



Inspired Brands.  
Intelligent World.™



# Pressure-Sensitive Adhesives

# Pressure-sensitive adhesives



## 01. Introduction

No matter where you look, you'll find Avery Dennison™ adhesives: self-adhesive postage stamps, mailing labels, bandages, automotive bonding, clear beer labels and battery labels.

Our adhesives are also used on disk drives, consumer goods labels, for medical products, architecture and transportation.

They have a broad performance range: from ultra-removable to ultra-high adhesion – our adhesive products are ideal for demanding applications in the electronics, medical, industrial, graphics, construction and consumer goods industries.

## Examples of Pressure-sensitive adhesives used in different forms in various applications:

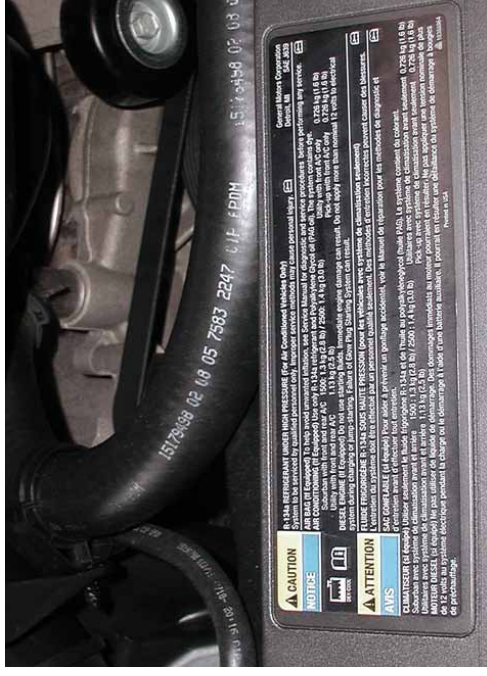
- Labels
- Medical Dressing
- Graphic Films
- Tapes
- Other Specialty Applications



Packaging labels clear & opaque films and substrates



Durable goods labeling



Automotive adhesives designed to work on a variety of substrates and conditions

# Pressure-sensitive adhesives



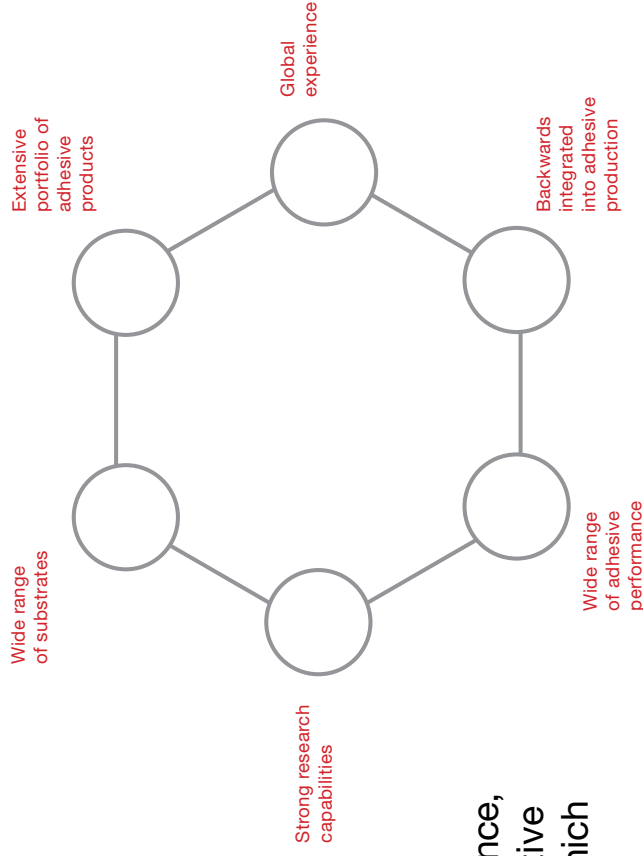
## Our competitive advantage

We are backward integrated into adhesives which gives us the ability to lead market changes in adhesives and turn customer input into proprietary materials.

Key adhesive technologies include solvent, emulsion, mini-emulsion and suspension polymerization techniques.

## Our value to the customer

Our advantage is in our global presence, experience, and an in depth knowledge of pressure-sensitive adhesives, that allow us to create adhesives which provide a range of solutions for the customer.



