Heat Seal Characteristics of Cyclic Olefin Copolymer / Polyethylene Blends
Introduction

- Cyclic Olefin Copolymers (COC) use is growing in flexible packaging films
- Attributes include easy processing, stiffness, heat resistance, moisture barrier and clarity
- Can be used to modify the heat sealing characteristics of polyethylenes:
  - improvements in seal strength
  - improvement of hot-tack strength
  - high temperature seal through capability with high Tg grades.
## Experimental

### Materials:

<table>
<thead>
<tr>
<th>Material</th>
<th>MI</th>
<th>Density</th>
<th>T&lt;sub&gt;g&lt;/sub&gt;°C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dow 2045 LLDPE</td>
<td>4</td>
<td>0.920</td>
<td>-127</td>
</tr>
<tr>
<td>Equistar NA 952 LDPE</td>
<td>2</td>
<td>0.918</td>
<td>-127</td>
</tr>
<tr>
<td>Equistar NA 204 LDPE</td>
<td>3</td>
<td>0.931</td>
<td>-127</td>
</tr>
<tr>
<td>Borealis 7230 LDPE</td>
<td>4.5</td>
<td>0.923</td>
<td>-127</td>
</tr>
<tr>
<td>Exxon Mobil 3125 Plastomer</td>
<td>1.2</td>
<td>0.91</td>
<td>-121</td>
</tr>
<tr>
<td>Dow 1140 Plastomer</td>
<td>1.2</td>
<td>0.902</td>
<td>-121</td>
</tr>
<tr>
<td>TOPAS 8007 COC</td>
<td>1.8</td>
<td>1.02</td>
<td>80 (low)</td>
</tr>
<tr>
<td>TOPAS 5013 COC</td>
<td>&lt;1.0</td>
<td>1.02</td>
<td>136 (high)</td>
</tr>
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### Extrusion:

- 25 mm Killion (DS), DSB I barrier type screw, 30: 1 L/D, Maddock Mixing head
Testing Equipment:

- Heat Seal Davinor Inc., J&B Hot Tack Tester
  - Seal Strength Test - Seal Pressure = 0.3034 N/mm (44psi), Seal Time = 1 sec., Cool Time = 30 sec., Peel speed = 200 mm/sec, sample size = 25.4 mm (1 inch) wide.
  - Hot-Tack Test - Seal Pressure = 0.3034 N/mm (44psi), Seal Time = 1 sec., Cool Time = 0.1 sec., Peel speed = 200 mm/sec, sample size = 25.4 mm (1 inch) wide.
  - Seal Initiation Temperature - defined as seal temperature where a 8.8 Newton seal strength is achieved.
TOPAS Blends Ultimate Seal Strength

Improved Ultimate Seal Strength with 8007 COC blended with LLDPE

- 0 % COC
- 15 % COC
- 25 % COC

Dwell Time = 250 ms
Seal Pressure = 63 psi

COC blends produce a wider sealing window
TOPAS Blends Hot Tack Force

Effect of Blending TOPAS 8007 COC with LLDPE on Hot Tack Force

COC blends produce a wider sealing window
Effect of COC Addition on Seal Strength

LDPE, Den.=0.923, MI = 4.5
LLDPE, Den.=0.920, MI=4
Plastomer, Den.=0.91, MI=3

Percent TOPAS 8007 in Blend
Effect of COC Addition on Hot-Tack

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LDPE,       Den.=0.923, MI = 4.5  
LLDPE       Den.=0.920, MI=4    
Plastomer   Den.=0.91, MI=3

Hot Tack Strength @ 120°C

LDPE

Percent TOPAS 8007 in Blend
Effect of TOPAS 8007 Addition on SIT

Seal Initiation Temperature (SIT) = Temp. where 8.8 Newton seal strength achieved

LDPE, Den.=0.923, MI = 4.5
LLDPE, Den.=0.920, MI=4
Plastomer, Den.=0.91, MI=3

Seal < 8.8 N
Seal Strength at 120°C of LDPE vs. LLDPE

LDPE to COC - no distortion of COC, LLDPE tore during pull
LDPE to COC - no distortion of COC, LDPE peeled off cleanly

Ultimate Seal Strength (Newtons)

- LLDPE
- 60% LLDPE/40% COC
- LDPE
- 60% LDPE/40% COC
- LLDPE to COC
- LDPE to COC

60% LLDPE/40% COC @ 2X seal pressure
60% LDPE / 40% COC @ 2X seal pressure
Seal Through Test Results

High Tg COC as an outer layer blend component can provide seal through capability
Conclusions

- COC/polyethylene blends can exhibit both improved modulus and heat seal performance
- COC is more compatible with LLDPE and Plastomers than LDPE
- COC level and matrix polymer affect heat seal performance
  - 8007 COC generally improves hot tack strength at all blend levels for the polyethylene systems studied.
  - 8007 COC reduced the seal strength of LDPE at concentrations of 20% and up while maintaining or improving the seal strength of LLDPE and Plastomer
- 130º Tg COC blended at levels above 20% can provide “seal through” capability to polyethylenes
1. ASTM, Designation: F 1921-98, Standard Test Methods for Hot Seal Strength (Hot Tack) of Thermoplastic Polymers and Blends Comprising the Sealing Surfaces of Flexible Webs, ASTM Standards 1999
