Sustainable Coatings for Medical Textiles
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Agenda / Content

• Market Needs of Coatings for Medical Textiles
• Polyurethane Dispersions
  • Material properties
  • Film properties and blending
  • Application example: Coating of bed linen for incontinence
• Polyurethanes for Cohesive Bandages
  • Market Needs
  • PUD “C”– a new material for the bandage market
  • The application triangle
Covestro – formerly Bayer MaterialScience
Otto Bayer (Bayer AG-Covestro) invented polyurethane in 1937. Covestro has over 80 years of polyurethane (PU) experience.

Applications in medical
- Coating for medical textiles
- Bandages/Compression therapy
- Sealants for medical devices
- Dipped articles, hospital disposables

Market Needs

Coatings for Medical Textiles
- Textile touch and chemical stability
- Excellent mechanical properties
- Sustainable Technology
- Ensures safe working environment
- Secure and high quality material supply
Market Needs for Medical Textiles

Textile touch (sensory impact) and chemical stability
• Medical textiles often need coating for protection from blood, body liquids, urine, disinfectants and other chemical products.
• Washing and cleaning is often a challenge.
• The textiles shall still keep their dry feel and shall not wrinkle or create rustling.

Mechanical strength
• Coating shall follow elongation/stretching of textile and shall not break.

Safe and Sustainable technology
• Materials for healthcare/medical require qualification and EQM* system
• Trend to reduce hazardous materials, exposure risk, and waste products
• More stringent regulations will further drive safety and cost advantageous of sustainable solutions.

*EQM- enhanced quality management

Challenge of DMF & potential solution
Waterborne dispersions – A sustainable technology

Gold Standard technology: solvent-cast PU films from N,N-Dimethylformamid (DMF)

• N,N-Dimethylformamid (DMF) is a polar, hydrophilic aprotic solvent with a high boiling point
• DMF is amongst others used in the production of medical devices
• DMF is classified as SVHC (Substance of Very High Concern) and CMR substance (Carcinogenic, Mutagenic and toxic to Reproduction)
• DMF is the most suitable solvent for polyurethane in solvent-casted films.
• There is no real alternative solvent of less toxic potential
DMF* emitted into air and water
Brings exposure & pollution risk

Restrictions on DMF use will present the industry with challenges to find qualified alternatives.
Water-based dispersions offer a solution!

Polyurethane Dispersions

- Raw material and film properties
- Crosslinking of PU-films
- Processing
Higher solid content PUD
Aqueous polyurethane dispersion – base material

**Composition of Polyurethane Dispersion:**
- Fully reacted polymer dispersed in water

<table>
<thead>
<tr>
<th>HiSolid PUD</th>
<th>Properties</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solid content</td>
<td>57 - 62 wt.%</td>
</tr>
<tr>
<td>Water content</td>
<td>38 - 43 wt.%</td>
</tr>
<tr>
<td>Solvent</td>
<td>no</td>
</tr>
<tr>
<td>Viscosity</td>
<td>&lt; 2,000 mPa•s</td>
</tr>
</tbody>
</table>

**Allows for:**
- Basic dispersion for textile coatings
- High solid content
- Cross-linkable for high chemical stability

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Lower solid content PUD’s for customization
Dispersions for tailoring mechanical properties – blend material

**Tailoring mechanical properties:**
- Water-based dispersions are fully miscible at any ratio.
- High elongation and excellent soft touch.
- Solution C allows cross-linkability.

<table>
<thead>
<tr>
<th>Specifications of PUD grades</th>
<th>A</th>
<th>B</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solid Content [%] (DIN EN ISO 3251)</td>
<td>39 - 41</td>
<td>39 - 41</td>
<td>48 - 52</td>
</tr>
<tr>
<td>Efﬂux time at 23°C, 4 mm cup [s] (AFAM 2008/10503)</td>
<td>max. 70</td>
<td>14 - 40</td>
<td>*</td>
</tr>
<tr>
<td>pH (DIN ISO 976)</td>
<td>6 - 8</td>
<td>5.5 - 7.5</td>
<td>6 - 9</td>
</tr>
</tbody>
</table>

* : Viscosity at 23°C: 50 - 1,000 mPas (ISO3219/A.3)
**High Solid Content PUD– Soft Touch Film**

