Water-based Compostable Lamination Adhesive

FlexPackCon 2017, Akbar Hussaini
# Water-based Adhesive Lamination Overview

<table>
<thead>
<tr>
<th>Section</th>
<th>Pages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Laminates in flexible packaging</td>
<td>3</td>
</tr>
<tr>
<td>Process</td>
<td></td>
</tr>
<tr>
<td>- Coating</td>
<td>5 - 9</td>
</tr>
<tr>
<td>- Drying</td>
<td>10</td>
</tr>
<tr>
<td>- Lamination</td>
<td>11 - 12</td>
</tr>
<tr>
<td>Water-based compostable adhesive</td>
<td>13 - 19</td>
</tr>
<tr>
<td>Compostability</td>
<td>20 - 23</td>
</tr>
</tbody>
</table>
Laminated Film Flexible Packaging

Typical Structure

- Structural Film
- Inks
- Adhesive
- Metallization
- Primer
- Sealant
Water-based Film-to-film Lamination Adhesives
Coater Overview

Gravure roll → Adhesive reservoir → Carrier web → Nip roll (70-90°C) → Rubber roll → Chill roll → Secondary web → Lamination section

Drying tunnel: 60°C → 70°C → 80°C

unwind #1 → Adhesive reservoir → Carrier web → Nip roll (70-90°C) → Rubber roll → Chill roll → Secondary web → Lamination section → rewind

Finished laminate
Films must be pretreated to ensure surface tension > 38 dynes/cm

High surface slip agent levels can cause adhesion issues

In-line corona treatment is recommended to fresh-up the surface tension

Insufficient film pretreatment can result in lower bond strength

Excessive corona treatment can destabilize the emulsion and generate coating defects.
Recommended coating weight depends on required performance level and roughness of the film surface:

- for General purpose applications: 2.0 - 2.5 g/m² dry
- for Medium performance: 2.3 - 2.8 g/m² dry
- for Retort applications: 2.5 - 3.2 g/m² dry

For lamination onto paper, coating weight of 3-4 g/m² is recommended.
Gravure cylinder with line structures are recommended

Recommendations for various coating weights:

<table>
<thead>
<tr>
<th>Coating weight</th>
<th>Line gravure angle</th>
<th>Lines / cm</th>
<th>Volume</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.9 - 2.3 g/m² dry</td>
<td>45°</td>
<td>80</td>
<td>17 ml/m²</td>
</tr>
<tr>
<td>2.3 - 2.8 g/m² dry</td>
<td>45°</td>
<td>50</td>
<td>22 ml/m²</td>
</tr>
<tr>
<td>3.5 - 4.0 g/m² dry</td>
<td>45°</td>
<td>44</td>
<td>30 ml/m²</td>
</tr>
</tbody>
</table>
A highly polished roll that can minimize coating patterns and irregularities
Water-based Film-to-film Lamination Adhesives

Smoothing Bar

- A smoothing bar can be helpful, but is not always required
- Smoothing bar improves flow-out of the coated surface before it is laminated to the second substrate
- “Smooth coatings” are easier to dry and result in better appearance of laminates
- How to install?
  - The smoothing bar should be placed as close to the coating unit as possible
  - It should be operated against web direction and have a variable speed control
**Water-based Film-to-film Lamination Adhesives**

*Drying*

- Very important: use maximum airflow / velocity (typical oven temperatures of 80-90°C)
- When using zoned ovens, use an increasing profile temperature
- Higher temperature in the first zone can lead to skinning of the adhesive and prevent further drying of inner layers
- Try to eliminate recirculation in the ovens by introducing fresh air to maximize its drying power
- Laminations made with poorly dried adhesive will not improve over time
- You must thoroughly dry the adhesive prior to lamination
- The higher the speed of lamination, the higher the oven temperature/ flow of air needs to be
Water-based Film-to-film Lamination Adhesives

