Laminating Adhesives for Industrial Applications®

Nolan McDougal
Technical Service & Development
The Dow Chemical Company

Science that Connects

Expertise  Capabilities  Collaboration  Solutions
The Dow Chemical Company

Collaborate
Innovate
Accelerate
Why Laminations and Coatings?

Why Laminations and Coatings?

- PET Printing Lam. Adhesive
- PE outer layer sealing
- PET Printing Lam. Adhesive
- PE outer layer sealing
- PE Printing Coating
- Foil outer layer sealing
- Printing Heat Seal Coating

Why Laminations and Coatings?
Laminating Adhesives & Coatings

Different Chemistries of Laminating Adhesives
The Adhesives
The Carriers
The Substrates

Application Methods for Laminating Adhesives
Rotogravure, Differential Speed, or Flexographic

Industrial Applications with Laminating Adhesives
Solar Control & Window Films
Sailcloth
Lidding Materials
Chemistries & Materials of Laminating Adhesives

Primary Chemistry
- Polyurethane-based Adhesives
- Polyester-based Adhesives
- Acrylic-based Adhesives
- Polypropylene-based Adhesives
- Ethylene-Vinyl Acetate-based Adhesives
- Ethylene-Acrylic Acid-based Adhesives
- Vinyl-based Adhesives
- Surlyn-based Adhesives

Adhesive Carriers
- Solvent-based Adhesives
- Water-based Adhesives
- Solventless Adhesives

Application Methods
- Rotogravure
- Differential Speed Rolls
- Flexographic

Lamination Substrates
- PE, PP, PET, HIPS, Paper, PVC, PVDC, Tedlar, Nylon, EVA, EVOH, Foil, Met-PET, PAN, Cellophane, PETG, ...
Chemistry of Urethane Prepolymers

Di-isocyanate A
Rigid

Poly-alkohol A
Heat Resistant

Di-isocyanate
Chemical Resistant

Poly-alkohol
Flexible

Polyurethane Prepolymer A

Polyurethane Prepolymer B
Chemistry of Coreactants & Prepolymers
Application Methods for Laminating Adhesives

Rotogravure Coating

Web Path

Rubber Roll

Doctor Blade

Gravure Roll

Adhesive Pan

Coated Web Path

Hexagonal Pattern

Pyramid Pattern

Quadrangular Pattern
Application Methods for Laminating Adhesives

Differential Speed Roll Coating

- Rubber Roll
- Steel Roll
- Rubber Roll
- Steel Roll
- Adhesive Pool
- Steel Roll
- Stationary

Flexographic Coating

- Steel Roll
- Anilox Roll
- Metering Roll
- Printing Cylinder
- Flexible Printing Plate
- Doctor Blade
- Adhesive Pan
Industrial Application: Window Films

Critical-to-Quality to Customers:
- Aesthetics: Tint, Color
- Comfort: Heat, Glare Reduction
- Protection: Fading of Interiors, Privacy/Security of Self

Critical-to-Quality to Convertors:
- Film Clarity
- Adhesion
- Color Stability
  - Dyed films or adhesives
  - Metallized or nano-ceramic films
Window Film: Mode of Action & Modes of Failure

- UV Light: Up to 99% Blocked
- Visible Light: 5-95% Blocked
- IR Light (heat): Up to 80% Blocked

Dyed Adhesives → Dyed Films → Metallized Films → nano-Ceramic Films
Window Film: Appearance & Transmittance Ratings

Back-lit Frosted Glass Window

Back-lit Glass Window

5% 10% 20% 30% 50%
Laminating Adhesives:
ADCOTE™ 76R36B-33 or ADCOTE™ 76R44 with Coreactant 9H1H, Coreactant 9L7, or Coreactant 9L10

Mounting Adhesives:
ADCOTE™ 89R1T or ADCOTE™ 89R3
Production: Polyester-based Adhesive and Clarity

**ADCOTE™ 76R44**
Polyester-Alcohol Laminating Adhesive

**COREACTANT 9L7**
Poly-isocyanate

**LOT A** + CR 9L7

**LOT B** + CR 9L7

Addition of Coreactant 9L7
mix for 60 seconds

Hazy Adhesive
Production: Polyester-based Adhesive and Clarity

**Polyester-Alcohol Laminating Adhesive**

- **ADCOTE™ 76R44**
- Poly-isocyanate

**COREACTANT 9L7**

+ **Polyester-Alcohol**

- Medium Mw PET

**Hazy Adhesive**

<table>
<thead>
<tr>
<th>LOT A</th>
<th>+0.15%</th>
<th>+0.30%</th>
<th>+0.60%</th>
<th>+1.25%</th>
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<td>med. Mw PET</td>
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**“Probability”**

**“Molecular Weight”**

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[Additional content not visible in the image]
Critical-to-Quality to Customers:
• Performance: Speed
• Reliability: Strength during Sailing and Storage
• Aesthetics: “casual market”

Critical-to-Quality to Convertors:
• Adhesion to Multiple Materials
• Reliability: Strength of Sailcloth and Weather-resistance
Films:
- Polyethylene terephthalate Film
- Polyethylene naphthalate Film

Fabrics:
- **Polyester:** Dacron
- **Polyamide:** Nylon, Kevlar, Twaron, Technora
- **Ultra-high M<sub>w</sub> Polyethylene:** Spectra, Dyneema
- **Liquid Crystal Polymers:** Vectran, Zylon

Scrims:
- Polyesters, Aramids, Ultra-high M<sub>w</sub> Polyethylene, Liquid Crystal Polymers, Polypropylene, Carbon
Laminating Adhesives:

ADCOTE™ 122-HV or ADCOTE™ 123
with Coreactant F, Coreactant 9H1H, or Coreactant 9L10
Catalysis: Polyester-based Adhesive & Curing

Polyester-Alcohol Laminating Adhesive

ADCOTE™ 123 + COREACTANT F
Poly-isocyanate → Cured Adhesive

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Catalysis: Polyester-based Adhesive & Curing

Curing of ADCOTE™ 123 /CR F with Catalysts

- Control
- Catalyst 1
- Catalyst 2
- Catalyst 3
- Catalyst 4

Iso Remaining (% of Absorbance)

Time (days)
Catalysis: Polyester-based Adhesive & Bond Strength

Mean Peel Strength of ADCOTE™ 123/CR F with Catalysts

- Catalyst 4
- Catalyst 3
- Catalyst 2
- Control

Bonds (gr/in)

Time (days)
Industrial Application: Medical Packaging

Critical-to-Quality to Customers:
• Performance: Sterile Packaging
• Reliability: Good Strength during Storage and Sterilization & Excellent Control during Usage

Critical-to-Quality to Convertors:
• Adhesion: Good Bond Strength to Multiple Materials
• Reliability: Even Peel when Used
Heat Seal Coatings (HSC) are thermoplastic materials that, when applied to a substrate, are solidified and tack-free. The heat seal-coated material can be rewound and used later.

1. Heat the substrate to activate the HSC to become soft and tacky.
2. Press the substrate to a secondary substrate to adhere.
3. Cool to form a bond between the layers of substrates.

Critical to Sealing: Temperature, Time, & Pressure
Formulation: EVA-based Adhesive & Bond Strength

Ethylene-Vinyl Acetate (EVA) is a copolymer of ethylene and vinyl acetate. Usually ~4-30% vinyl acetate by mass with remainder ethylene. Material is flexible with high clarity, high gloss, resistance to UV light, & low-temperature toughness.

Ethylene-Vinyl Acetate (EVA)

1° Substrates: Foil, PE, PET, Paper
2° Substrates: PE, PP, (PVDC-)HIPS, Paperboard

Heat Seal Coating:
ADCOTE™ 37P295HV

Customer Request: higher bonds strength

Customer Request: higher bonds strength
Formulation: EVA-based Adhesive & Bond Strength

1° Substrate: Foil
2° Substrates: PETG, HDPE, HSC-coated Foil

Newly-formulated product has higher heat seal bonds while maintaining appearance, shelf stability, viscosity, and activation temperature.

Mean Seal Bonds of Heat Seal Coatings

- Incumbent HSC
- Formulated HSC

![Graph showing mean seal bonds of heat seal coatings](image-url)
Heat Seal Coating:
ADCOTE™ 40-3E

Customer Request: better “footprint” & lower bonds strength

Newly-formulated product has whiter footprint and lower heat seal bonds while maintaining shelf stability, viscosity, and activation temperature.

1° Substrate: Foil-PET prelam.
2° Substrates: PETG

White footprint shows integrity of the seal
Sterile/Aseptic

Film Tear Partial Film Tear Footprint White Footprint

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Laminating Adhesives & Coatings

Diverse Variety of Different Chemistries: Adhesives & Substrates
Different Application Methods: Gravure, Differential Speed, & Flexo.
Different Industrial Applications:
   Solar Control & Window Films, Sailcloth, Lidding Materials, ...

More information is always useful before a recommendations is made
• Specific performance targets for specific applications
• May be unique product for application
• Need to define performance & testing requirements
• Know the capabilities of the converter
Thank You

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Expertise
Capabilities
Collaboration
Solutions