Understanding Pressure Sensitive Adhesives PSA 101

Presented by

The Adchem Corporation

Adhesive Technology

Here's what you will learn:

- **Formal definition of PSA**
- **Common PSA product formats**
- **Rubber vs. Acrylic adhesive formats**
- **Common factors that will:**
  - Influence your PSA selection
  - Determine application success

Definition

- Pressure Sensitive Adhesive:

  "Aggressive and permanently tacky substance that adheres with finger or hand pressure, and exerts a strong holding force..." **Pressure Sensitive Tape Council**

- Common consumer products that use PSA:
  - Masking tape
  - Packaging tape
  - Self-stick postage stamps
  - Mailing labels

Common PSA Terminology

- **Adhesion**
  - Ability to stick or bond to a substrate.
- **Cohesion**
  - Internal strength of an adhesive to itself
- **Substrate**
  - The surface or material to which you want your PSA to stick.
- **Surface Energy**
  - A measure of the molecular attraction of the facial contact of a material.
  - Property that will effect the ability the PSA to stick
- **Wet out**
  - The ability of an adhesive to flow and/or reflow over a surface to maximize bond strength based on higher contact area.

Common PSA Product Formats

Adhesive Transfer Tape or Laminating Adhesive

Double-Coated Tape (Carrier)

Single-Coated Tape

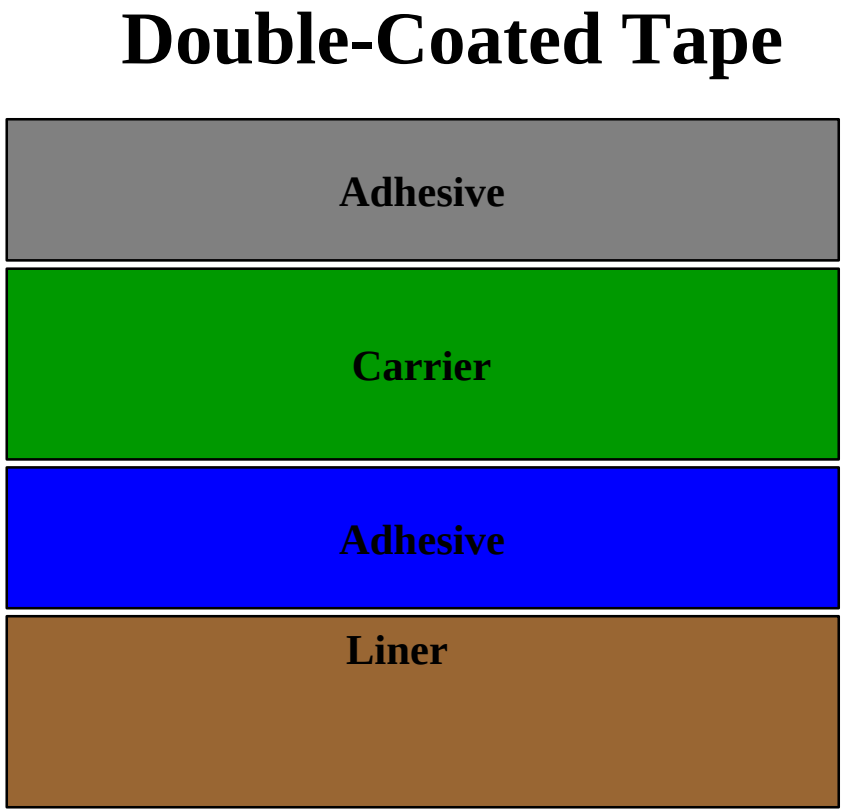
Double-Coated vs. ATT

- **Double-Coated Tapes**
  - Thicker (3-10 mil)
  - Less conformable
  - Easier dispensing
  - Level-winding or spooling
  - Lower temp resistance
  - “Removable”
  - Reinforces substrate
- **Transfer Tapes or Laminating Adhesive**
  - Thinner (1-5 mil)
  - More conformable
  - More difficult dispense
  - No level-winding
  - Higher temp resistance
  - “Permanent”
  - Doesn’t reinforce substrate

Biggest Difference – Double-Coated Tapes have a **Carrier**.

Carrier Function

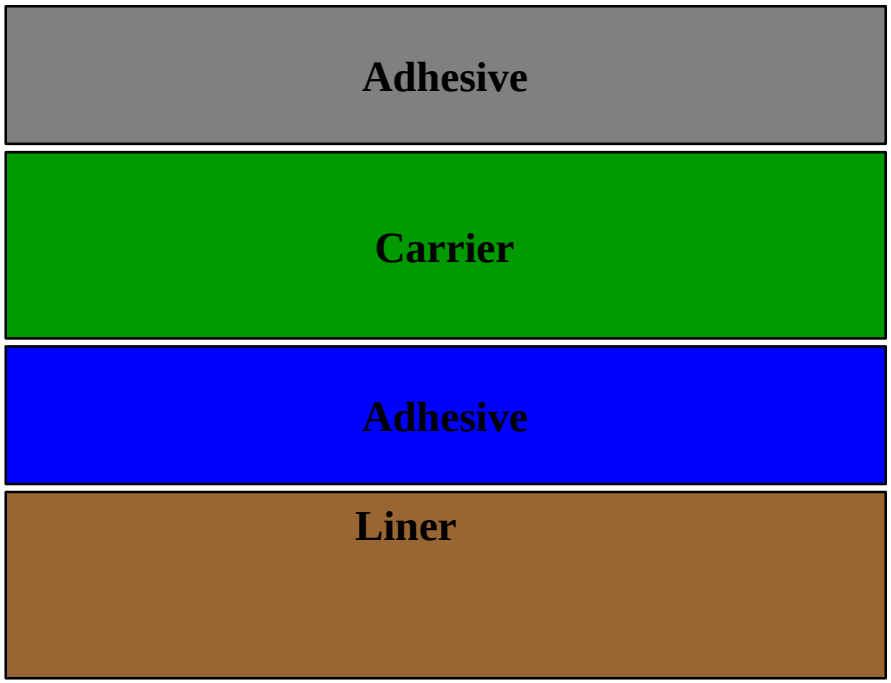
- Stabilize the Adhesive
- Improve Handling
- Add Thickness
- Provide Removability
- Provide Barrier Between Adhesive



Carrier Types

- Polyester
- Polypropylene
- Polyethylene
- Foam
- Paper
- Tissue

Double-Coated Tape



Release Liners

A protective covering for the adhesive to prevent “unwanted” adhesion and contamination of surface during shipping and handling.

- *Release liners are typically engineered to provide a desired release characteristic.*
- Suitable liners may be:
  - densified Kraft
  - poly-coated Kraft
  - plastic films (PET, PE, HDPE, PP)
  - “board”

Three Types of PSAs

- Rubber PSA (Indoor)
- Acrylic PSA (Outdoor)
- Silicone PSA (Wide Temp)

Rubber Adhesives

Adhesives made from natural or synthetic rubbers which are made tacky by mixing them with various compounds.

- Oldest PSA
- High Initial Strength (Good Thumb Appeal)
- Economical

Performance Characteristics Include:

- Adequate for short term, non-critical applications **(Indoor)**
- Limited chemical, temperature and Ultra Violet light resistance

Acrylic Adhesives

A combination of acrylic monomers and other compounds, formulated to create specific chemical structures which are tacky. *Unlike rubber formulations, compounding creates a chemical change of the components.*

- Permanent Bonding applications
- Have a high initial bond and adhere well to most surfaces
- Lower initial adhesion than their rubber counterparts

They have outstanding performance features:

- Excellent aging characteristics **(Outdoor & High Performance)**
- Outstanding chemical and ultra violet light resistance
- Higher temperature stability than rubber adhesives
- Great for long term, durable applications!

Silicone Adhesives

Polymers with an inorganic backbone and organic side groups that are especially formulated for premium performance

- Bond to silicone-coated and other LSE surfaces
- Widest temperature range
- High cost

Performance Characteristics Include:

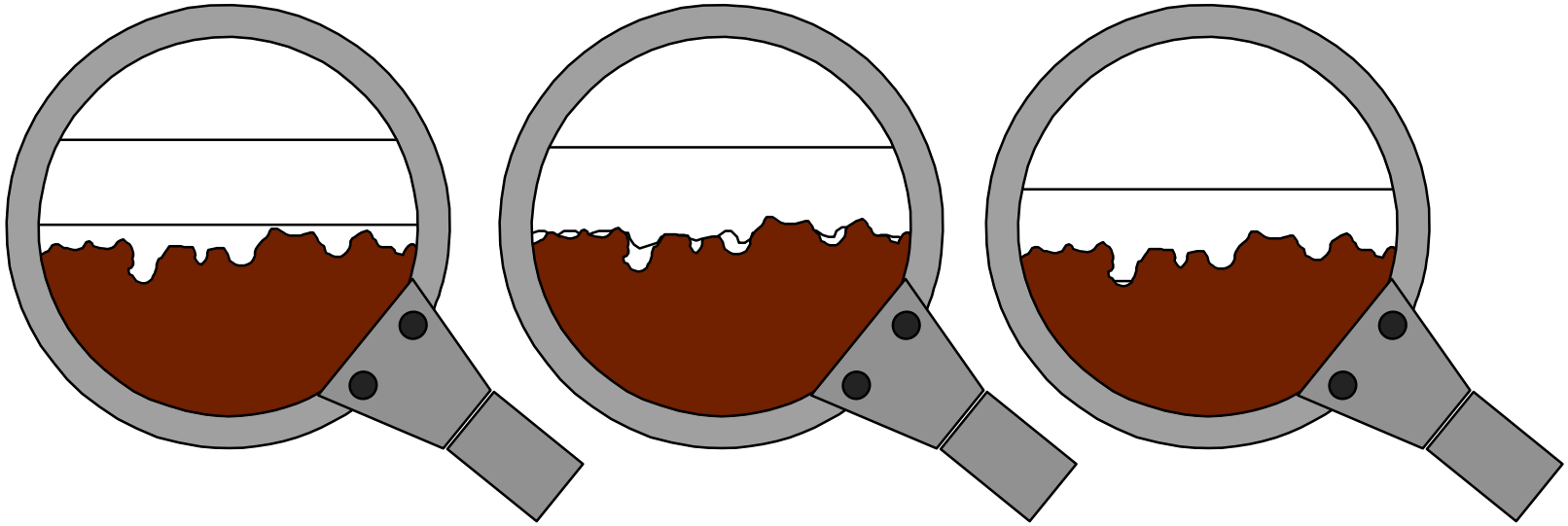
- Suitable for long term, critical applications
- Higher temperature resistance, service range -30ºF to 500ºF (depending on applied load).
- Resistance to chemicals, moisture and ultraviolet rays
- Clean removability to some substrates

How PSA Bonds ?

- PSAs flow into the substrates
- No curing process.

