



Adhesives for Automotive Interiors

Executive Summary

Engineers are faced with a myriad of choices when it comes to adhesives for interior trim assemblies. Choosing the proper adhesive can be confusing considering that many different types of adhesive will work for any given application. Each different type of adhesive brings with it different processing requirements, different product handling requirements along with different assembly and end performance characteristics. Sorting through these adhesive choices and determining which process may be the best for any given application can take years of experience to understand.

This paper is designed to be a starting point for engineers who are addressing these choices. It is intended to:

- Provide background information about different types of adhesives used in automotive interior assembly;
- Familiarize the reader with the different processes used with adhesives;
- Introduce the basic types of equipment associated with these adhesives and processes; and
- Serve as a primer to help an engineer understand the many factors behind selecting and matching the proper adhesive with the proper process.

Questions to Answer Before Getting Started

Before beginning any project requiring adhesives it is imperative to be prepared to answer specific questions regarding exactly what the adhesive is required to do. Following is a general list of starter questions to assist in moving the qualification process along. If these questions are answered before beginning your research, you will be well on your way to selecting the proper adhesive and process for your application.

1. Does the adhesive or process I am going to use have to be pre-approved by the specific OEM for whom the part is being made?
2. Is this application global in nature? Is this adhesive available where I will be manufacturing this item?
3. What is the service environment of the adhesive? What environmental screening methods and temperatures will be used? What forces will be placed upon adhesive in this application (sheer, pull, etc)?
4. What is my required cycle time? How many parts do I have to make per hour or per shift?
5. What is my overall target cost on each part? What is the impact of the different adhesives and their costs to the overall cost target?
6. Where is the adhesive going to be applied in the assembly process? How will the assembled product be handled before and after the adhesive is applied?
7. What is the time proper time and environment for the material to be set or cured (if required)?
8. Is an operator required to apply the adhesive or is it going to be automated?
9. What are my substrates and do they need to be surface pre-treated? Note: Dyne level and substrate technical data should be available from an adhesive supplier's Technical Data Sheets.

Automotive Interior Adhesive Applications

Following is a short list of some of common interior trim adhesive applications. Many other applications exist for interior trim purposes.

Headliners:

Head-impact composite adhesion, wire-harness attachment, water-hose attachment, HVAC climate control attachment, stiffener applications, velcro attachment, foam/foam block attachments, clip attachments, edge folds, others

Consoles:

Vacuum-forming, carpet attachment, edge-folding, sound absorbers

Door Panels:

Door bolsters, speaker attachment, sound absorbers, energy absorbing foams / safety plastic, water management

Flooring:

Padding, sound deadeners, carpet, composite bonding, and accessory bonding

Instrument Panels:

Vinyl wrapping, sound dampening, safety foams/plastics, component sound-dampening

Pillar Assemblies:

Cloth wrap, vinyl wrap, crash & sound foams

Seating:

Seat backcloth or vinyl wrap, cloth attachment, and foam repair, bun-cloth composite assembly

Water-Management Systems:

Watershields, baffle assemblies, cowl assemblies, firewall adhesion and water-management.

Common Adhesive Terms:

The following terms are used interchangeably between many different and technologies of adhesives:

- **Adhesive:** