Improved Adhesion EVA for Extrusion Coating / Extrusion Laminating

Presented by:
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Overview

- Objective
- Market / Applications
- Experimental Procedures
- Results
- Conclusions
Objective: Improve adhesion of EVA to substrates in extrusion coating / lamination processes

Potential Cost/Efficiency Benefits

- Increased adhesion to substrates
- Increased line speeds
- Reduced air-gaps for improved neck-in
- Reduced melt temperatures
Markets / Applications

- Flexible Packaging
  - Lidding stock
  - Cheese packaging
- Thermal Lamination
  - Document protection
  - Gift cards
Celanese Ateva® ExtruBond™
EVA Extrusion Coating Grades

Property Ranges
• VA 16-28%
• MI 6-30

Additives
• Antioxidant
• Slip
• Antiblock
• Chill Roll Release
• UV Stabilizer

- 1615 16% VA, 15 MI
- 1641 16% VA, 28 MI
- 1941 19% VA, 30 MI
- 1943MS 19% VA, 30 MI
- 1943SB 19% VA, 30 MI
- 2020 20% VA, 20 MI
- 2861A 28% VA, 6 MI
- 2821A 28% VA, 25 MI
Experimental Approach

- Performed lab studies to evaluate if the new technology will increase adhesion to PET substrates
- Produced simulated extrusion coated samples for adhesion testing
- Measure adhesion force of samples
Simulated Extrusion Coating Samples

• Produced simulated Extrusion coated samples for adhesion testing
  
  • EVA 1 - 16% VA 8.5 MI (Standard)
  • EVA 2 - 16% VA 8.5 MI (New Technology)
  • 92ga PET (Hand sheets)

• Tested untreated and corona treated PET

• Measure adhesion force of samples

• If successful, complete extrusion coating trials on production line
Experimental Approach

- Adhesion test samples were prepared using a laboratory cast film line
  - Coating Thickness – 25microns (1mil)
  - Line Speed 1.5 m/min (5 fpm)
Experimental Approach

- PET Slip sheets were fed by hand onto the rubber roll to create a coated sample.
- Coated untreated and corona treated PET
- One inch wide strips were cut from the coated samples for adhesion testing
Lab Trials Adhesion Results

- Untreated PET Film (Gen 1)
  - EVA 1 = 6 g/cm (15 g/in)
  - EVA 2 = 7.5 g/cm (19 g/in)
  - ~ 25% Adhesion Improvement
Lab Trials Adhesion Results

- Corona Treated PET Film (Gen 1)
  - EVA 1 = 23.5 g/cm (60 g/in)
  - EVA 2 = 31.5 g/cm (80 g/in)
  - ~ 30% Adhesion Improvement
Lab Trials Adhesion Results

- Modified the Technology (Gen 2)
- Corona Treated PET Film

- EVA 1 = 23.5 g/cm (60 g/in)
- EVA 2 = 146 g/cm (370 g/in)

- ~515% Adhesion Improvement
Extrusion Coating Trials

- Next steps for scale up production EC trials
  - Purchased line time for commercial Extrusion Coating Trials
  - Define Trial Conditions
Extrusion Coating Trials

- Extrusion Coating Trial Conditions
  - 1 Mil Coating - Melt Temperature 227°C (440°F)
  - Line Speeds 107m/min & 214m/min (350 fpm / 700 fpm)
  - 12 micron (48ga) PET
  - Substrate pre-treatments
    - No Treatment
    - Corona
    - Corona / Primer / Ozone
  - 178mm (7in) Air-gap
<table>
<thead>
<tr>
<th>Force g/cm (g/in)</th>
<th>EVA 1</th>
<th>EVA 2</th>
<th>% Increase</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Untreated film</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>107 mpm (350 fpm)</td>
<td>8 (20)</td>
<td>12 (30)</td>
<td>50%</td>
</tr>
<tr>
<td>214 mpm (700 fpm)</td>
<td>8 (20)</td>
<td>16 (40)</td>
<td>100%</td>
</tr>
<tr>
<td><strong>Corona treated</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>107 mpm (350 fpm)</td>
<td>16 (40)</td>
<td>55 (140)</td>
<td>250%</td>
</tr>
<tr>
<td>214 mpm (700 fpm)</td>
<td>24 (60)</td>
<td>63 (160)</td>
<td>167%</td>
</tr>
<tr>
<td><strong>Corona/primer/O3</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>107 mpm (350 fpm)</td>
<td>110 (280)</td>
<td>173 (440)</td>
<td>57%</td>
</tr>
<tr>
<td>214 mpm (700 fpm)</td>
<td>106 (270)</td>
<td>173 (440)</td>
<td>63%</td>
</tr>
</tbody>
</table>
Heat Seal Performance

![Graph showing the heat seal performance of EVA 1 and EVA 2.](image)

- EVA 1
- EVA 2
Hot-Tack Performance

![Graph showing Hot-Tack Performance with two curves: EVA 1 and EVA 2. The graph plots Force (g/cm) against Temperature (Deg C).]
Conclusions

• Demonstrated the following:
  • Improved adhesion of standard EVA grades
  • Increased line speeds while maintaining adhesion levels
  • Improved adhesion at high extrusion coating line speeds
  • No effects to processing conditions
  • No effects to sealing characteristics
Extrusion-coated polyester films were thermally laminated to several substrates to test for adhesion with a t-peel test.

Lamination to Paper

- Standard EVA = 60 g/in
- ExtruBond™ = 100 g/in

Lamination to corona-treated PET

- Standard EVA = 45 g/in
- ExtruBond™ = 110 g/in

Lamination to untreated PET

- Standard EVA = 25 g/in
- ExtruBond™ = 25 g/in

Samples laminated at nominal temperature of 90°C.
Going Beyond EVA??

- LDPE Improved Adhesion Technology
  - Produced simulated Extrusion coated samples for adhesion testing
    - LDPE 1 - 12.7mi .917 Density (Standard)
    - LDPE 2 - 12.7mi .917 Density (New Technology)
  - PET (Hand sheets)
    - Tested untreated and corona treated PET
    - Measure adhesion force of samples
Experimental Approach

- Coating Thickness - 1mil
- Melt Temp = 230°C (445°F)
- Line Speed 1.5 m/min (5 fpm)
- PET slip sheets to create a coated sample
- Coated untreated and corona treated PET
- One inch wide strips were cut from the coated samples for adhesion testing
Lab tests have demonstrated LDPE adhesion improvements with similar gains to the EVA results:

- ~2x increase on untreated film
- ~10x increase on corona treated film

<table>
<thead>
<tr>
<th>Substrate</th>
<th>LDPE 1</th>
<th>LDPE 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Untreated PET Film</td>
<td>4 g/cm (11 g/in)</td>
<td>8 g/cm (20 g/in)</td>
</tr>
<tr>
<td>Corona Treated PET Film</td>
<td>6 g/cm (15 g/in)</td>
<td>51 g/cm (130 g/in)</td>
</tr>
</tbody>
</table>
Next Steps

• Evaluate the Improved Adhesion EVA on other flexible substrates
  • Nylon, OPP, BOPP, Metalized

• Conduct Extrusion Coating Trials to evaluate the LDPE adhesion improvement
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Questions?

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