*Nip Roll*

- **Gravure roller**
  - **adhesive reservoir**
  - **Carrier web**
- **unwind #1**
- **Chill roll**
- **Nip roll (70-90°C)**
- **Rubber**
- **Secondary web**
- **unwind #2**
- **Finished laminate**
- ** rewind**
- **Drying tunnel**
  - 60°C
  - 70°C
  - 80°C
Water-based Film-to-film Lamination Adhesives

Off the Laminator

- The laminate should be clear with good appearance
- Water-based adhesives have a very high shear strength
- Laminates can be slit shortly after lamination
  - Initial bond can be measured, but may not be indicative of capability to slit
  - Slitting capability after lamination should be evaluated for each laminate construction
- Adhesive may exhibit some cold flow; as a result you may see improvement in appearance and bond performance within 24 hours
- Full product and thermal resistance is reached after 3-4 days (depending on laminate construction and Epotal® grade) → then heat sealing is possible
Flexible Packaging Technology

**Differences**

*Health & Safety*

### Solvent-based / solvent-free adhesives
- Low molecular weight components dominating
- Formation of polyurethane network in laminate at converter
- Solution of high molecular weight too viscous

### Water-based adhesives
- Application of high molecular weight polyacrylate / polyurethane
- Adhesive synthesis in chemical reactor
- Low viscosity despite high molecular weight

Water-based adhesive’s high molecular weight reduces migration concerns while remaining low in viscosity for easy application.
Molecular weight distribution of typical lamination adhesives

- OH-component solventless adhesive
- NCO-component solventless adhesive
- Polyurethane dispersion
- Base component solvent-based adhesive
- Acrylic dispersion

Potential zone of migration
Time dependence of peel strength
(PET-ink/PE, 2.5 g/m²; peel at 300 mm/min; with cross-linker)
Water-based COMPOSTABLE Laminating Adhesives

- An aqueous dispersion of a polyester-polyurethane elastomer

\[
\text{OCN} \quad \text{NCO} + \quad \text{HO} - \text{O} - \text{OH} + \quad \text{OCN} \quad \text{NCO}
\]

**aliphatic linear polyol**

Isocyanate & Polyol react

\[
\text{OCN} \quad \text{NCO}
\]

in acetone / catalyst

to form pre-polymer

\[
\text{urethane group} \quad \text{urea} \quad \text{aliphatic, aromatic}
\]

which further reacts with an ionomer salt to further extend the molecular chains during polymerization...

water allows for a dispersion of finely divided PU particles

addition of water

distillation of acetone

acetone removal yields a Solvent free dispersion
BASF’s Medium Performance Portfolio

Epotal® CF 500 w/ Basonat® LR 9056

Epotal CF 500

(2.5 g/m²; after 7d, peel at 100 mm/min, PET/OPP)
N/15mm

Basonat LR 9056 can be added when heat stability and chemical resistance are necessary
## Polyisocyanate Cross-linkers for Heat Resistance

<table>
<thead>
<tr>
<th>Basonat®</th>
<th>HW 100</th>
<th>HW 180 PC</th>
<th>LR 9056</th>
<th>LR 9080*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solids Content [DIN EN ISO 3251]</td>
<td>100 %</td>
<td>79-81%</td>
<td>100 %</td>
<td>79-81%</td>
</tr>
<tr>
<td>NCO (%) [DIN EN ISO 11909]</td>
<td>16.5 – 17.5</td>
<td>13.0 – 14.0</td>
<td>17.5 – 18.5</td>
<td>11.5 – 12.5</td>
</tr>
<tr>
<td>Viscosity (mPas, 23°C) [DIN EN ISO 3219]</td>
<td>2000 – 6000</td>
<td>450 – 850</td>
<td>1500 – 3000</td>
<td>500 – 900 (~80%)</td>
</tr>
<tr>
<td>Platinum cobalt color (Hazen) [DIN ISO 6271]</td>
<td>&lt; 100</td>
<td>&lt; 40</td>
<td>&lt; 40</td>
<td></td>
</tr>
<tr>
<td>Key Properties</td>
<td>Excellent potlife</td>
<td>Excellent potlife, better incorporation</td>
<td>Simplified Incorporation, low foaming</td>
<td>Fast drying, excellent hardness</td>
</tr>
</tbody>
</table>