## Core competencies

- Developing PSAs (Solvent, Emulsion, Hot melt)
- High-speed coating
- Understanding the value of adhesive's benefits/features for final-use markets
- Demonstrated product performance and knowledge of the industry

- Technical service support – ability to apply adhesive know-how to solve problems
- Market/application knowledge
- Application testing capability

# Pressure-sensitive adhesives



## Definition of terms

- **Emulsions** are acrylic polymers in water. Labels and Packaging Materials (LPM) has manufacturing capabilities in the US and Europe and a toll manufacturing network to provide Avery Dennison emulsions around the world.
- **Solutions** are the legacy technology for the industry. They are acrylic polymers in petroleum-based solvents – usually of low to moderate solids content. End users prefer the performance but not at the cost.
- **Hot melt PSAs** are based on block copolymers – usually hard soft hard block SBC's. Oils, plasticizers and tackifiers are needed to obtain performance criteria. Most hot melts (HM) are dependent on C5/C9 streams from petroleum distilleries.
- **UV:** Compositions of coatable viscosities without solvent. Produces thick films, including foam-like adhesives. Dual stage process which creates performance advantages through second stage curing, which enables very high molecular weight fractions which can't be cast from solvent.
- **100% solids:** Materials also known as warm melts. They are either made in solvent and stripped (AC resin) or polymerized to near 100% and coated. Designed to utilize hot-melt equipment (high coating speeds) and give performance of a solvent (current state similar/better than emulsion). Benefits – high coating speed and solvent-like performance.

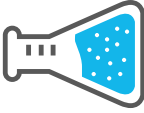
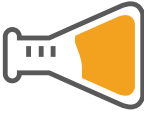



## Adhesive classifications

- Permanent** - An adhesive designed to stick to a substrate without edge lifting that can not be removed without damaging either the label or the substrate.
- Removable** - An adhesive designed to stick to a substrate without edge lifting that can be removed without damage to either the label or the substrate.

# Pressure-sensitive adhesives



There are five types of pressure-sensitive adhesives:

<p><b>EMULSIONS</b> <i>Emulsions are acrylic polymer adhesives that are suspended in water.</i></p> 	<p><b>SOLUTIONS</b> <i>Solutions, also called solvent adhesives, are acrylic polymers in a petroleum-based solution or solvent.</i></p> 	<p><b>HOT-MELTS</b> <i>Hot-melts are based on block copolymers usually hard soft hard block SBC's. Oils, plasticizers and tackifiers are added to improve performance.</i></p> 
<p><b>ULTRAVIOLETS</b> <i>These adhesives have the characteristic of being a light-cured acrylic adhesive (thermoset).</i></p> 	<p><b>100% SOLIDS</b> <i>A 100% solids refers to the amount of non-solvent content in an adhesive by weight.</i></p> 	