Competitive testing shows excellent mechanics and flexibility

*Low friction – Stretchability – Natural feeling*

![Graph showing 100% modulus (MPa)]

- 100% modulus relates to force needed for short elongation.
- The lower the 100% modulus, the softer the film feeling.
- *Therefore, low 100% modulus is indication for better soft touch!*

**HiSolid PUD Film Properties**

Flexible, soft touch, breathable film

**Film characteristics:**

- Soft touch
- Flexible and elastic
- Excellent mechanical stability
- Breathable

**Different PU dispersions are available to match film performance**

- Blend with “B” to enhance rigidity.
- Blend with “A” and/ or “C” for more softness and elongation.
- Mix with cross-linker to increase chemical resistance.
Polyurethane - Film Properties
Choose a combination to tailor mechanical properties

<table>
<thead>
<tr>
<th>Properties of film made from waterborne PUDs (Thickness of film)</th>
<th>HiSolid film</th>
<th>A (70 μm)</th>
<th>B (50 μm)</th>
<th>C (40 μm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>100% modulus [MPa] (DIN EN ISO 527-2)</td>
<td>~ 3.3</td>
<td>1.6</td>
<td>5.8</td>
<td>~ 0.3</td>
</tr>
<tr>
<td>Tensile strength [MPa] (DIN EN ISO 527-2)</td>
<td>40 ~ 42</td>
<td>18</td>
<td>35</td>
<td>5</td>
</tr>
<tr>
<td>Elongation at break [%] (DIN EN ISO 527-2)</td>
<td>550</td>
<td>1,100</td>
<td>700</td>
<td>&gt; 2,000</td>
</tr>
<tr>
<td>MVTR [g/(24h•m²)] (related to DIN EN 13726-2, Part 3.2)</td>
<td>2,100 (25 μm)</td>
<td>1,800</td>
<td>1,400</td>
<td>1,600 (80 μm)</td>
</tr>
<tr>
<td>Major performance aspect (blending or mixing)</td>
<td></td>
<td>Very flexible</td>
<td>Higher rigidity</td>
<td>Very soft Cross-linkable</td>
</tr>
</tbody>
</table>

* Drying conditions: 37°C, 10 min. followed by 120°C, 2 min., 50 μm

HiSolid PUD with cross-linker
Enhanced chemical stability using cross-linker

**Cross-linker properties:**
- Hydrophilic, solvent-free
- Ease of processing (pot life ~ 8 hrs)
- High chemical stability of HiSolid film with cross-linker
- Recommended ratio: ~ 5 wt.-%

**Film made with HiSolid PUD and cross-linker:**
Comparison of standard and cross-linked film made of HiSolid PUD after several weeks incubation in disinfectant solution

<table>
<thead>
<tr>
<th>Property</th>
<th>Cross-linker</th>
<th>Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>NCO content</td>
<td>~ 17.4 %</td>
<td>M105-ISO 11909</td>
</tr>
<tr>
<td>Viscosity at 23°C</td>
<td>~ 2,800 mPa•s</td>
<td>M014-ISO 3219/A.3</td>
</tr>
<tr>
<td>Monomer content</td>
<td>&lt; 0.15 %</td>
<td>M106-ISO 10283</td>
</tr>
</tbody>
</table>
HiSolid PUD Processing
Easy manufacturing of film by coating process

Rollstock coating:

Manufacturing:

- Easy application, 1K polyurethane dispersion
- Waterborne, physical drying only
- Direct or transfer coating on foams, nonwovens, textiles
- Recommended to use non-siliconized release liners
- Drying (lab procedure): 10 min. @ 37 °C, followed by 3 min. @ 150 °C
- Machine process: optional curing at ≥130 °C, approx. 3 min recommended for better film forming

Why Polyurethane Dispersions?
Tailored sustainable technology for cast films

Competitive advantages:

- Aqueous dispersion ensures safe working environment
- Sustainable technology
- Hydrophilic and breathable
- Cross-linking for solvent and disinfectant resistance
- Soft touch films with excellent mechanical stability and flexibility
- Easy to functionalize (dyes, matting agent, etc.), partners for formulation development available.
Application Example