* Preliminary values
Water Dispersable Polyisocyanate

Chemistry

Technical Solution: PIC modification via reaction with a reactive emulsifier

Dispersibility

Aqueous system

Emulsifier acts as:
- a surfactant
- a protecting layer

Dispersible via mechanical or hand mixing

„Pot-life“ of several hours
The Key to Compostability, Aliphatic Linear Polyester

- Hydrolysis disintegrates (converts) the aliphatic linear polyester

- Microorganisms (bacteria, fungi) incorporate these fragments

- The temperature in the industrial compost (50-60°C) accelerates this process

- \( T_{\text{compost}} > T_{\text{crystallization}} \)
EN (European norm) 13432: To call a substance “compostable”, it must biodegrade more than 90% within 90 days. Epotal P 100 ECO accomplishes this in just 70 days.
## Certifications and Clearances

**Epotal ECO 3702 & Epotal P100 ECO**

### Regulatory
- **TSCA**
  - Released/listed
- **FDA**
  - The application rate of the product will be no greater than 0.039 g/in² (60 gsm).
  - Therefore the product may be used for applications according to 21 FDA CFR §175.105, 175.125, 175.300, 175.320, 176.170 und 176.180.
- **Prop 65**
  - Warning

### Compostability
- **DIN-CERTO to DIN EN 13432**
  - 8Z0004 Epotal P100 ECO/Basonat LR 9056/Lumiten® I-SC
  - 8Z0004 Epotal 3702 ECO/Basonat LR 9056/Lumiten I-SC
- **BPI to ASTM D 6400**
  - Epotal P100 ECO in progress
  - Epotal ECO 3702 in submission
BASF’s Certified Compostable Adhesive

*Epotal ECO 3702*

**Compostable adhesive Epotal ECO 3702**

- Provides opportunities to address new markets
- Contributes to sustainability policy
- First certified compostable water-based laminating adhesive
- Substrates include all different types of degradable films, e.g., ecovio®, ecoflex®, PLA, paper, metalized films, cellulosics, starch-based films
Thank You

Tel: 1-800-962-7829  
Email: dpsolutions@basf.com  
Website: www.basf.us/dpsolutions

Paul Kearns  
New Business Development – Sustainable Packaging  
Phone: +1-734-324-6412, Mobile: +1-734-250-0255, E-Mail: paul.kearns@basf.com

Akbar Hussaini  
Technical Specialist – Flexible Packaging Adhesive Formulations  
Phone: +1-248-948-2527, Mobile: +1-734-353-5397, E-Mail: akbar.hussaini@basf.com
While the descriptions, designs, data and information contained herein are presented in good faith and believed to be accurate, they are provided for guidance only. Because many factors may affect processing or application/use, BASF recommends that the reader make tests to determine the suitability of a product for a particular purpose prior to use. **NO WARRANTIES OF ANY KIND, EITHER EXPRESSED OR IMPLIED, INCLUDING, BUT NOT LIMITED TO, WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE, ARE MADE REGARDING PRODUCTS DESCRIBED OR DESIGNS, DATA OR INFORMATION SET FORTH, OR THAT THE PRODUCTS, DESCRIPTIONS, DESIGNS, DATA OR INFORMATION MAY BE USED WITHOUT INFRINGING THE INTELLECTUAL PROPERTY RIGHTS OF OTHERS.** In no case shall the descriptions, information, data or designs provided be considered a part of BASF's terms and conditions of sale. Further, the descriptions, designs, data, and information furnished by BASF hereunder are given gratis and BASF assumes no obligation or liability for the descriptions, designs, data or information given or results obtained all such being given and accepted at the reader's risk.

*Epotal®, Basonat®, Lumiten®, ecovio® and ecoflex® are registered trademarks of BASF Group.*

© 2017 BASF Corporation
BASF
We create chemistry