IN VACUUM FLEXO TOP-COATING ON METALLIZED FILM: AN UPDATE ON THE STATE OF THE ART

Dante Ferrari
Celplast Metallized Products Limited
OUTLINE

Introduction
- History of In-Chamber Coating
- The In-Line Vacuum Top-Coating Process
- Post Scale-Up Capabilities

Flat Sheet Performance
- Barrier Comparison between Pilot & Commercial Line
- Product Reliability

Lamination & Retort Performance
- Barrier & Bond Data in Multi-Ply Structures
INTRODUCTION
HISTORY

Acrylate curing under vacuum
- Originally developed at GE in mid-1980’s
- Spectrum Polytronics formed as spin-off company in Tucson, AZ, closed in 1989
- Three companies continued to develop technology, with focus on flash evaporation under vacuum:
  - Sigma Technologies
  - Batelle PNNL
  - Catalina Coatings

Flexo roll coating under vacuum
- MST (Metallized Surface Technologies) created in 2008, JV between partners in VAST and Celplast, to develop in-chamber flexo coating
- Use unique energy curable chemistry that is stable under high vacuum environment, and low enough viscosity to be roll-coated
THE IN-LINE VACUUM COATING PROCESS

Won 2010 AIMCAL Technology of the Year Award

Patents filed in 2010 & 2012
## POST SCALE-UP CAPABILITIES

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>PILOT LINE</th>
<th>COMMERCIAL LINE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coating Width</td>
<td>Up to 1500 mm</td>
<td>Up to 2500 mm</td>
</tr>
<tr>
<td>Coating Speed</td>
<td>Up to 2 m/s</td>
<td>Up to 6 m/s</td>
</tr>
</tbody>
</table>
FLAT SHEET PERFORMANCE
The commercial line barrier performance exceeded expectations, with a 10x overall barrier improvement from metallized films in some cases.
# FLAT SHEET PROPERTIES:
Measuring Product Reproducibility – 12 micron PET

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>Average value +/- Standard Deviation</th>
<th>Number of Data Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>OTR (cc/m²/day) @ 23°C, 50%RH</td>
<td>0.066 +/- 0.020</td>
<td>~ 40</td>
</tr>
<tr>
<td>WVTR (g/m²/day) @ 38°C, 90%RH</td>
<td>0.060 +/- 0.029</td>
<td>~ 40</td>
</tr>
<tr>
<td>Emissivity for mid E market</td>
<td>0.068 +/- 0.008</td>
<td>~ 400</td>
</tr>
<tr>
<td>Coat weight for mid E market (micron)</td>
<td>0.60 +/- 0.07</td>
<td>Calculated</td>
</tr>
<tr>
<td>Emissivity for low E market</td>
<td>0.060 +/- 0.007</td>
<td>~ 600</td>
</tr>
<tr>
<td>Coat weight for low E market (micron)</td>
<td>0.44 +/- 0.05</td>
<td>Calculated</td>
</tr>
</tbody>
</table>
FLAT SHEET PROPERTIES: Other Product Properties

- **Visual appearance**
  - Consistent, satin appearance on metal

- **Corrosion resistance**
  - Metal layer visually withstands high heat & humidity conditions (71 C, 100%RH for 7 days)

- **Cure level**
  - Must pass 30 IPA rubs
  - Qualitative test, cross-reference with process controls

- **Surface energy**
  - Consistently 40+ dynes
FLAT SHEET PROPERTIES:
Other Product Properties

Food Contact
- Migration testing from pilot line shows product suitable
- Migration testing from commercial line confirms product can be used for food contact
- 40°C & 135°C
- Compliant with FDA, EU, Swiss Ordinance & CFIA
LAMINATION & RETORT PERFORMANCE
**LAMINATE STRUCTURES**

**STANDARD RETORT STRUCTURE**
- 12 Micron PET
- Solvent Based Adhesive
- 9 Micron Foil
- Solvent Based Adhesive
- 15 Micron Nylon
- Solvent Based Adhesive
- 75 Micron CPP

**Adhesive Weight = 1.5 gsm**

**TEST STRUCTURE #1**
- 12 Micron PET
- Solvent Based Adhesive
- 0.5 Micron Topcoat
- 12 Micron METPET
- Solvent Based Adhesive
- 75 Micron CPP

