Clear barrier films - Process, Performance and Opportunities

Andrew Skinner
Technical Manager
Amcor Flexibles Camvac
Vacuum Coated Transparent Barrier Films

- Coatings and substrates
  - Production routes and costs
  - Properties
  - Packaging applications
  - Global market requirements/characteristics
  - Market growth projections
  - Techniques to further improve barrier
Transparent Barrier Coating Materials

1. ALUMINIUM OXIDE – 70%

2. SILICON DIOXIDE/SiO$_x$ – 30%
# Substrates for Transparent Barrier Films

<table>
<thead>
<tr>
<th>Type</th>
<th>Material</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>STANDARD</td>
<td>PET</td>
<td>80 - 90%</td>
</tr>
<tr>
<td>PET/PEN</td>
<td>COEX</td>
<td>small specialist market (higher barrier)</td>
</tr>
<tr>
<td></td>
<td>OPA</td>
<td>ca. 5 - 10% (mainly Japan)</td>
</tr>
<tr>
<td></td>
<td>OPP</td>
<td>relatively new</td>
</tr>
<tr>
<td></td>
<td>PVOH</td>
<td>small specialist market (mainly Japan)</td>
</tr>
</tbody>
</table>
Vacuum Coated Transparent Barrier Films

• Coatings and substrates

• **Production routes and costs**

• Properties

• Packaging applications

• Global market requirements/characteristics

• Market growth projections

• Techniques to further improve barrier
Production Routes for Transparent Barrier Films

PHYSICAL VAPOUR DEPOSITION (PVD)

- ELECTRON BEAM EVAPORATION \( \text{Al}_2\text{O}_3, \text{SiO}_x \)
- REACTIVE EVAPORATION \( \text{Al}_2\text{O}_3, \text{SiO}_x \)

CHEMICAL VAPOUR DEPOSITION (CVD)

- PECVD \( \text{SiO}_x \)
PRODUCTION ROUTES FOR CLEAR BARRIER VACUUM COATED FILMS

• Reactive Evaporation/Physical vapour deposition (PVD)
  • $\text{Al}_2\text{O}_3$
    Electron beam evaporation
    Reactive evaporation ($\text{AL}+\text{O}_2$)
  • $\text{SiO}_x$
    Electron beam evaporation
    Reactive evaporation ($\text{SiO}+\text{O}_2$)

• Chemical vapour deposition (CVD)
  • $\text{SiO}_2$
    PECVD of Organosilanes.
PRODUCTION ROUTES-
REACTIVE EVAPORATION.

- $\text{Al}_2\text{O}_3$
- Minor modifications to standard vacuum chamber
- Inexpensive raw material
- Fast line speed.
- $\text{SiO}_x$
- Minor modifications to standard vacuum chamber.
- Raw material more expensive.
- Lower line speed?
PRODUCTION ROUTES - ELECTRON BEAM

• Direct evaporation of barrier material source using the electron beam.

• Any oxide can be evaporated.

• Mixed oxides can be evaporated improving coating density and barrier.

• High capital cost/dedicated equipment

• More difficult to monitor coat weights/stoichiometry
PRODUCTION ROUTES.
PECVD.

• Decomposition of monomer using plasma.

• Organosilanes ➔ $\text{SiO}_2$

• Continuous feeding of gaseous monomer

• High capital costs/dedicated equipment

• Low efficiency – in the case of $\text{SiO}_2$, only ~ 10% goes on substrate.
Vacuum Coated Transparent Barrier Films

- Coatings and substrates
- Production routes and costs
  - Properties
- Packaging applications
- Global market requirements/characteristics
- Market growth projections
- Techniques to further improve barrier
Key Performance Properties of Vacuum-Coated Transparent Barrier Films

- Gas barrier
- Moisture barrier
- Transparency (to light + microwaves)
- Clarity
- Surface energy/printability
- Retortability/steam resistance
- Barrier loss during conversion/packaging
## Properties of Vacuum-Coated Transparent Barrier PET Films

