDPE Replacement
Food Wrap Coatings

- It is common for paper-based food packaging to apply a barrier coating (LDPE, Acrylic) which renders the food wraps non-recyclable and they must instead be land filled.

- New green technology allows this paper to be repulpable and recyclable.
Repulpability/Recyclability Investigation
Western Michigan University

Substrates Coated with Mantrose (type A) Barrier Coating

Study conducted by Jan Pekarovich. PhD
Research Associate

Voluntary Standard elaborated by the Fiber Box Association and the American Forest & Paper Association (AF&PA) to evaluate the repulpability and recyclability of moisture barrier treatments or coatings

Repulpability & Recyclability by 3rd party study by WMU
Repulpability/Recyclability Investigation
Western Michigan University

Repulpable Standard

From this Voluntary Standard the sample marked as repulpable has to show “Fiber yield” from the repulpability test at least 80% based on the total weight, or 85% based on the bone dry fiber charge to the pulper, where Fiber-on-fiber yield is the amount of fiber that remains after the processing action, expressed as a percentage of the fiber present in the material to be tested.
Conclusions

(1) The use of type A material for the coating shows insignificant effect on the values of the reject. The test data were on the level of less then 1%.
(2) In both cases, the presence of type A material applied as the coating lowered the density of the handsheet (enhanced the bulk).
(3) The presence of type A material within the coatings on bleached substrate positively affects the values of strength properties, especially the tensile index values.
(4) The presence of type A material within the coatings on unbleached substrate insignificantly affects the values of all of strength properties measured.
(5) Finally, it might be stated, that the use of type A material within the coating on both of the substrates doesn’t negatively affect the repulpability of coated samples, if not positively affects some of the strength properties.
Lab Samples

BOPP  LDPE  Uncoated
Biodegradability
Definitions & Standards

ASTM International is one of the largest voluntary standards development organizations in the world -- a trusted source for technical standards for materials, products, systems, and services. Known for their high technical quality and market relevancy, ASTM International standards have an important role in the information infrastructure that guides design, manufacturing and trade in the global economy.

Standards developed at ASTM are the work of over 30,000 ASTM members. These technical experts represent producers, users, consumers, government and academia from over 120 countries. Participation in ASTM International is open to all with a material interest, anywhere in the world.

The Biodegradable Products Institute worked with ASTM and its members to develop acceptable standards for biodegradable products that truly biodegrade and have no detrimental impact on composting, agriculture or soil.

ASTM D6400: Test to certify if a product can be composted
ASTM D6868: Test to determine if a biodegradable plastic is truly biodegradable
This specification covers biodegradable plastics and products (including packaging), where plastic film or sheet is attached (either through lamination or extrusion directly onto the paper) to substrates and the entire product or package is designed to be composted in municipal and industrial aerobic composting facilities.

This specification is intended to establish the requirements for labeling of materials and products, including packaging, using coatings of biodegradable plastics, as "compostable in municipal and industrial composting facilities."

The properties in this specification are those required to determine if products (including packaging) using plastic films or sheets will compost satisfactorily, including biodegrading at a rate comparable to known compostable materials. Further, the properties in the specification are required to assure that the degradation of these materials will not diminish the value or utility of the compost resulting from the composting process.
This specification covers plastics and products made from plastics that are designed to be composted in municipal and industrial aerobic composting facilities.

This specification is intended to establish the requirements for labeling of materials and products, including packaging made from plastics, as "compostable in municipal and industrial composting facilities."

The properties in this specification are those required to determine if plastics and products made from plastics will compost satisfactorily, including biodegrading at a rate comparable to known compostable materials.

Further, the properties in the specification are required to assure that the degradation of these materials will not diminish the value or utility of the compost resulting from the composting process.
**Biodegradability & Compostability**

**Conclusions**

In our opinion, based on the overall weight loss and disintegration, Samples B and C have fulfilled the requirements presented in ASTM D 6868. The Films have surpassed the 90% weight loss requirement expressed in ASTM D 6400-04 in the ninety (90) day compost exposure.