Adhesive Technology

Dwell Time allows the adhesive to "flow" into the Peaks & Valleys of the Substrate

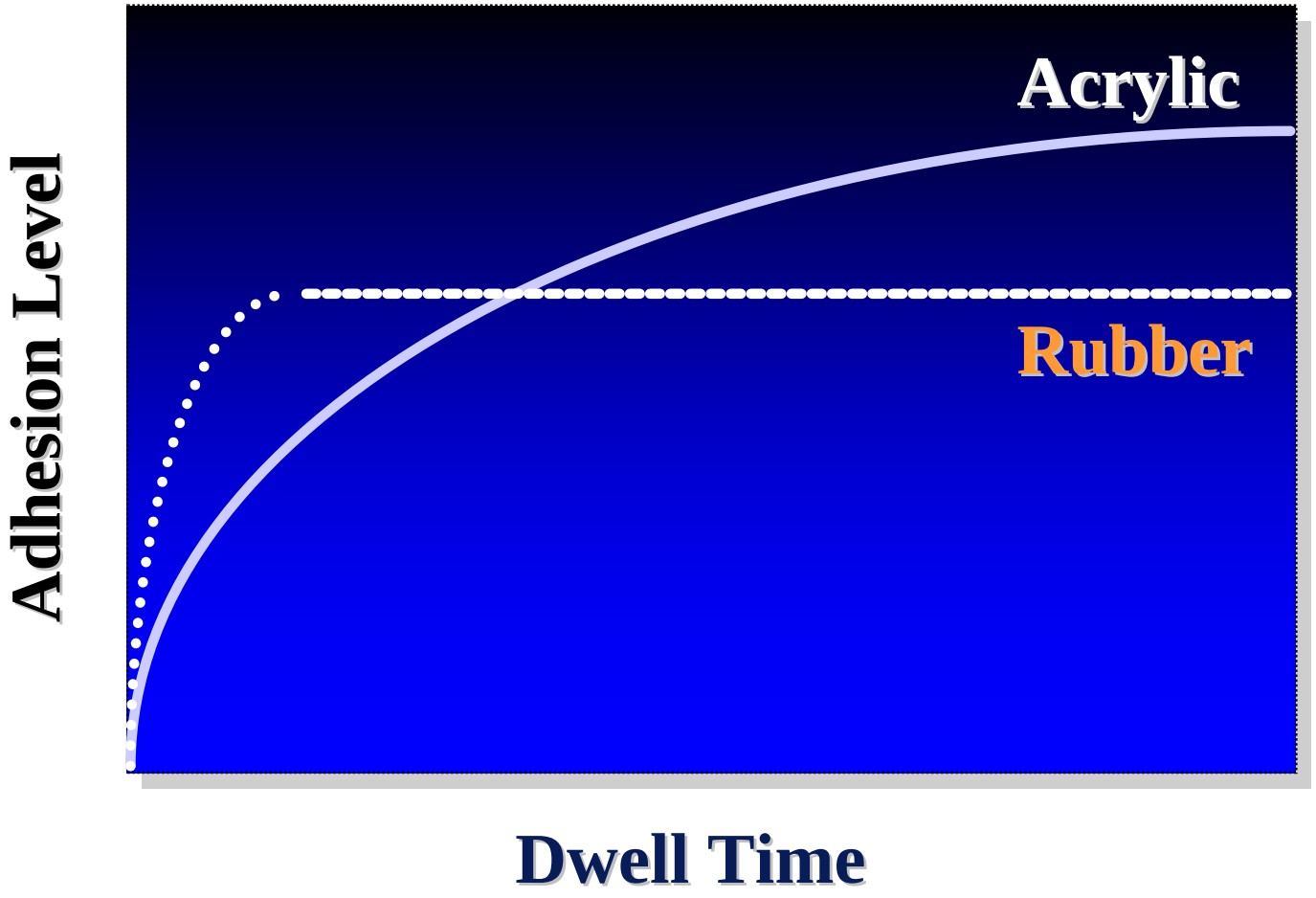


Initial Adhesion
No Dwell Time

Ultimate Adhesion
72 hrs @ 25 °C

Adhesive Technology

The bond strength of Acrylic adhesives builds over time…



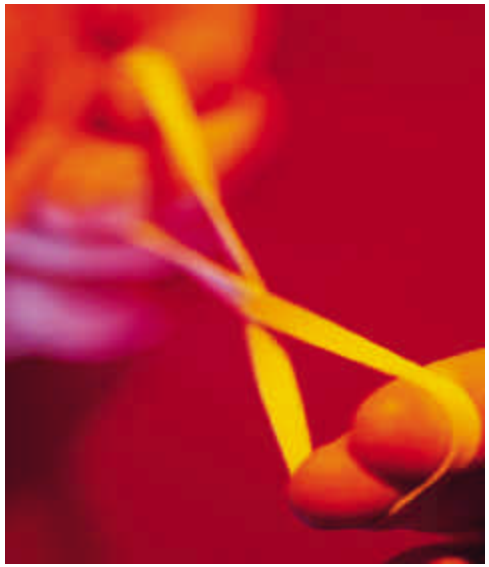
Visco-Elasticity

"Say it with Me"

Peanut Butter

- Viscosity = Thickness

- Elasticity = Stretch



Visco-Elasticity

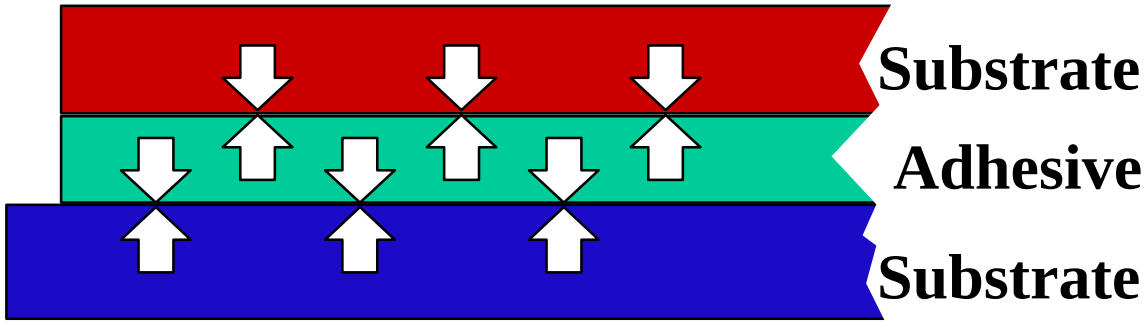
- Viscosity allows the PSA to bond and flow.

