Innovative Bonding Solutions from Evonik Product Line Adhesive Resins

Dr. Volker Schrenk
European Web Convention, 2013-10-31
1. Polymer with additional functionality: New Polyester-Polyol with inherent flame retardancy

2. Packaging Innovation: Easy Peel Package for reactive Polyolefins

3. Entirely new product: Waterbased Dispersion derived from amorphous Polyolefins
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**Introduction:**

DYNA机动® Portfolio

With our DYNACOLL® product range we offer polyester-polyols, copolyesters and polyacrylates for reactive and thermoplastic hot melts.

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**Our Product Portfolio**

<table>
<thead>
<tr>
<th>DYNACOLL® 7000 series: Polyester-Polyols</th>
<th>DYNACOLL® S series: Copolyesters</th>
<th>DYNACOLL® AC series: Polyacrylates</th>
</tr>
</thead>
<tbody>
<tr>
<td>➢ Linear Polyester-Polyols with primary hydroxyl functionality and medium molecular weight.</td>
<td>➢ Thermoplastic Copolyesters of high molecular weight.</td>
<td>➢ Bead Polymers made of methyl methacrylate and n-butyl methacrylate.</td>
</tr>
<tr>
<td>• Tg: -60 – 50 °C</td>
<td>• Tg: -30 – 65 °C</td>
<td>• Tg: 44 – 85 °C</td>
</tr>
<tr>
<td>• FP (R&amp;B): &lt; RT – 130 °C</td>
<td>• FP (R&amp;B): 95 – 195 °C</td>
<td>• FP (R&amp;B): 120 – 190 °C</td>
</tr>
<tr>
<td>• Vis (130°C): 0,5 – 50 Pa.s</td>
<td>• MFR (200°C): 30 – 750 g/10min</td>
<td>• MFR (190°C): 7 – 1000 g/10min</td>
</tr>
</tbody>
</table>
Specific Applications for Flame Retardant Adhesives

Even non-flammable materials can be rendered flammable by bonding materials that use a standard adhesive. This is why – in addition to adhesive properties – high flame resistance often is an additional requirement particularly in:

- **Public buildings**
  - Technical textiles (e.g. curtains, carpeting)

- **Public transport**
  - Textile adhesives in vehicles

- **Aircraft construction**
  - Bonding materials for textiles and leather

- **Clothing industry**
  - Lamination of protective clothing and outdoor clothing

- **Boat building**
  - Lamination of paneling and textile adhesives

- **Electronic industry**
  - Lamination of metal foils and plastic films (e.g. for flexible flat cables)
## Challenge: Development of a Polyester-Polyol with inherent Flame Retardancy for moisture curing Reactive Hot Melts (RHM‘s)

<table>
<thead>
<tr>
<th>Problem</th>
</tr>
</thead>
<tbody>
<tr>
<td>State-of-the-art adhesives contain flame retardants as additives which lead to significantly reduced adhesion performance</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Challenge</th>
</tr>
</thead>
<tbody>
<tr>
<td>Find a reactive phosphorus-based organic flame retardant as monomeric building block</td>
</tr>
</tbody>
</table>

### Process

<table>
<thead>
<tr>
<th>Literature research</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Learn about flame retardants in general</td>
</tr>
<tr>
<td>• Find reactive phosphorus based ones</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Market screening</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Check on availabilities</td>
</tr>
<tr>
<td>• Check on prices</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Development</th>
</tr>
</thead>
<tbody>
<tr>
<td>Check of suitability for polyester synthesis with regard to</td>
</tr>
<tr>
<td>• thermal stability</td>
</tr>
<tr>
<td>• reactivity</td>
</tr>
<tr>
<td>• purity</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polymer design</td>
</tr>
<tr>
<td>Chemical incorporation of flame retardant during polyester synthesis</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Development of first prototype (DYNACOLL® EP 455.04FR)</th>
</tr>
</thead>
<tbody>
<tr>
<td>successful: patent application filed</td>
</tr>
</tbody>
</table>
RHM Properties: inherent vs. external Flame Retardancy

RHM 1: DYNACOLL® EP 455.04FR
RHM 2: Conventional pasty polyester
RHM 3: Conventional pasty polyester with additive liquid flame retardant
RHM 4: Conventional pasty polyester with additive powder flame retardant

...were tested according to UL 94 burning test. The results:

<table>
<thead>
<tr>
<th>RHM data</th>
<th>Unit</th>
<th>RHM 1</th>
<th>RHM 2</th>
<th>RHM 3</th>
<th>RHM 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Viscosity at 100°C / 120°C</td>
<td>Pa.s</td>
<td>6/ 3</td>
<td>11/ 6</td>
<td>7/ 4</td>
<td>8/ 4</td>
</tr>
<tr>
<td>Tensile strength</td>
<td>N/mm²</td>
<td>15</td>
<td>25</td>
<td>20</td>
<td>30</td>
</tr>
<tr>
<td>Elongation at break</td>
<td>%</td>
<td>1100</td>
<td>1100</td>
<td>1300</td>
<td>1250</td>
</tr>
<tr>
<td>Flammability testing UL 94</td>
<td></td>
<td>V-0</td>
<td>V-2</td>
<td>V-0</td>
<td>V-2</td>
</tr>
</tbody>
</table>
Comparison of RHM based on Polyester with inherent vs. additive FR

Adhesion Properties

Shear adhesion [MPa]

Reactive Hot Melts based on:
- Polyesters with inherent flame retardant
- Polyesters with flame retardant additives
- Conventional Polyester
Chemical and Heat Resistance

**Chemical Resistance**

Method: Determination of soluble components after extraction in boiling acetone

**Heat Resistance**

Method: According to WPS 68

Reactive Hot Melts based on:
- **Polyesters with inherent flame retardant**
- **Polyesters with flame retardant additives**
- **Conventional Polyester**
### RHM based on Polyester Mixtures: Flammability Results

#### Flame retardant Polyester: Required amount in RHM composition

<table>
<thead>
<tr>
<th>RHM composition</th>
<th>20</th>
<th>80</th>
<th>100</th>
</tr>
</thead>
<tbody>
<tr>
<td>DYNACOLL® EP 455.04 FR</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Conventional pasty Polyester with additive FR</td>
<td>20</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Conventional crystalline Polyester</td>
<td>100</td>
<td>80</td>
<td>80</td>
</tr>
<tr>
<td>4,4’-MDI [OH/NCO]</td>
<td>1/2.2</td>
<td>1/2.2</td>
<td>1/2.2</td>
</tr>
<tr>
<td>Flammability testing UL 94</td>
<td>V-2</td>
<td>V-2</td>
<td>V-0</td>
</tr>
</tbody>
</table>

**Result**

Only 20 ppw of flame retardant polyester are needed!
Discover the benefits of…

...our flame retardant solutions:

- Highly effective flame retardant properties
- Excellent adhesion performance
- Improved chemical and heat resistance
- Adequate hydrolysis resistance
- Adjustable melt stability
- Very good compatibility with various polyester polyols
1. Polymer with additional functionality: New Polyester-Polyol with inherent flame retardancy

2. Packaging Innovation: Easy Peel Package for reactive Polyolefins

3. Entirely new product: Waterbased Dispersion derived from amorphous Polyolefins
With VESTOPLAST®, amorphous poly-alpha-olefins (APAO) we offer a broad range of co- and terpolymers of ethene, propene and 1-butene as raw materials for various applications.

Our Product Portfolio

<table>
<thead>
<tr>
<th>Thermoplastic Polyolefines</th>
<th>Reactive Silane Modified Polyolefines</th>
</tr>
</thead>
<tbody>
<tr>
<td>Butene-rich Grades</td>
<td></td>
</tr>
<tr>
<td>C4-content &gt; 50%</td>
<td>Grafted Silane-groups in the Polymer Chain</td>
</tr>
<tr>
<td></td>
<td>Moisture-curable, reactive Systems</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Propene-rich Grades</td>
<td></td>
</tr>
<tr>
<td>C3-content &gt; 50%</td>
<td></td>
</tr>
<tr>
<td>2.700 – 120.000 mPa.s</td>
<td>Melt Viscosity (190 °C): 3.000 – 12.000 mPa.s</td>
</tr>
<tr>
<td>30.000-120.000 g/mol</td>
<td>91 – 100 °C</td>
</tr>
<tr>
<td>84 – 162 °C</td>
<td>Needle Penetration: 15 – 22 1/10mm</td>
</tr>
<tr>
<td>5 – 36 1/10mm</td>
<td>Open Time: 20 – 60 sec</td>
</tr>
<tr>
<td>&lt;2 sec – &gt;30 min</td>
<td>30.000-120.000 g/mol</td>
</tr>
<tr>
<td>around -30 °C</td>
<td>84 – 162 °C</td>
</tr>
</tbody>
</table>

- Melt Viscosity (190 °C): 2.700 – 120.000 mPa.s
- Molecular weight: 30.000-120.000 g/mol
- Softening Point (R&B): 84 – 162 °C
- Needle Penetration: 5 – 36 1/10mm
- Open Time: <2 sec – >30 min
- Glass Transition Temp.: around -30 °C
- Melt Viscosity (190 °C): 3.000 – 12.000 mPa.s
- Softening Point (R&B): 91 – 100 °C
- Needle Penetration: 15 – 22 1/10mm
- Open Time: 20 – 60 sec
# Deep Dive: Reactive silane modified VESTOPLAST for sealants