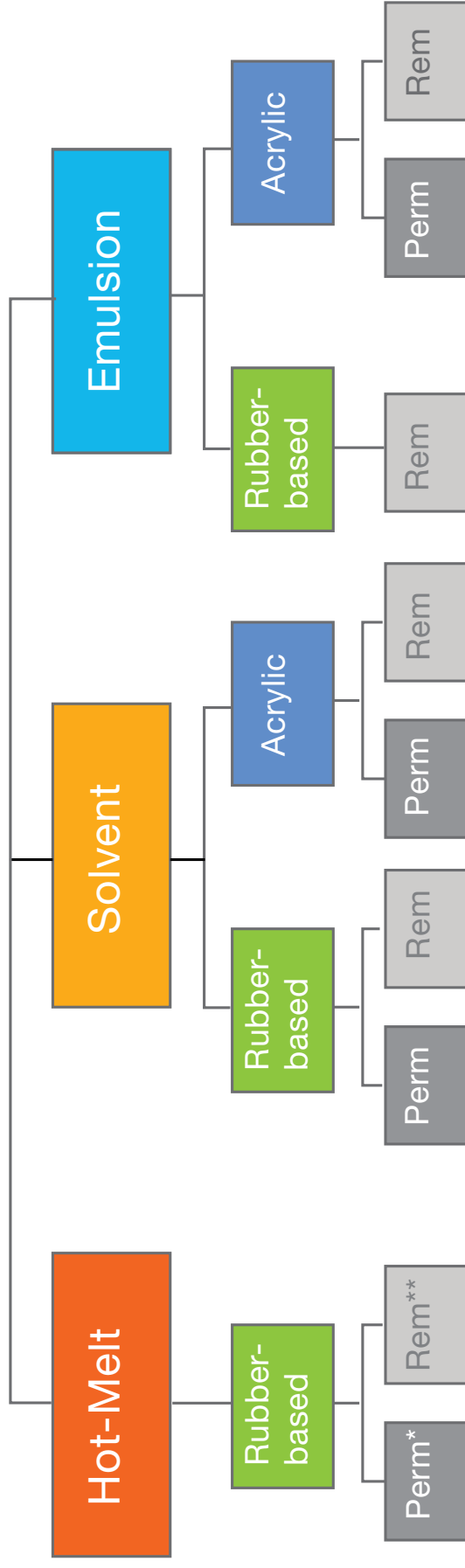
# Pressure-sensitive adhesives



## Adhesive technology

Pressure-sensitive adhesives are divided into categories based on the chemical composition of the adhesive: Rubber-based and acrylic adhesives. The chemical makeup of the product is a major contributor to the performance of the product.

## Categories of adhesives



\* Perm = Permanent

\*\* Rem = Removeable

# Pressure-sensitive adhesives



## Where do we utilize pressure-sensitive adhesives?

Adhesive technologies are a key component of our product lines.

Our adhesive solutions meet a range of specific requirements, from repositionability, anti-microbial properties or moisture resistance, to operating in extreme environments of heat or cold. By creating solutions for a broad spectrum of product needs, we have the capability to produce innovations in the industries below:

### Medical Solutions



- Skin adhesives:
- Catheter
  - Medical tapes
  - Wearable sensors
  - Wound dressings
  - Hydrocolloids

### Graphics and Reflective Solutions



- Graphic adhesives:
- Vehicle wraps
  - Architectural films
  - Reflective products (highway signage)

### Designed and Engineered Solutions



- Durable adhesives:
- Instructional labels (bonds to fabric plastic, vinyl or metal surfaces)
  - Adhesive tapes (trims)

### Performance Tapes



- Specialty tapes:
- Automotive
  - Electronics
  - Building and Construction
  - Specialty Industrial
  - Personal Care

### Labeling and Packaging Materials



- Labeling adhesives:
- Packaging labels
  - Opaque labels
  - Adhesive films
  - Industrial hard goods labeling
  - Water resistant

### Office and Consumer Products



- Office labels:
- Address Labels
  - Easy Peel® Clear Mailing Labels
  - Note Tabs™
  - Software/media labels

### RFID



- RFID labels:
- Inventory
  - Security
  - Tracking

# Pressure-sensitive adhesives

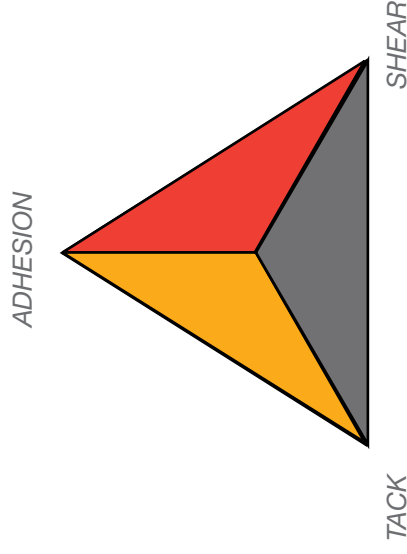


## The typical adhesive properties include:

**Initial Tack** - The immediate holding power of the label upon contact with the substrate. A label with high initial tack will grab the substrate quickly. A label with low initial tack will exhibit a low level of adhesion when first applied and may remove cleanly.

**Ultimate Adhesion** - The ultimate or maximum holding power that the label will achieve as the adhesive penetrates into the substrate. The time required to obtain ultimate adhesion may depend on the stiffness (shear) of the adhesive, the roughness of the substrate and the temperature of the environment. Dwell time can vary from 2 to 24 hours depending on the conditions. Initial tack and ultimate adhesion are not necessarily related.

**Shear Resistance** - A measure of the internal cohesive strength of the adhesive. The shear of the adhesive is an indication of how soft an adhesive is. A low-shear adhesive (soft) has more of a tendency to flow (resulting in higher initial tack), and has a higher chance that the adhesive will split apart if put under stress. A high-shear adhesive (firm) is less likely to split under stress because of its good internal cohesive strength, and will be less likely to flow (possibly lower initial tack).