- Elasticity absorbs energy & shock.

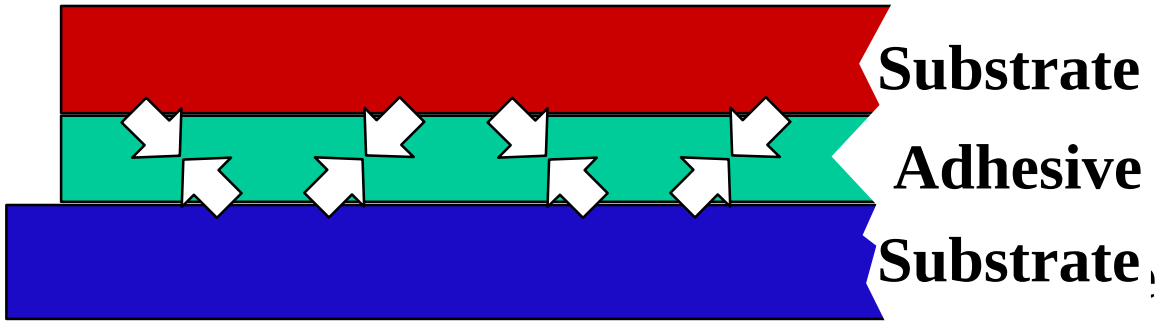
Gives PSAs Strength

Two important PSA characteristics:

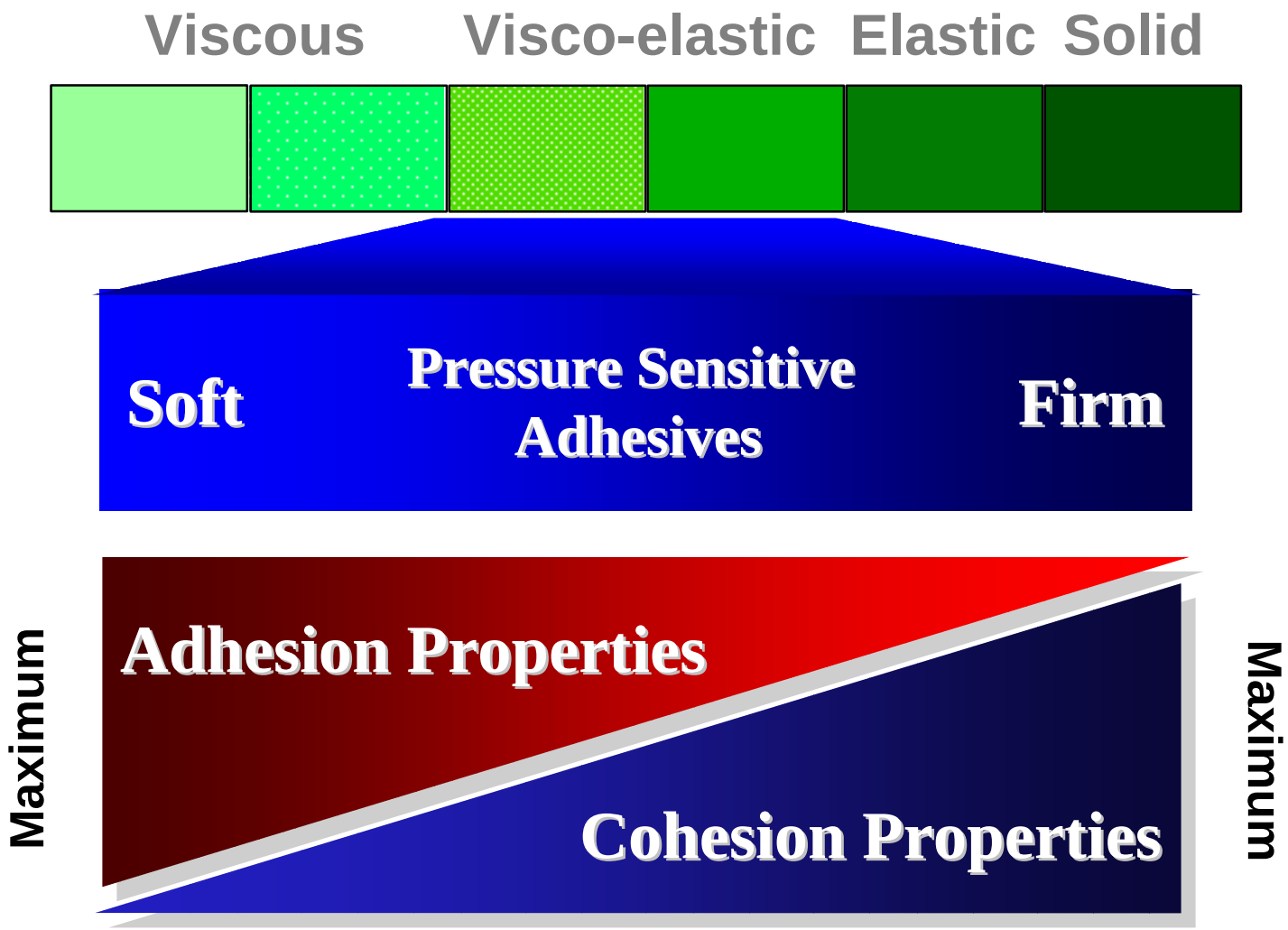
Adhesion Attraction forces joining unlike substrates