Coating of bed linen for incontinence patients

HiSolid PUD Application Example

Coating of bed linen or mattress cover for incontinence patients

Task to be solved:

Functionalized cotton damask fabric with the following requirement profile:

- Waterproof
- Chemical proof
- Textile haptics
- No or low rustling
- Mechanical stability

Droplet test on coated linen
HiSolid PUD Application Example
Coating of bed linen or mattress cover for incontinence patients

Solution:
Functionalized coating of HiSolid PUD and cross-linker:
• Applicable in knife-over-roll coating and rotary screen printing
• Wet thickness 200 μm, no cut-through

Result:
• Soft, transparent, water-proof coating with
  with no micro scratches.
• No colour change.
• Coated linen passed 20 times industrial laundry (hospital) @ 75 °C using
  chlorinated detergent, each followed by 60°C tumbler without wrinkling or loss of soft
touch.

HiSolid PUD –Further Examples
Prototype Samples on Display

Protective Clothing for emergency medical services:
• Barrier-tight
• Stable vs. disinfectants.

Non-woven anti-slip barrier:
• Fabric for e.g. surgical sheets
• Structured surface coating.

Hygienic orthopedic material:
• High elasticity
• Stable vs. disinfectants.
• Potential wound contact.

Drape and gown material:
• Barrier-tight
• Suitable for both, woven fabrics and non-wovens.
Waterborne PU for Cohesive Bandages

Polyurethane-based, Latex-free Contact Adhesive Dispersion

Market Needs for Cohesive Bandages

Application of cohesive bandages
- Compression therapy, sports bandages, wound care (secondary dressings).

Differentiation
- No new material development since multiple years.
- PU offers unique advantages such as white, non-yellowing, low odor.

Non-allergic
- Current market products are subject to latex allergies.

Sustainable technology
- Covestro offers water-based polyurethane dispersions.
- Covestro medical grades have been tested and qualified for medical use.
Why waterborne PU– Safe Technology
Non-allergenic and Latex-free

Latex allergies:
• Approx. 2% of the total population suffer from natural latex sensitization
• Employees in the medical area are affected by 10% to 17% (e.g. gloves)
• This is a matter of either a type 4 contact hypersensitivity causing post reactions on the contained additives in latex-products or type 1 hypersensitivity caused by different water soluble proteins in natural latex
• Due to the fact that the allergens are known and avoided during manufacturing the occurrence of type 4 hypersensitivity is decreasing
• In contrast the type 1 hypersensitivity increased over the last years

Allergic reactions can have severe consequences, therefore the market demands alternatives

Source: http://www.daab.de/allergien/latexallergie/

Waterborne PUD for Cohesive Bandage
PUD “C”

Composition of Polyurethane Dispersion:
• Fully reacted aliphatic polyurethane polymer dispersed in water.
• Latex-free, chlorine-free, white.

<table>
<thead>
<tr>
<th>Prov. Specification</th>
<th>C</th>
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<tr>
<td>Solid Content [%]</td>
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<td>(DIN EN ISO 3251)</td>
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<tr>
<td>Viscosity at 23°C (shear rate 40s⁻¹) [mPas] (M014-ISO 3219/A.3)</td>
<td>50 - 1,000</td>
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<td>pH (DIN ISO 976)</td>
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PUD “C” – The Magic Triangle
Tailoring of Textile, Formulation and Application Method

Type of textile
- Rough or smooth surface
- Elasticity
- Hooking of textile layers

Chemical Formulation
- Use of tackifiers
- Use of fillers

Application Triangle

Method of Application
- Spray coating
- Squeegee
- Coating thickness

Summary
Summary
Sustainable polyurethane coatings for medical textiles and bandages

• High quality and longer use time are key requirements of new medical textiles.

• Non-allergenic and solvent free medical textiles are getting more and more importance.

• Water based PU-dispersions serve all those needs and offer sustainable and long term tailor made solutions.

• Especially developed Baymedix dispersions can be blended to achieve high elasticity, chemical resistance, soft touch and other features.

• Waterproof and stable coating of bed linen with textile haptic for incontinence, or water based coatings for cohesive bandages which stay white and have low odor, are examples for this new sustainable polyurethane technology.

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