ASTMD-6868 and D-6400-04 requirements include the samples being tested for twelve (12) weeks and reaching a minimum of 90% weight loss, in which the materials both achieved.

**Results:**

<table>
<thead>
<tr>
<th>Sample</th>
<th>Description</th>
<th>Weight Loss</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample A</td>
<td>Positive Cellulose Control</td>
<td>100%</td>
</tr>
<tr>
<td>Sample B</td>
<td>Cellulose Coated w/ Barrier Coating #1</td>
<td>100%</td>
</tr>
<tr>
<td>Sample C</td>
<td>Cellulose Coated w/ Barrier Coating #2</td>
<td>100%</td>
</tr>
</tbody>
</table>

in percentage by weight
## Oxygen Transmission Rate (OTR) Results from MOCON

<table>
<thead>
<tr>
<th>Sample Identification</th>
<th>OTR (cc/(100 in²/day))</th>
<th>OTR (cc/(100 in²/day))</th>
</tr>
</thead>
<tbody>
<tr>
<td>Black Corona Discharged Mylar (CDM)</td>
<td>Replicate 1: 8.13</td>
<td>Replicate 2: 7.87</td>
</tr>
<tr>
<td>Verdecoat BOPP coated CDM</td>
<td>Replicate 1: 1.73</td>
<td>Replicate 2: 2.19</td>
</tr>
<tr>
<td></td>
<td>Replicate 1: 4.06</td>
<td>Replicate 2: 4.37</td>
</tr>
</tbody>
</table>

Results by MOCON Oxtran 2/21L module Oxygen Permeability Instrument
# Barrier Coating Properties

<table>
<thead>
<tr>
<th></th>
<th>LDPE Coated Paper</th>
<th>Biopolymer</th>
</tr>
</thead>
<tbody>
<tr>
<td>MVTR</td>
<td>0.83</td>
<td>1.02</td>
</tr>
<tr>
<td>OTR</td>
<td>1395</td>
<td>1248</td>
</tr>
<tr>
<td>Mullen Burst Strength</td>
<td>26.3</td>
<td>38.5</td>
</tr>
</tbody>
</table>

MVTR and OTR in g/100 sq inches/ 24 hours
### Other Market Ideas

<table>
<thead>
<tr>
<th>Bags and Wraps</th>
<th>Folding Carton and Boxes</th>
<th>Flexible</th>
<th>Food Service</th>
<th>Industrial</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sandwich Wrap</td>
<td>Pizza</td>
<td>Retort</td>
<td>Plates</td>
<td>Cement Bags</td>
</tr>
<tr>
<td>Pre-Packed Food</td>
<td>Cereal</td>
<td>Stand up pouches</td>
<td>Cups</td>
<td>Machine Parts</td>
</tr>
<tr>
<td>Pet Food</td>
<td>Fresh Produce Boxes</td>
<td>Meats and cheese</td>
<td>Trays</td>
<td>Detergents</td>
</tr>
<tr>
<td>Microwave Food</td>
<td>Frozen Food</td>
<td>Confectionary</td>
<td>Molded products</td>
<td>Electrical Products</td>
</tr>
<tr>
<td>Baked Goods</td>
<td>Pet Food</td>
<td>Liquid Packaging</td>
<td>Take out containers</td>
<td>Bottles</td>
</tr>
<tr>
<td>Release Paper</td>
<td>Bacon Board</td>
<td>Ice Cream</td>
<td>Sauces</td>
<td>Protective Packaging</td>
</tr>
</tbody>
</table>
Conclusion

New coating technology has been developed that has good barrier properties and is:

- Renewable and sustainable
- Biodegradable
- Compostable
- Recyclable
- Water or solvent based
- Suitable for direct food contact
Thank you

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