Cohesion Internal strength of material

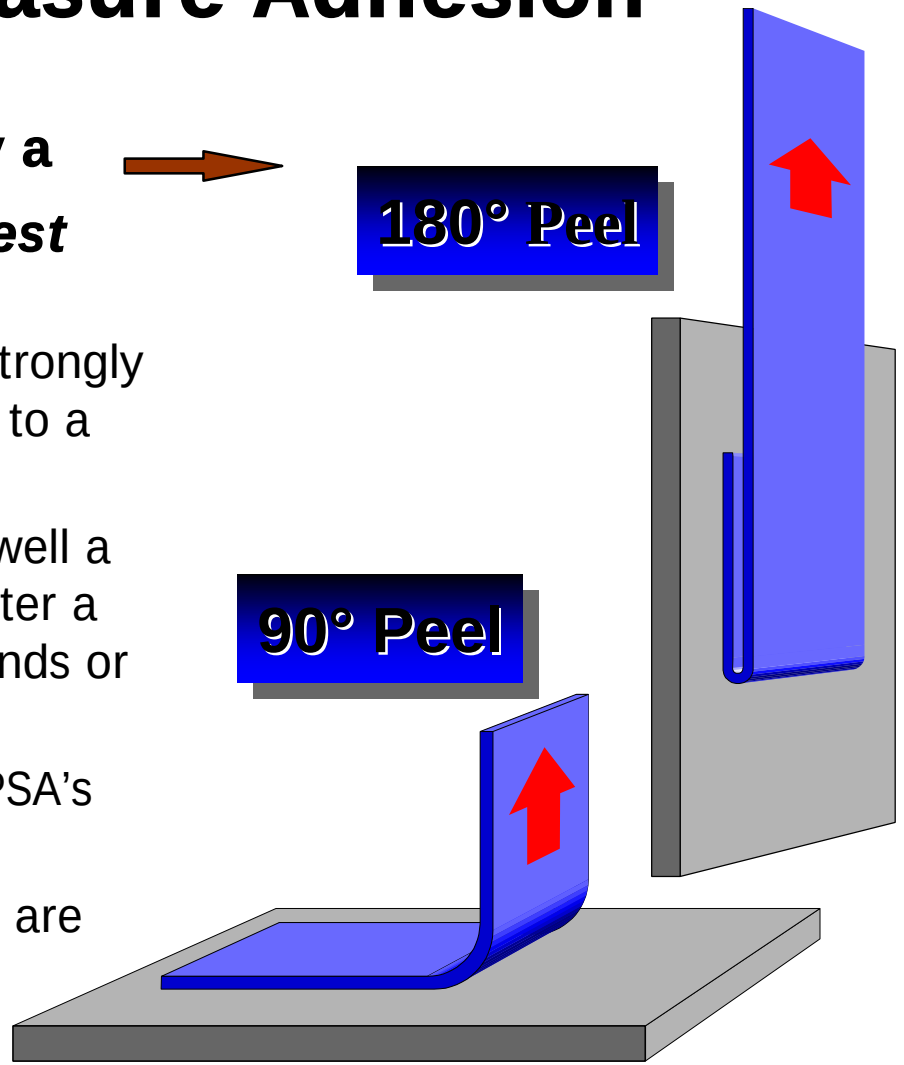


Viscosity and Elasticity

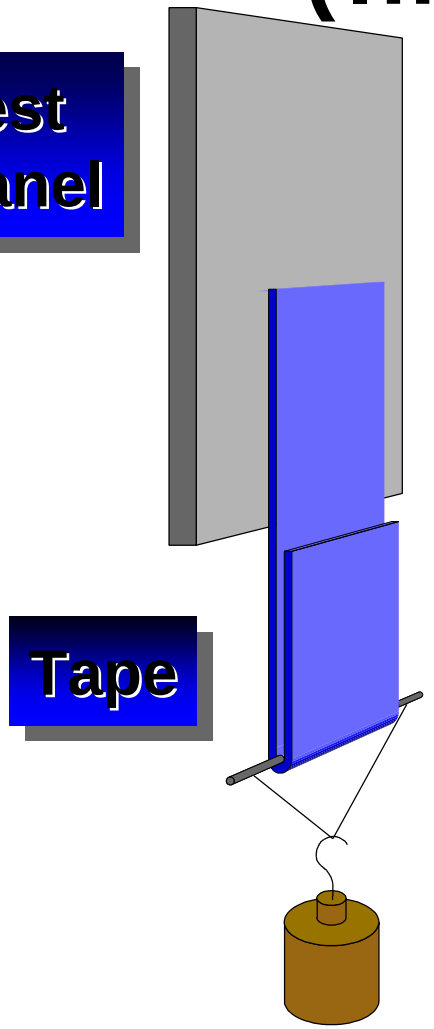


"Peel Tests" measure Adhesion

- **Adhesion can be measured by a test method called the *Peel Test* *(PSTC or ASTM)***
  - ***Peel Values*** then indicate how strongly the PSA has bonded, or adhered, to a particular substrate
  - ***Initial adhesion*** indicates how well a PSA has bonded to a substrate after a short period of time, usually seconds or minutes
  - ***Ultimate adhesion*** refers to a PSA's bond strength after 72 hours
  - Both initial and ultimate adhesion are measured by the Peel Test



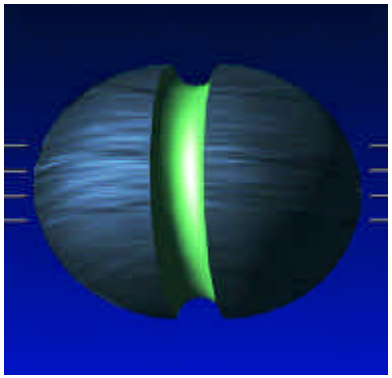
"Shear Tests" measure Cohesion (Internal Strength)



