Environmentally friendly high performance Pressure Sensitive Adhesives

Product tailoring of advanced Acrylic Dispersions

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### PSA Definition

*Pressure Sensitive Adhesive (PSA)*

- remains tacky on application and throughout its lifetime
- adheres instantly to a variety of substrates with just light to moderate pressure
- do not require activation by external source to form strong bonds

### Key properties

- **Peel strength** – is a measure of the resistance to peel determined by peeling a strip of tape from a rigid surface.
- **Tack** – a measure of the bond formed on instantaneous adhesion to a surface upon light pressure. Also known as quick stick or initial adhesion.
- **Shear** – a measure of cohesive strength, or resistance to creep, over a defined contact area.
PSA Introduction (II) - Test methods

- Adhesion (Peel) test
- Cohesion failure
- Adhesion (thermal stability) test
- Loop tack test
- Failure test

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**PSA Introduction (III) - The chemical tool kit**

**Polymer structure**
- co-monomer composition
- functional monomers
- molecular structure
- colloidal system (emulsifiers, particle size distribution, rheology)

**PSA properties**
- TG, affinity to surfaces (surface roughness, polarity)
- interaction to carrier & substrate reaction points for external cross linking, tape unwinding properties
- balance of shear & peel & tack
- mechanical stability, carrier wetting coating speed, water resistance, noise (tape unwinding)

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**Example molecular structure**
- high cohesion low tack low peel
- high tack high peel low cohesion

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PSA Introduction (IV) - Challenges to the PSA industry

- water based materials are replacing solvent systems and hot melts
- tailored ready-to-use products with excellent run ability
- high solid dispersions for energy conservation
- low VOC product requirements
- no Alkylphenolethoxylates
- no Formaldehyde or Formaldehyde releasing agents
- anti fogging automotive directive
- ...

Our Scope:

- Design of tailored value added products providing real problem solutions
- No APEO, no formaldehyde, no solvents, low VOC
- Focus on aqueous based systems (Acrylic dispersions)
CASE STUDY
Industrial bonding systems / building insulation tapes

Targets:

- energy saving by control of air-exchange
- improvement of hygienic (anti-mildew) by control of humidity
- avoiding of damages to building
- green technology, no SVHC

Building insulation is driven by legislation and rationality!
Challenges for Industrial bonding systems / building insulation tape

1. Critical / High-Critical Substrates
   - moist/wet wood
   - mineral building materials (clay/cement)
   - high variability of substrates
   - critical low energy substrates like PE or hydrophobic fleece

2. Different Mechanical Stresses
   - static stress (self-weight)
   - dynamic stress (harmonic, periodic)

3. Climate Effects
   - deformation/shaping by climate
   - moisture
   - low and high temperatures
Requirements for building insulation adhesives

- high initial tack
- high peel on different substrates
- high cohesion / static shear
- good water resistance
- good cold bonding behaviour
- good adhesion at high humidity and high temperature
- good aging behaviour / UV-resistance
- high elasticity
- good run ability
- APEO free, low VOC, no formaldehyde
  - no solvent, high total solid content
Tailored product design - peel resistance after water storage

Development of new in house test standard

Example: insulation tape PSA

240g/m² on LDPE, laminated to Tyvek 1058D
storage at under water for 24h (RT)
Tailored product design - simulation of peel adhesion (I)

Development of new in house test standard

<table>
<thead>
<tr>
<th>ref 1</th>
<th>ref 2</th>
<th>prod. 1</th>
<th>prod. 2</th>
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</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Substrate: hydrophobic fleece</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Load: 500 g/12.5 mm</td>
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<td></td>
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<td>Coating weight: 240 g/m² on BOPP</td>
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</tbody>
</table>

Example: insulation tape PSA

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Tailored product design - simulation of peel adhesion (II)

Development of new in house test standard

Example: insulation tape PSA
Tailored product design - high adhesion on building materials

Example: insulation tape PSA

250g/m² on BOPP, 180° according to FTM1
Tailored product design – balanced hexagon application profile

Example: insulation tape PSA
Tailored product design - how to achieve good run ability?

- Or: How to achieve low viscosity at high solid content?

  We need broad particle size distribution,
  But this affects water-resistance

  Compensation by tailoring of particle size distribution

- High TSC (60%) at low viscosities by “shoulders” at 100 and 700 nm
- Excellent water resistance by narrow distribution of main polymer fraction

Example: insulation tape PSA
Tailored product design: Low emission PSA
Production technology counts – Example VDA 278 (automotive tapes)

The VOC value is the total of readily volatile to medium volatile substances. It is calculated as toluene equivalent. The method allows substances in the boiling / elution range up to n-Pentacosane (C25) to be determined and analysed.

Recommendation / limit (Tape)

VOC VDA 278
100 µg/g

The FOG value is the total of substances with low volatility. It is calculated as hexadecan equivalent. Substances in the boiling range of n-Alkanes “C14” to “C32” are determined and analysed. These substances condense easily at room temperature.

Recommendation / limit (Tape)

Fogging VDA 278
250 µg/g

- No solvents, high monomer conversion, raw material selection
- Fully integrated technical treatment process in the polymerisation plants to reduce on residual VOC on all DS product types
- DS product types are a safe formulation base for VDA 278 compliant tapes
Conclusion
Tailored product design is the key to success for value added high performance PSAs

Case Study: Industrial Bonding PSA/ Insulation Tape
✓ high adhesion even on critical substrates
✓ optimized water-resistance
✓ balanced profile of peel, shear and tack
✓ high aging resistance
✓ excellent temperature resistance
✓ optimized run ability
✓ no APEO, no Formaldehyde, low VOC

Biodegradable surfactants
reduced environmental impact

No formaldehyde or formaldehyde release agents
e. g. optimized redox-system and biocides rates

No APEO
endocrine disruptor and rated as SVHC, 2018 sunset date for EU

Low VOC / fogging
formulation base for VDA 278 and EC1 conform end products

New product standard for moisture proof industrial tapes
Environmentally friendly high performance Pressure Sensitive Adhesives

Product tailoring of advanced Acrylic Dispersions

Thank you for your attention
Tailored product design - high adhesion at extreme temperatures

220 g/m² stored at -10°C, stuck to untreated PE - foil

28 N/25mm

Example: insulation tape PSA