## Properties
- Low water vapor permeability
- Excellent adhesion to glass and/or metal, plastics
- High weather resistance and temperature resistance
- High shear-tear strength

## How to use
- Since cross-linking of VESTOPLAST 206 is accelerated by humidity, the degradation starts at surfaces exposed to air, i.e. the top of the vessel.
- Storage of molten VESTOPLAST 206 under dry, inert atmosphere is highly recommended
- Make sure, that the atmosphere above the pot is dry.
- Tubes and pipes should be carefully purged with dry nitrogen before inserting them into the pot.
- For cleaning use additional non-reactive VESTOPLAST grades to dilute and purge your equipment or use solvents.
VESTOPLAST has a strong hot tack because of its thermoplastic, amorphous polyolefine backbone and immediately establishes green strength as it solidifies by cooling. The silane modification additionally leads to a reactive bond with the substrate and strengthens adhesion. But: the product should not bond inseparably with its packaging!

**Challenge:** create suitable packaging form

**Problem**

**Challenge**

- Minimal weight and volume
- Safe and easy handling
- Easy and cost-effective disposability

**Create product-specific supplementary requirements:**

- The package must be able to withstand filling temperatures up to 160°C that typically dominate in filling systems for hot melt raw materials
- The package must be highly resistant to moisture traces to prevent premature crosslinking / curing of the product
- The package should be light-weight and easy to peel without residue

**Results**

**Innovation in Packaging**

Special Packaging developed for moisture-curing, silane-modified APAO's

Development of „Easy Peel Packaging“:
patent application filed, expected start of production in Q1/2014
Discover the benefits of our “Easy Peel Package”

Your benefits
✓ Increased safety in the production
✓ Cost savings

<table>
<thead>
<tr>
<th>Cost component</th>
<th>Aspect</th>
<th>Usual packaging: Hobbock / drum</th>
<th>New Easy Peel Packaging</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy</td>
<td>Heating of thermal chambers, drum melters, package heating</td>
<td>required</td>
<td>n/a</td>
</tr>
<tr>
<td>Quality</td>
<td>Premature crosslinking due to contact with moisture during refilling</td>
<td>possible</td>
<td>n/a</td>
</tr>
<tr>
<td>Logistics and storage</td>
<td>Movement and storage of empty containers</td>
<td>required</td>
<td>n/a</td>
</tr>
<tr>
<td>Disposal</td>
<td>Share of packaging in total weight</td>
<td>9-12% (sorted, additional cleaning may be required)</td>
<td>1% (household waste)</td>
</tr>
</tbody>
</table>
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3. Entirely new product: Waterbased Dispersion derived from amorphous Polyolefins
Beneath our well established Product Portfolio of

- Thermoplastic Polyolefines
- Reactive Silane Modified Polyolefines

... we recently introduced an entirely innovative product:

**Dispersion derived from amorphous polyolefins**
VESTOPLAST® W-1750:
Water-based Polyolefine Dispersion

### Properties
- Mainly based on terpolymers without chemical functionality
- Solid Content: ~47%
- pH value: 9.5 ± 1
- Viscosity (20°C): 550 ± 100 mPa.s
- Color: white
- Surface Tension: 39.3 mN/m (20°C)

### Processing
- Shear resistant (1000 Upm/5min)
- Temperature resistant (50°C/14d)
- Freeze/thaw stable
- Penetration: 5 – 7 1/10mm
- Softening Point (R&B): ~140 °C
- Particle size: D(0.5) approx. 2-3µm, > 99% < 8µm
- Surface Energy: 21.6 mN/m
- Contact Angle (water): 113.6 °

### Solid Body Properties
- Viscosity (190°C/3.5s⁻¹): 100.000 mPa*s
- Temperature resistant (50°C/14d)
- Freeze/thaw stable
- Penetration: 5 – 7 1/10mm
- Softening Point (R&B): ~140 °C
- Surface Energy: 21.6 mN/m
- Contact Angle (water): 113.6 °
VESTOPLAST W-1750
Applications

First Tests and Results

Carpet Pre-Coating

- Different application possible (e.g. spraying, “foamed latex coating”)
- Addition of filler similar to latex
- Excellent fibre bonding, specially after “heat activating”
- Application of additional layers without using further adhesives
- Well shapable (car carpets)

Corrosion Protection

- Sprayable, dippable
- Excellent film formation after heat activation
- Outstanding adhesion on steel
- Further formulation possible (e.g. micronised waxes)

Further Applications / Prospects

- WB-adhesives/sealants for various substrates
- “Food grade” (modified surfactents and polymers)
- Polymer variation for special applications
Thanks for your attention!

- Questions?
- More information needed?

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Please also visit our website: www.evonik.com/designed-polymers