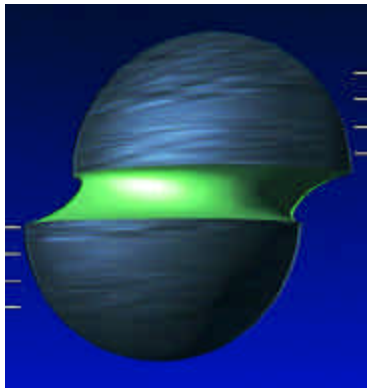
- **Cohesion can be measured by a test method called the *Shear Test* *(PSTC or ASTM)***
  - ***Shear Values*** then indicate the internal strength of an adhesive
  - Adhesives with higher shear values (which equates to stronger cohesion) will withstand exposure to higher temperatures and chemicals

Forces Effecting PSA Performance

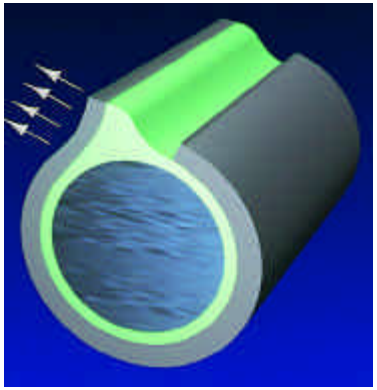
Tensile



Shear



Peel



Factors that can influence your PSA success...

Surface:

- Surface Texture
- Surface Contour
- Surface Energy
- Surface Contamination

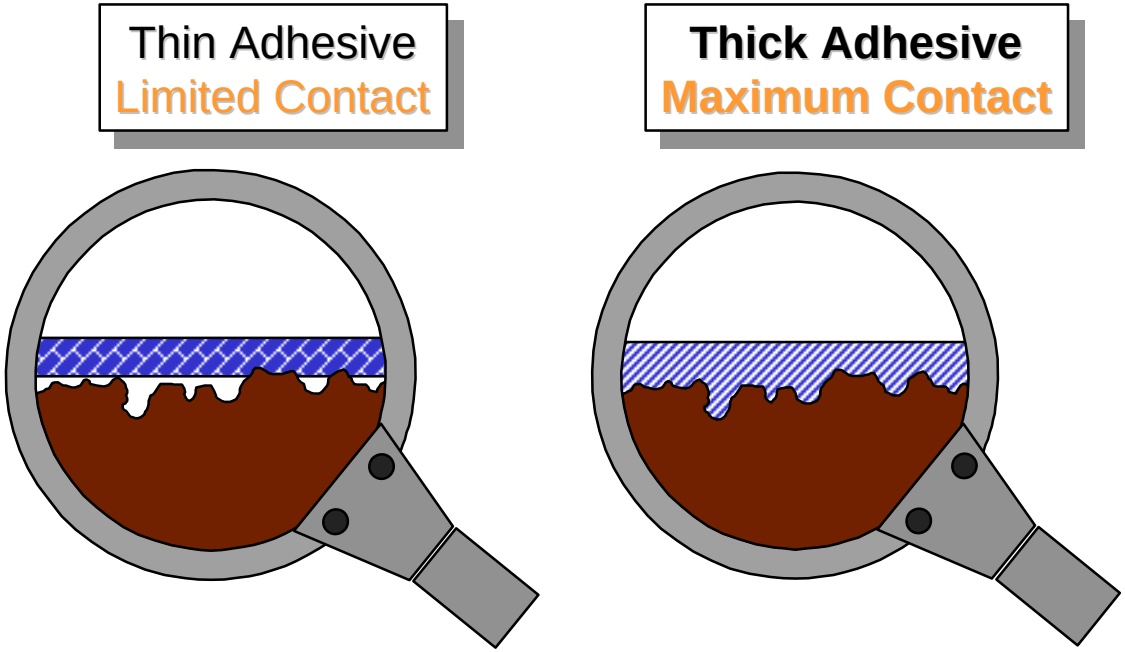
Environment:

- Solvents/Chemicals
- Temperature Exposure
- UV Light Exposure

Application:

- Time
- Temperature
- Pressure

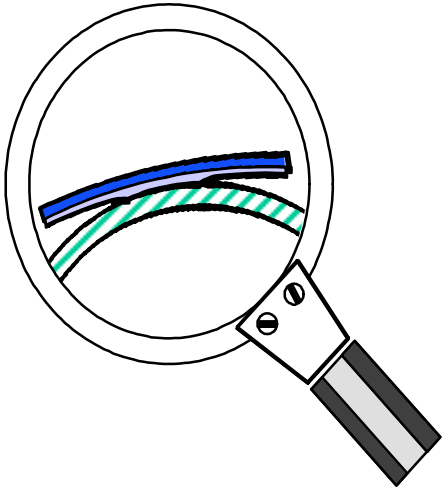
Surface Texture



For rough surfaces, use a thicker adhesive!

But thicker is not always better! Use the right thickness for your substrate; testing will help determine this.

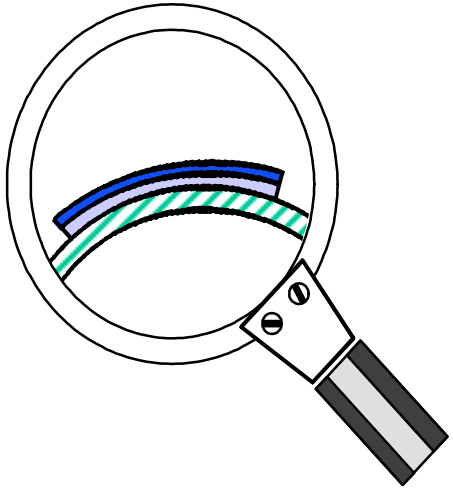
Surface Contour



Curved Surface combined with **thin** and **firm** adhesive may cause:

* Internal stresses and

* Edge lift (Flagging)



Curved Surface combined with **thick** and **soft** adhesive may provide:

* Maximum surface contact

* additional bond strength

Surface Energy

Adhesion is the molecular attraction between unlike materials, similar to magnetic force.

