Innovative Bonding Solutions from Evonik Product Line Adhesive Resins

Dr. Volker Schrenk

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Outline

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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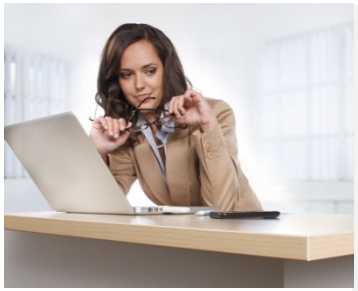
Introduction: DYNACOLL® Portfolio



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

Our Product Portfolio

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

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)

Clothing industry

Lamination of protective clothing and outdoor clothing

Public transport

Textile adhesives in vehicles

Boat building

Lamination of paneling and textile adhesives

Aircraft construction

Bonding materials for textiles and leather

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)

Problem

State-of-the-art adhesives contain flame retardants as additives which lead to significantly reduced adhesion performance

Challenge

Find a reactive phosphorus-based organic flame retardant as monomeric building block

Process

Literature research

- Learn about flame retardants in general
- Find reactive phosphorus based ones

Market screening

- Check on availabilities
- Check on prices

Development

Check of suitability for polyester sythesis with regard to

- thermal stability
- reactivity
- purity

Results

Polymer design
Chemical incorporation of flame retardant during polyester synthesis

Development of first prototype (DYNACOLL® EP 455.04FR) successful: patent application filed

RHM Properties:
inherent vs. external Flame Retardancy

Reaction products with MDI OH/NCO ratio 1/2.2 based on…

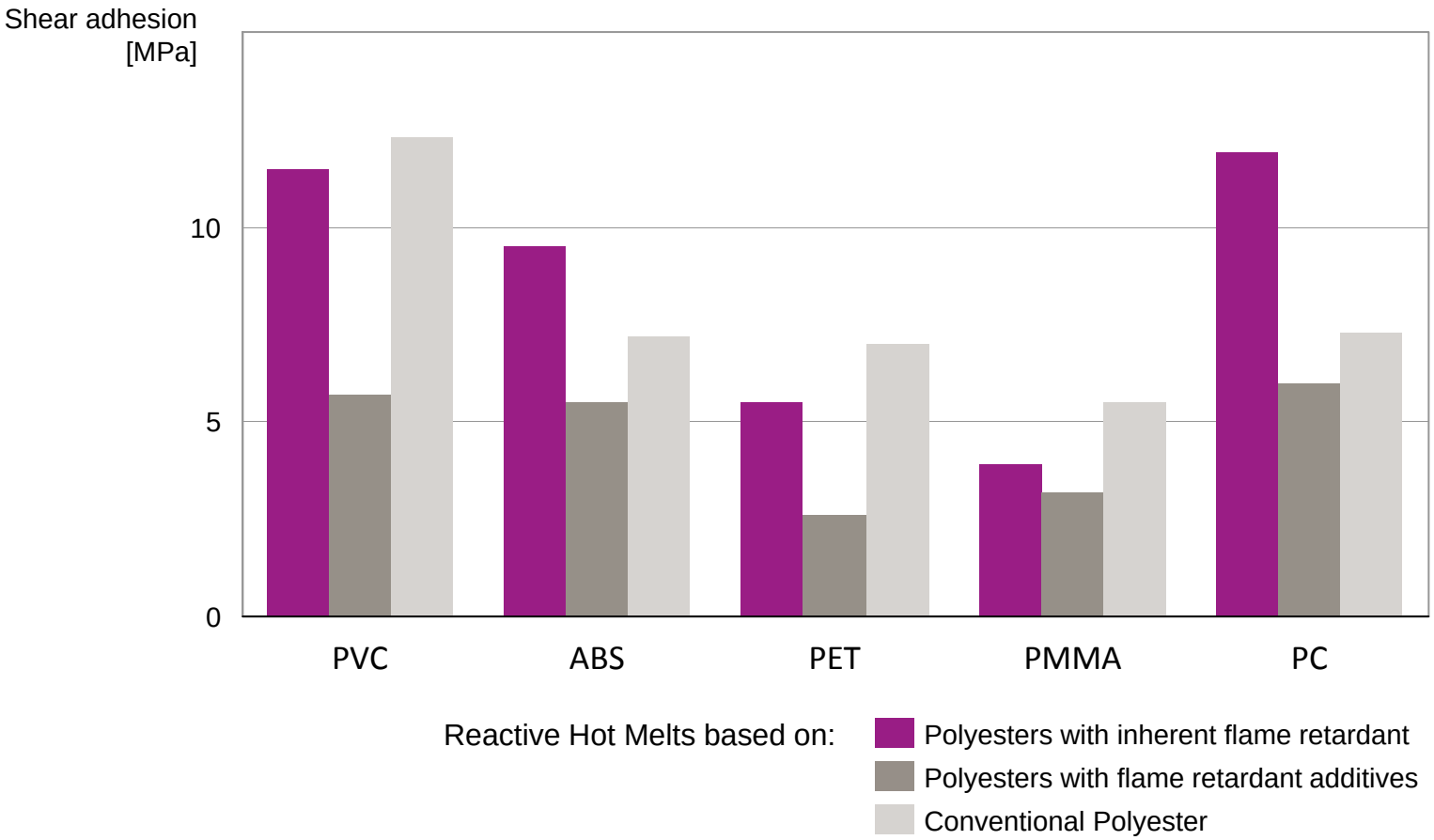
- RHM 1: DYNACOLL® EP 455.04FR
- RHM 2: Conventional pasty polyester
- RHM 3: Conventional pasty polyester with additive liquid flame retardant
- RHM 4: Conventional pasty polyester with additive powder flame retardant

