New Design-Enabling Technologies For Flexible Packaging

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Market Applications for Metallized Films

### Food Packaging
- Snacks, Chips
- Bakery products
- Candy, Confectionary
- Coffee, ...

### Decoration
- Gift and Flower Wrapping
- Labels
- Hot Stamping Foils
- Holograms, ...

### Industrial
- Solar Window Films
- Anti-Counterfeiting Films
- Road Signs, ...
## Market for Metallized and AlOx-Coated Films
### Strong Growth in India and Asia

### Estimated Market Growth 1)

<table>
<thead>
<tr>
<th>Region</th>
<th>Metalized Films</th>
<th>Al Ox-coated Films</th>
</tr>
</thead>
<tbody>
<tr>
<td>Europe</td>
<td>2.5</td>
<td>2.9</td>
</tr>
<tr>
<td>North America</td>
<td>4.0</td>
<td>4.5</td>
</tr>
<tr>
<td>India &amp; Middle East</td>
<td>13.3</td>
<td>15.1</td>
</tr>
<tr>
<td>Asia</td>
<td>8.9</td>
<td>10.1</td>
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<tr>
<td>South America</td>
<td>6.7</td>
<td>7.6</td>
</tr>
</tbody>
</table>

1) Market estimates based on information from Henkel, Nordmeccanica, and several market studies
Market Applications for Functional Coatings

- Coating Functionalities
  - Sealability
  - Better anchorage
  - Improved barrier
  - Protection
  - Optical effects (gloss, matte, ...)
  - Slip modification

Trend: Multifunctional Coatings
Integration and Interaction of Product Lines
Freedom of Design – Case Studies

- Traditional
  - Lamination of metallized films with printed stock

- High Performance Protective Top-Coatings
  - Top-coating fragile layers like AlOx with protective coatings

- Novel Metallization Primers
  - Metallizing on top of multifunctional metallization primers
Metal Deposition
Principle & Key Technical Data

- Aluminum layer deposited to films and paper in vacuum
  - Thickness: 0.005 – 0.07 micron
  - Optical Density: 0.2 – 4
  - Electrical Resistance: 0.5 – 10 Ω/m²

P (chamber pressure) = 5E-4 mbar
System Layout

Schematic Representations

Roots Pumps - Vacuum 5 X 10^-2 mbar

Diffusions pumps - Vacuum 2-5 X 10^-4 mbar

Process drum chill roller

Al evaporators

Unwind

Rewind
System Layout

Product Pictures

- Vacuum chamber
- AI evaporation system
- Winder

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Process Schematic
Metallization Process

High vacuum chamber

Boat

Al evaporators
Coater Technology
Product Pictures

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Safe and highly focused innovation process created fast results!
Case Study AlOx-Coated Films
New High-Performance Protective Coating Technology

- AlOx-coated films
  - Very good oxygen and moisture barrier
  - Very fragile
  - Converting leads to diminished barrier performance
- Current top-coating technologies provide mechanical protection
- New top-coating technology
  - Mechanical protection
  - Significant barrier improvement

Protected AlOx-coated Film

High-performance Top-coating Technology
AlOx-layer
Substrate (e.g. PET, OPP)
Case Study AlOx-Coated Films
Process Flow-Chart

AlOx-Coating
- Optimal anchorage
- Superior barrier performance
- Best clarity

Top-Coating
- Fragile AlOx-layer unprotected
- Additional functionality for very high performance

Printing
- Protection of AlOx-layer
- Ink anchorage
- High mechanical and thermal stress

Lamination
- Good anchorage of ink on AlOx during lamination
- Keeps top barrier performance throughout process
Case Study AlOx-Coated Films
Testing Mechanical Protection

- Strongly improved robustness
- Barrier performance not reduced by stretching or abrasion
- Gelboflex testing
- Significantly more robust than traditional top-coat

<table>
<thead>
<tr>
<th>Treatment</th>
<th>OTR (cm³/m²·24h·bar)</th>
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<tbody>
<tr>
<td>Before Treatment</td>
<td>13.1</td>
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<tr>
<td>Stretching (2%)</td>
<td>21.2</td>
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<tr>
<td>Abrasion Test</td>
<td>47.4</td>
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<tr>
<td>Gelboflex-50</td>
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- No Top-Coat
- Traditional Top-Coat
- Henkel's Top-Coat

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Case Study AlOx-Coated Films
Production Scale Testing

- Strong barrier improvement by AlOx-coating
- Significant boost in oxygen barrier performance by Henkel’s new top-coating technology
- Moisture barrier stabilized or improved
- Very good stability throughout entire process

<table>
<thead>
<tr>
<th></th>
<th>AlOx-Coating</th>
<th>Top-Coating</th>
<th>Printing</th>
<th>Laminating</th>
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<tbody>
<tr>
<td>OTR</td>
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<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
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<tr>
<td></td>
<td>4.9</td>
<td>3.7</td>
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No Top-Coat | Henkel's Top-Coat
Case Study Metallized Films
Novel Metallization Primer Technology

- Metallization is state of the art
- Improvement of anchorage of metal layer to plastic substrate
- Henkel’s novel coating technology provides additional improvement in oxygen barrier
Case Study Metallized Films
Process Flow-Chart

- Primer Application
  - Full coverage and smooth laydown
  - Strong anchorage to film

- Metallization
  - Optical density determines barrier
  - Primer holding both materials in place

- Lamination
  - Good anchorage of metal-layer to substrate
  - Withstand mechanical and thermal stress
Case Study Metallized Films
Barrier Performance Development on PET Film

- Very strong improvement of barrier performance by Henkel’s new coating technology
- Significant barrier improvement by metallization
- Very good stability throughout entire process

Coating Metallizing Laminating

<table>
<thead>
<tr>
<th>OTR (cm³/m².24h.bar)</th>
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<tbody>
<tr>
<td>120</td>
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<tr>
<td>2.0</td>
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<td>1.5</td>
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<tr>
<td>1.0</td>
</tr>
<tr>
<td>0.5</td>
</tr>
<tr>
<td>0.5</td>
</tr>
</tbody>
</table>

- Henkel's High Performance Technology
- Traditional Primer
Summary
Enabling new designs for flexible packaging

- Synergy of metallizing technology and multifunctional coating
- High barrier metallized films
- More sustainable transparent barrier films
- Layer reduction
- Access to high barrier recyclable structures (Circular Economy)

Enabled by BarrEnhanceTech Alliance by Nordmeccanica and Henkel.
Two industry leaders working in perfect collaboration
Thank you!