The *surface energy* of a material determines the strength of this attraction. The higher the surface energy, the greater the attraction. The lower the surface energy, the weaker the attraction.

On an automobile, unwaxed for years, water spreads on the surface in large puddles. This is "High Surface Energy", allowing the water to flow. On a freshly waxed car, the water will bead up. This is Low Surface Energy keeping the water from flowing out!

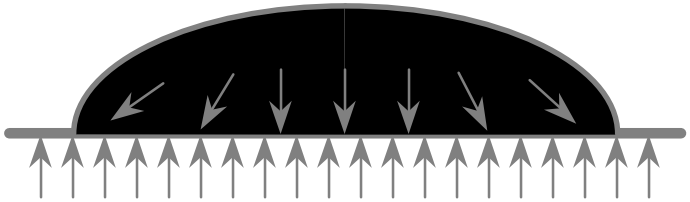
Adhesive Technology

Common materials and their respective surface energies…

High Surface Energy

Easy-to-adhere

good adhesive "wet-out"

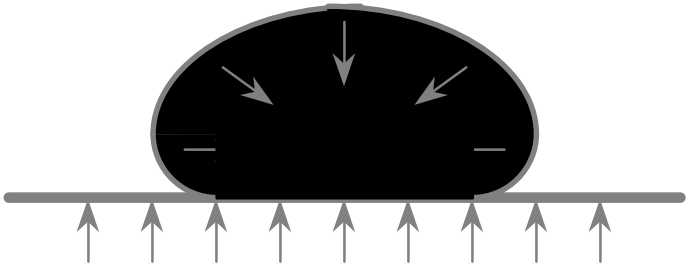


Metals
Kapton
Polyester
Polyurethane
ABS
Polycarbonate
PVC
Acrylic

Low Surface Energy

Hard-to-adhere

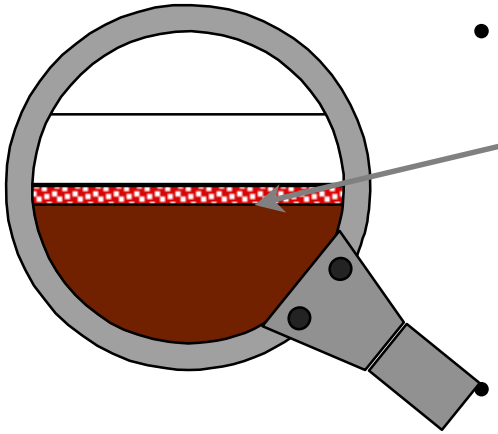
poor adhesive "wet-out"



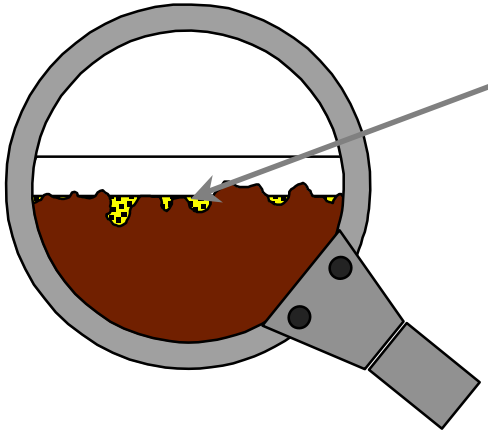
Polyvinyl Acetate
Polystyrene
Acetal
EVA
Powder paints
Polyethylene
Polypropylene
Tedlar (PVF)
Teflon

Surface Contamination

Each of these situations can result in a poor bond....



- **Grease, Moisture, Oil, Mold Release Chemicals**
  - Creates a barrier between adhesive and substrate



- **Dust, Talc, Fiber, Particle Contamination**
  - Affects tackiness of adhesive
  - Reduces contact surface area

Always clean your substrates before applying a PSA!

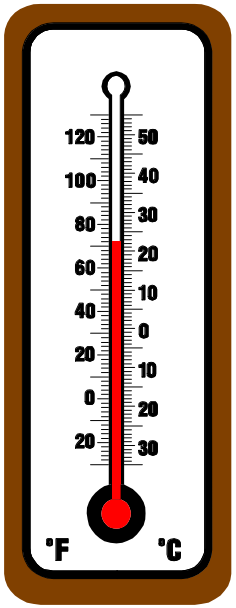
Chemical / Solvent Resistance

- Solvent Effects on PSAs
  - Adhesive swelling
  - Adhesive softening
  - Dissolve adhesive

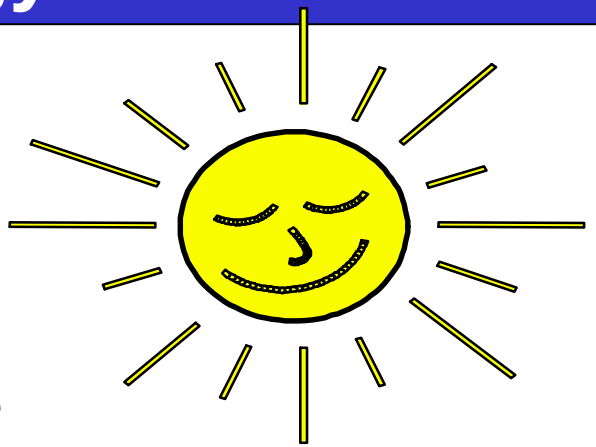
Many acrylic adhesives have high cohesive strength allowing them to withstand many different types of solvents for extended periods of time.