# Pressure-sensitive adhesives



## Adhesive Technology

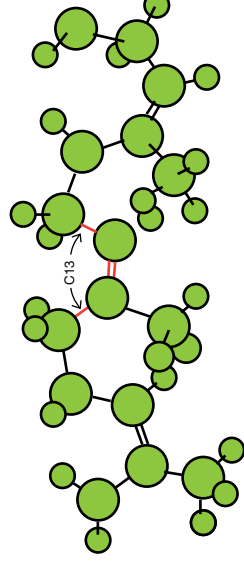
**Rubber-based adhesives** are formulated from organic rubbers and resins. Rubber-based adhesives are typically less expensive, however, they are effected by oxidation and ultraviolet light, and are designed for general purpose applications. Rubber-based adhesives, in general, exhibit higher initial tack (quick stick) because of the softer formulation, however, they are more prone to cause sticky edges through adhesive flow (edge ooze\*). Removable rubber-based adhesives tend to increase in adhesion throughout the life of the label and could possibly become permanent.

**Acrylic-based adhesives** are formulated from cross-linked acrylic polymers, and are typically more expensive but resistant to high heat and oxidation. Acrylic-base adhesives, in general, exhibit lower initial tack and require a longer set-up period to obtain their maximum adhesion, however, they are less prone to develop sticky edges and maintain a more consistent level of removability on removable labels.

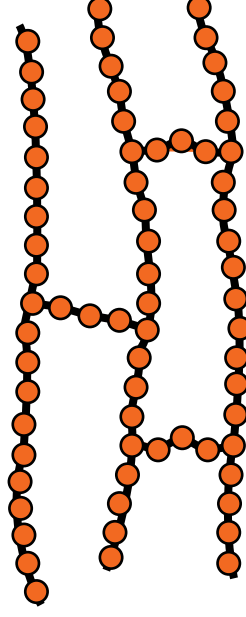
**Modified Acrylic** is an acrylic adhesive combined with tackifying resins to enhance bonding properties. They offer higher initial tack and improved bonding to low-energy surfaces, but there is some loss of UV and solvent resistance.

**Silicone adhesives** are used for specialty applications such as high oxygen/gas permeability, low pain upon removal to sensitive skin.

Examples of rubber-based and acrylic-based adhesives



Organic rubber



Cross-linked acrylic polymer

\* Edge ooze is term used to describe the flow of adhesive out of the edge of the laminate. Edge ooze causes a sticky edge and can cause feeding problems and contamination in some printing processes.

# Pressure-sensitive adhesives



## Emulsion-based PSAs

Emulsion polymers are commonly used for packaging, labeling, and tapes. Label and Packaging Materials uses emulsion adhesives extensively.

The main type of emulsion Avery Dennison uses is acrylic polymers. Acrylics function well in both permanent and removable PSAs. For permanent PSAs, acrylics offer high tack and peel strength. For removable usage, acrylic PSAs have good mechanical stability and cohesive strength. Acrylics work across a wide variety of substrates and surfaces.

Other types of emulsions include PVA (polyvinyl acetate) and EVA (ethylene vinyl acetate).



Vehicle wraps



Performance Tapes

# Pressure-sensitive adhesives



## Solvent-based PSAs

Solvent-based adhesives are acrylic polymers in petroleum-based solvents.

Advantages of solvent-based adhesives are their strength. They provide superior shear and peel strength to water-based adhesives. Solvent-based PSAs tend to have better film formation, and have higher moisture resistance than water-based adhesives.



Examples of custom applications for sealing, gasketing, shielding and sound insulation.



Foam tapes and adhesives are used in automotive or other industrial applications where strength, heat, or moisture resistance is required. Close-up application of heated mirror.

# Pressure-sensitive adhesives



## UV PSAs

These adhesives have the characteristic of being a light-cured acrylic adhesive (thermoset). UV PSAs are non-flammable and solvent free. UV adhesives offer advantages of lower VOCs and better environmental compliance.

A key benefit is no carrier solvents are needed which means no drying ovens.

## Hot-melt PSAs

Hot-melt PSAs come in several forms:

- Styrenic block copolymers (SBCs) are most widely used. These require tackifiers and oil modifiers to achieve the desired adhesive performance.

100% solids adhesives can also fall into this category.

## 100% solids

A 100% solids refers to the amount of non-solvent content in an adhesive by weight. Hot-melt PSAs are one type of 100% solid. Low-viscosity polymers that are coated and reacted with radiation to change molecular density/weight are one type, or high-viscosity materials that are heated to reduce viscosity for coating purposes and then cooled for final use.