<table>
<thead>
<tr>
<th>PROPERTY</th>
<th>DEPENDS ON</th>
<th>AlOₓ/RE</th>
<th>AlOₓ/EB</th>
<th>SiOₓ/RE</th>
<th>SiOₓ/EB</th>
<th>SiOₓ/CVD</th>
<th>C/CVD</th>
</tr>
</thead>
<tbody>
<tr>
<td>OTR *</td>
<td>PROCESS</td>
<td>1 - 3</td>
<td>1 - 3</td>
<td>1 - 3</td>
<td>1 - 3</td>
<td>1 - 3</td>
<td>1 - 3</td>
</tr>
<tr>
<td>MVTR **</td>
<td>PROCESS</td>
<td>1 - 3</td>
<td>1 - 3</td>
<td>1 - 3</td>
<td>1 - 3</td>
<td>1 - 10</td>
<td>1 - 3</td>
</tr>
<tr>
<td>STRETCH RESISTANCE</td>
<td>PROCESS</td>
<td>3 - 4%</td>
<td>3 - 4%</td>
<td>3 - 4%</td>
<td>3 - 4%</td>
<td>5 - 6%</td>
<td>5 - 6%</td>
</tr>
<tr>
<td>RETORTABILITY</td>
<td>SUBSTRATE + PROCES</td>
<td>GOOD</td>
<td>GOOD</td>
<td>GOOD?</td>
<td>GOOD</td>
<td>POOR?</td>
<td>GOOD?</td>
</tr>
</tbody>
</table>

* cc/m²/24 hours/atmos at 23°C, 50% RH
** gram/m²/24 hours at 38°C, 90% RH
Vacuum Coated Transparent Barrier Films

- Coatings and substrates
- Production routes and costs
- Properties
- **Packaging applications**
- Market growth projections
- Global market requirements/characteristics
- Techniques to further improve barrier
Vacuum Coated Transparent Barrier Films
Packaging Applications.

- MAP lidding of fresh/processed foods
- Ready meals
- Stand-up pouches
- Flow wraps
- Microwaveable snacks
- Moisture sensitive confectionery
- Barrier susceptors
- Flexibles tubes
- Medical packaging (disposables, fluids etc.)
Vacuum Coated Transparent Barrier Films

- Coatings and substrates
- Production routes and costs
- Properties
  - Global market requirements/characteristics
- Market growth projections
- Techniques to further improve barrier
- Packaging applications
Markets for Vacuum Coated Transparent Barrier Films - Europe

- Domestic production and imported specialities.

- $\text{AlO}_x$ and $\text{SiO}_x$ coatings, but $\text{AlO}_x$ has larger share.

- Largely commodity market, often price sensitive.

- Environmental pressure varies from country to country

- Main application MAP lidding.

- Retorting market growing rapidly.

- Most applications require oxygen rather than moisture barrier.
Markets for Vacuum Coated Transparent Barrier Films - Japan

- Domestic production.

- $\text{AlO}_x$ and $\text{SiO}_x$ coatings, but $\text{AlO}_x$ has larger share.

- Fairly mature but speciality (i.e. relatively high price) market.

- Strong pressure for chlorine-free packaging.

- Original main application retorting, but diversifying.

- Most applications require oxygen rather than moisture barrier.
Markets for Vacuum Coated Transparent Barrier Films - USA

- Mainly imported films.
- Market in its infancy - no clear main application.
- Little environmental pressure.
- Most applications require moisture rather than oxygen barrier.
Vacuum Coated Transparent Barrier Films

- Coatings and substrates
- Production routes and costs
- Properties
- Packaging applications
- Global market requirements/characteristics

- Market growth projections
- Techniques to further improve barrier
Growth Projections for Transparent Barrier Films

ANNUAL GROWTH RATE (GLOBALLY) = 35%

PUBLICATION: PACKAGING STRATEGIES - BARRIER FILMS AND COATINGS 2001-2005
AUTHOR: ALLIED DEVELOPMENT CORP. LAKEVILLE, MN U.S.A.
Transparent Barrier Films - Growth by End Use

2000

2005

PUBLICATION: PACKAGING STRATEGIES - BARRIER FILMS AND COATINGS 2001-2005
AUTHOR: ALLIED DEVELOPMENT CORP. LAKEVILLE, MN U.S.A.
Vacuum Coated Transparent Barrier Films

- Market growth projections
- Coatings and substrates
- Production routes and costs
- Properties
- Packaging applications
- Global market requirements/characteristics
- Techniques to further improve barrier
Techniques to Improve Barrier

• ALOx/SIOx coated PET in combination with Barrier Primers or Barrier Over lacquers.
  Typical O$_2$ barrier - 0.5cc/m$^2$/24hrs (23$^{\circ}$C/~50%rh)
  Typical Mvtr barrier – 0.5g/m$^2$/24hrs (38$^{\circ}$C/90%rh)

• Polymer Multilayer Coatings.
• Multi-layers of PET/Oxide/Organic layer/Oxide/Organic layer etc/etc.
  Typical O$_2$ barrier <0.1cc/m$^2$/24hrs.

• Nanocomposite coatings.
  In combination with oxide coatings.
Thank you.

Andrew Skinner
Technical Manager
Amcor Flexibles Camvac