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

RHM data	Unit	RHM 1	RHM 2	RHM 3	RHM 4
Viscosity at 100°C / 120°C	Pa.s	6/ 3	11/ 6	7/ 4	8/ 4
Tensile strength	N/mm²	15	25	20	30
Elongation at break	%	1100	1100	1300	1250
Flammability testing UL 94		**V-0**	**V-2**	**V-0**	**V-2**

Comparison of RHM based on Polyester with inherent vs. additive FR

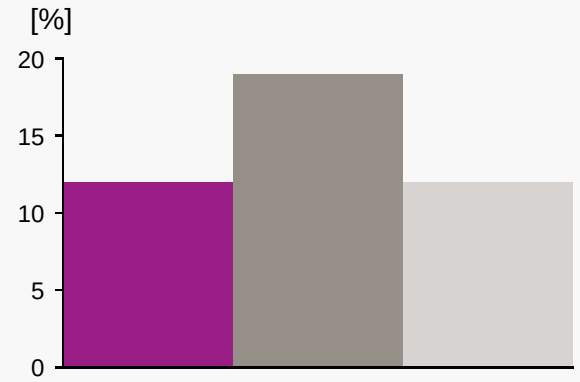
Adhesion Properties



Chemical and Heat Resistance

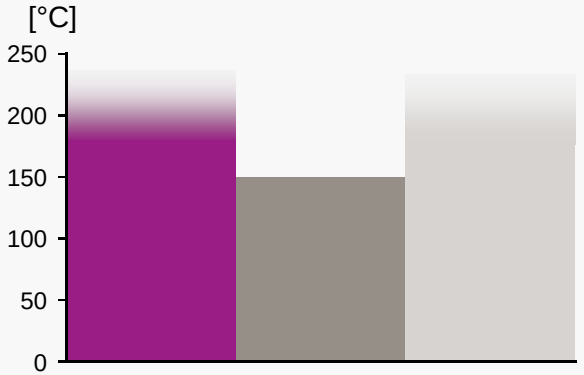
Chemical Resistance

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

RHM composition					
DYNACOLL® EP 455.04 FR			**20**	80	100
Conventional pasty Polyester with additive FR		20			
Conventional crystalline Polyester	100	80	**80**	20	
4,4‘-MDI [OH/NCO]		1/2.2	**1/2.2**	1/2.2	1/2.2
Flammability testing UL 94	V-2	V-2	**V-0**	V-0	V-0

Result

Only 20 ppw of flame retardant polyester are needed!

Flame retardant DYNACOLL®: Your Benefits

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

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Easy Peel Package for reactive Polyolefins

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Waterbased Dispersion derived from amorphous Polyolefins

