HDPE Barrier Laminating Films for Use in Flexible Packaging Structures

Presented by:
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Presentation Outline

• Objective
• Market / Applications
• Experimental Procedures
• Results
• Benefits / Conclusions
HDPE Barrier Laminating Films

• Proposition: Extrusion lamination of high barrier HDPE-based films to replace:
  – Foils and metalized films
  – HDPE extrusion coatings

• Potential Benefits
  – Sustainability/Recyclability – Eliminating or reducing foils and metalized films
  – Weight and energy savings
  – Cost savings – Replacing over-engineered structures
  – Improved Water Vapor Transmission Rates (WVTR) compared to LDPE and HDPE extrusion coatings
  – Design flexibility to optimize WVTR and Oxygen Transmission Rate (OTR)
Extrusion Coating Markets / Applications

• Flexible Packaging
  – Snacks (chips, peanuts)
  – Dry-goods (instant potatoes, hot chocolate)

• Medical Flexible Packaging

• Paper / Paper Board Packaging
  – Folding cartons (frozen foods, bulk packaging)
  – Liquid cartons (orange juice)
Alathon M6010SB (1.1 g/10 min Melt Index, Homopolymer)
Next-generation MMW HDPE for Barrier Films

- Used in films having optimized moisture barrier improvement through resin structure design and nucleation
  - 30-40% WVTR improvement compared to incumbent barrier HDPE resins

- Specifically formulated to retain important film properties
  - Tear
  - Puncture, dart
  - Stiffness
  - Low organoleptics
  - Low gels

- Film processability – can be used in any film layer without processing issues
  - Low dusting
  - No melt fracture

![Graph showing WVTR Improvement (2.3 mil coextrusion)]
Extrusion Coating Structures

• Incumbent Structures Using:
  – HDPE extrusion coating resins
  – High cost specialty resins or substrates
    • e.g. laminations using foils and metalized films

• Proposed Structures
  – Laminations Using HDPE-Based Barrier Films
    • Laminations designed for specific product requirements
    • Can incorporate monolayer and co-ex HDPE film structures
Potential Film Structures for Lamination

• Monolayer Structure
  – Supports WVTR Barrier improvements
  – WVTR controlled by film thickness

• 3 Layer Structures
  – Skins for heat seal / seal strength requirements
  – Core layer for WVTR requirements

• 5-Layer Structures
  – Skins: HDPE for WVTR needs
  – Core: Specialty resin for OTR requirements
Experimental Outline

• Performed laboratory studies to evaluate the performance of barrier HDPE film laminations compared to:
  – standard HDPE extrusion coatings
  – incumbent foil-based packaging structures

• Produced monolayer and 5-layer coextruded films at three thicknesses

• Conducted extrusion coating / lamination trials

• Measured WVTR and OTR
HDPE Blown Film Lab Trials
Samples produced at 19, 32 & 51 microns (0.75, 1.25 and 2.0 mils)

• Monolayer 100% high barrier HDPE Film Structure
  – 152 mm die, 1520 micron gap, 2.8 BUR, 80 kg/hr (175 lbs/hr)

• 5-Layer Co-ex Film Structure
  – 203 mm die, 1400 micron gap, 2.5 BUR, 68 kg/hr (150 lbs/hr)
  – ABCBA film structure:

  ![Diagram showing film structure](image)
  Next Gen. Barrier HDPE 33%
  Tie Layer 13%
  O₂ Barrier EVOH 28%
  Tie Layer 13%
  Next Gen. Barrier HDPE 13%
Extrusion Coating / Lamination Lab Trials

• Coating trials were designed to compare HDPE extrusion coatings to HDPE-based film laminations

• Extrusion coating processing conditions:
  – 320°C melt temperature
  – 180 m/min line speed
  – 178 mm air gap
  – 68 micron Kraft paper
# Extrusion Coated Lab Structures
## Incorporating HDPE Extrusion Coating Resins

<table>
<thead>
<tr>
<th>Sample ID</th>
<th>Substrate 68 micron</th>
<th>Inner Layer 21 micron (25%)</th>
<th>Core Layer 41 micron (50%)</th>
<th>Sealant Layer 21 micron (25%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ctg. - Coex</td>
<td>kraft</td>
<td>LDPE MI: 10 g/10 min Density: 0.918 g/cc</td>
<td>HDPE MI: 12 g/10 min Density: 0.960 g/cc</td>
<td>LDPE MI: 10 g/10 min Density: 0.918 g/cc</td>
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<tr>
<td>Ctg. – Nucl. Coex</td>
<td>kraft</td>
<td>LDPE</td>
<td>Nucleated HDPE</td>
<td>LDPE</td>
</tr>
<tr>
<td>Ctg. - Blend</td>
<td>kraft</td>
<td>Monolayer Blend of 50% LDPE / 50% HDPE</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ctg. – Nucl. Blend</td>
<td>kraft</td>
<td>Monolayer Blend of 50% LDPE / 50% Nucleated HDPE</td>
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</table>
WVTR Results
Comparing HDPE-Based Extrusion Coatings

* Industry standard barrier values
Extrusion Lamination Lab Structures Incorporating HDPE-Based Lamination Films

<table>
<thead>
<tr>
<th>Sample ID</th>
<th>Substrate 68 micron</th>
<th>Core Layer 12 micron</th>
<th>Laminating Film 19 – 51 micron</th>
</tr>
</thead>
<tbody>
<tr>
<td>19 Mono</td>
<td>kraft</td>
<td>LDPE</td>
<td>19 Micron Monolayer Film</td>
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<tr>
<td></td>
<td></td>
<td>MI: 5.6 g/10 min</td>
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<tr>
<td></td>
<td></td>
<td>Density: 0.923 g/cc</td>
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<tr>
<td>32 Mono</td>
<td>kraft</td>
<td>LDPE</td>
<td>32 Micron Monolayer Film</td>
</tr>
<tr>
<td>51 Mono</td>
<td>kraft</td>
<td>LDPE</td>
<td>51 Micron Monolayer Film</td>
</tr>
<tr>
<td>19 Coex</td>
<td>kraft</td>
<td>LDPE</td>
<td>19 Micron 5-Layer Film</td>
</tr>
<tr>
<td>32 Coex</td>
<td>kraft</td>
<td>LDPE</td>
<td>32 Micron 5-Layer Film</td>
</tr>
<tr>
<td>51 Coex</td>
<td>kraft</td>
<td>LDPE</td>
<td>51 Micron 5-Layer Film</td>
</tr>
</tbody>
</table>
WVTR Results
Monolayer HDPE Film Laminations vs. Incumbents

* Industry standard barrier values
WVTR / OTR Results
Co-ex HDPE Film Laminations vs. Incumbents

* Industry standard barrier values
Conclusions / Demonstrated Benefits

- Primary Benefits
  - Sustainability/Recyclability – Eliminating or reducing foils and metalized films
  - Weight and energy saving
  - Cost savings – Replacing over-engineered structures
  - Improved Water Vapor Transmission Rates (WVTR) compared to LDPE and HDPE extrusion coatings
  - Design flexibility to optimize WVTR and Oxygen Transmission Rate (OTR)

- Additional Benefits vs. HDPE Coatings
  - Package physical property improvements (e.g. tear, puncture, modulus)
  - Design flexibility for package sealant layer
  - Improved processing
  - Organoleptics
Polyolefin Innovations from LyondellBasell

• Thank you for your attention. Questions?

• Special thanks to: Tom Schwab, Jeff Borke, Scott Clayton, Bob Holweger and Barb Harding

• Please contact scott.weber2@lyondellbasell.com for more information
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Thank you

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