**TEST STRUCTURE #2**
- 12 Micron PET
- Solvent Based Adhesive
- 12 Micron METPET
- 0.5 Micron Topcoat
- Solvent Based Adhesive
- 75 Micron CPP

Presented by
Dante Ferrari

AIMCAL R2R
October 28 - 31, 2018
BOND & BARRIER DATA

STANDARD RETORT STRUCTURE

12 Micron PET
Solvent Based Adhesive

9 Micron Foil
Solvent Based Adhesive

15 Micron Nylon
Solvent Based Adhesive

75 Micron CPP

12 Micron PET
Solvent Based Adhesive

12 Micron METPET
Solvent Based Adhesive

75 Micron CPP

OTR = 0.101 cc/m²/d
WVTR = 0.150 g/m²/d

OTR = 0.147 cc/m²/d
WVTR = 0.047 g/m²/d

12.6 N/25mm

13.6 N/25mm

16.2 N/25mm

21.7 N/25mm

8.21 N/25mm

9.79 N/25mm

TEST STRUCTURE #1

TEST STRUCTURE #2

Presented by Dante Ferrari

AIMCAL R2R
October 28 - 31, 2018

celplast metallized products
POST - RETORT PERFORMANCE

- 4-side seal pouches of 4x4 inches were prepared, and filled with 60 ml of DI water
- Pouches were put into a retort chamber and processed at 121°C for 30 minutes in water spray mode

There was no noticeable delamination or shrinkage in both the structures containing top-coated PET

The metal layer kept intact throughout the retort process signaling the protection being provided by the top coating

Presented by Dante Ferrari

AIMCAL R2R
October 28 - 31, 2018
POST RETORT BOND & BARRIER DATA

STANDARD RETORT STRUCTURE

12 Micron PET
Solvent Based Adhesive
9 Micron Foil
Solvent Based Adhesive
15 Micron Nylon
Solvent Based Adhesive
75 Micron CPP

OTR = 5.642 cc/m2/d
WVTR = 2.511 g/m2/d

9.25 N/25mm

5.27 N/25mm

TEST STRUCTURE #1

12 Micron PET
Solvent Based Adhesive
0.5 Micron Topcoat
12 Micron METPET
Solvent Based Adhesive
75 Micron CPP

OTR = 8.804 cc/m2/d
WVTR = 2.604 g/m2/d

7.08 N/25mm

0.16 N/25mm

TEST STRUCTURE #2

12 Micron PET
Solvent Based Adhesive
12 Micron METPET
Solvent Based Adhesive
0.5 Micron Topcoat
Solvent Based Adhesive
75 Micron CPP

OTR = 0.011 cc/m2/d
WVTR = 0.124 g/m2/d

7.07 N/25mm

0.86 N/25mm

Presented by Dante Ferrari

AIMCAL R2R
October 28 - 31, 2018
CONCLUSIONS

Large scale production
- Have successfully overcome the challenges of scaling process up to wider, much faster production tool
- Uptime & yields are acceptable, with further opportunities to improve

Flat Sheet Performance
- Barrier & other properties compare favorably between Pilot & Commercial Line
- Product reliability has been established, commercially successful

High Barrier Recyclable Structures
- Very good barrier & bond data with BOPP & PE sealant webs
CONCLUSIONS

Lamination & Retort Performance

- 3-ply structures with top-coated metallized PET have very favorable barrier & bonds at each interface, when compared to 4-ply foil-based structures.
- After retort, visual appearance of top-coated metallized pouches is not compromised.
- However, barrier & bonds are compromised after retorting, with weak link being metal-to-PET interface. 
- Additional work, with different high performance PET films, has not yielded any better results as yet.
- Celplast is interested in partnering with converters and other industry suppliers to continue work on improving retort performance of this 3-ply structure.
SPECIAL THANKS

To Nicholas Enders and the team at Henkel USA in Cary, NC for being our partners in collecting the retort and lamination data for this study
Thank you

DANTE FERRARI
OFFICE – 416-644-3507
CELL – 416-918-8790
E-MAIL – dante@celplast.com
Website – www.celplast.com