Introduction: VESTOPLAST® Portfolio

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

Thermoplastic Polyolefines

Butene-rich Grades

C4-content > 50%

- 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

Propene-rich Grades

C3-content > 50%

Reactive Silane Modified Polyolefines

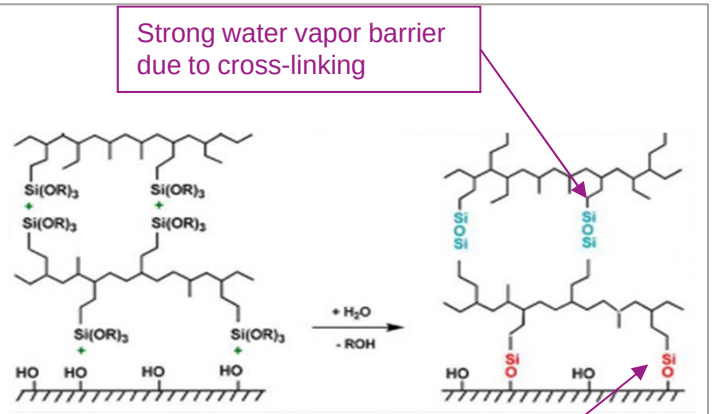
- Grafted Silane-groups in the Polymer Chain
- Moisture-curable, reactive Systems

- 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.

Challenge:
create suitable packaging form

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Problem

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 modication additionally leads to a reactive bond with the substrate and strenghtens adhesion. But: the product should not bond inseparably with its packaging!

Challenge

Meet general packaging requirements, like:

- 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 systemes 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

Cost component	Aspect	Usual packaging: Hobbock / drum	New Easy Peel Packaging
Energy	Heating of thermal chambers, drum melters, package heating	required	n/a
Quality	Premature crosslinking due to contact with moisture during refilling	possible	n/a
Logistics and storage	Movement and storage of empty containers	required	n/a
Disposal	Share of packaging in total weight	9-12% (sorted, additional cleaning may be required)	1% (household waste)

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VESTOPLAST®
Expansion of Product Portfolio

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

VESTOPLAST® W -1750

Properties

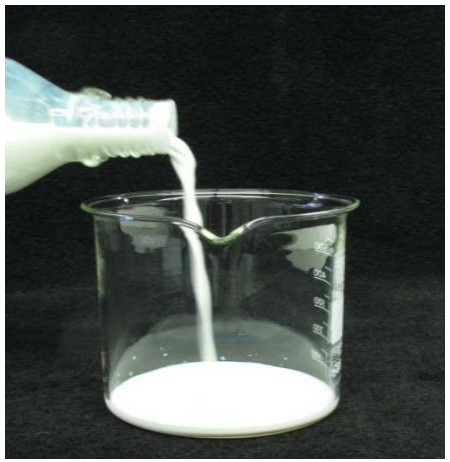
- Mainly based on terpolymers without chemical functionality
- Solid Content: ~47%
- pH value: 9.5 ± 1
- Viscosity (20°C): 550 ± 100 mPa.s
- Color: white
- Surface Tension 39.3 mN/m (20°C)

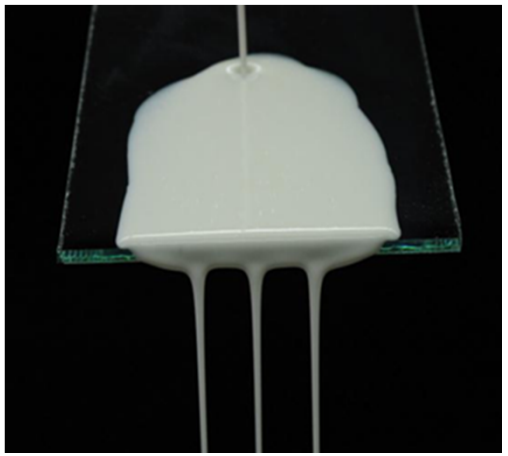
Processing

- Shear resistant (1000 Upm/5min)
- Temperature resistant (50°C/14d)
- Freeze/thaw stable
  RT → -15°C → RT
- Particle size: D(0.5)
  approx.2-3µm, > 99% < 8µm

Solid Body Properties

- Viscosity (190°C/3.5s^{-1}): 100.000 mPa*s
- Penetration: 5 – 7 1/10mm
- Softening Point (R&B): ~140 °C
- Surface Energy: 21.6 mN/m
- Contact Angle (water) 113.6 °

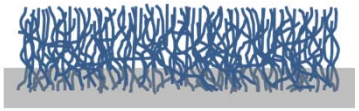




VESTOPLAST W-1750
Applications

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 applcations

Thanks for your attention!

- Questions?
- More information needed?

Gabriele Brenner
Flame retardant Polyester

PHONE +49 2365 49 4534
gabriele.brenner@evonik.com

André Ebbers
Easy Peel Package

PHONE +49 2365 49 2502
andre.ebbers@evonik.com

Volker Schrenk
Waterbased APAO Dispersion

PHONE +49 2365 49 9583
volker.schrenk@evonik.com

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