Temperature Factors

- Low Temperatures can have a negative affect on adhesives....
  - Firms & makes adhesives brittle
  - Reduce adhesive tack
  - Increase shock sensitivity
- So can high temperatures...
  - Adhesive softening
  - Reduce shear strength
  - Reduce cohesive strength



Know the temperature range of your application, then select an adhesive that will meet both the high and low temperature extremes.



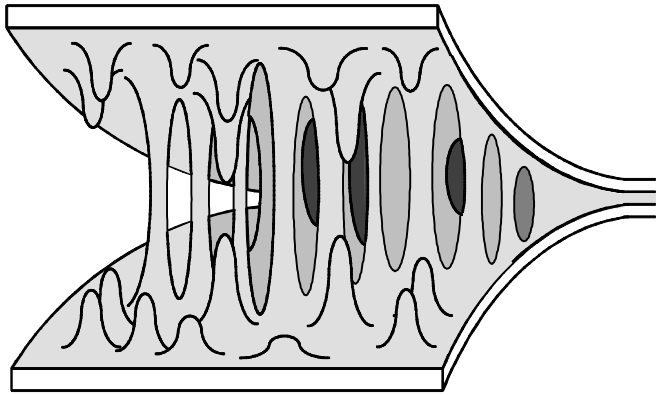
UV Light

- Ultra Violet (UV) light can have negative affects on adhesives as well:
  - Discoloration
  - Brittleness
  - Chemical Degradation

When you know UV light will be a factor, select an adhesive that has UV resistance!

Plasticizers

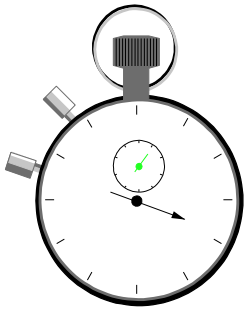
- Make adhesive soft and pliable
- Causes adhesives to:
  - Soften
  - Turn stringy
  - Discolor

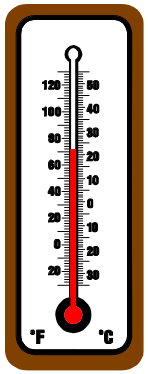


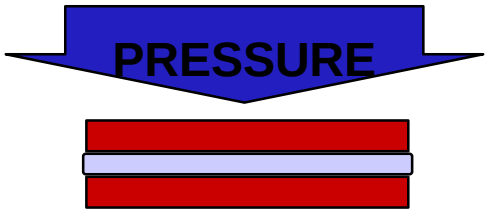
Some adhesives have varying resistance to plasticizer migration allowing them to withstand the softening effect.

Adhesive Technology

Applying your PSA can be THE determining factor for success…



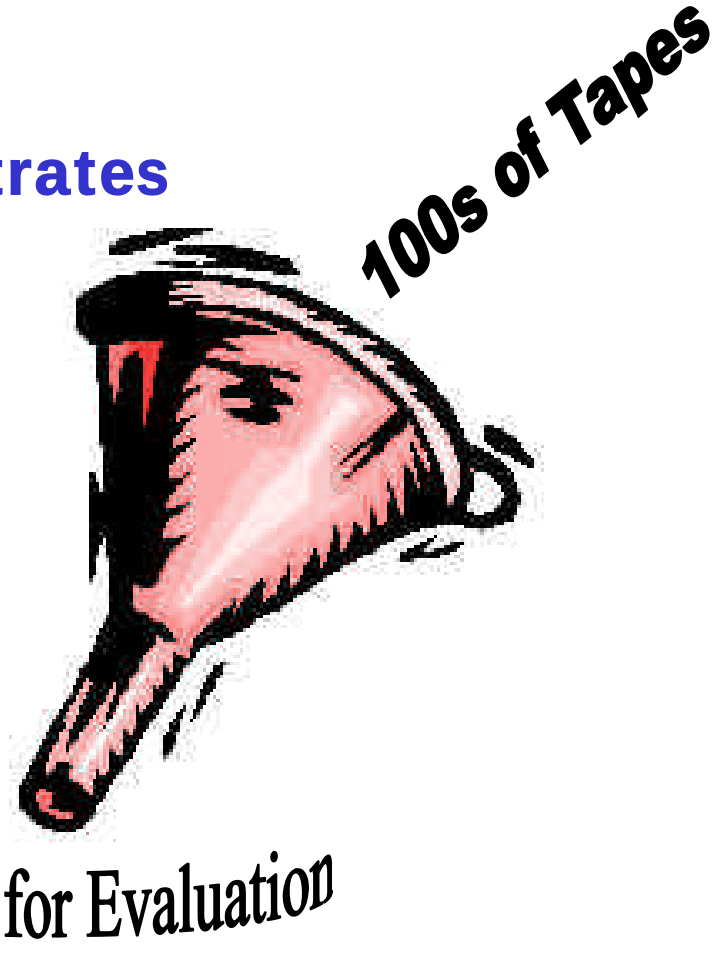




- **Time**
  - Allow at least 72 hours before testing the ultimate adhesion strength. This gives the adhesive time to *flow*, effectively covering your substrates.
- **Temperature**
  - Applying your adhesive at room temperature is always best. Slightly higher temperatures can actually improve adhesive flow, speeding up the the bonding process. At cold temperatures, select an adhesive made for application in cold temps.
- **Pressure**
  - Applying adequate pressure will accelerate the adhesive flow and eliminate trapped air. This will ensure higher adhesive coverage of the substrate.

Some final tips:

- **Know your surfaces or substrates**
- **Select the right adhesive**
- **Finally, clean your substrate**



Quiz

Name Three Factors that can influence PSA Selection

- Surface Texture
- Surface Contour
- Surface Energy
- Surface Contamination
- Solvents/Chemicals
- Temperature Exposure
- UV Light Exposure
- Time
- Temperature
- Pressure

Questions or Comments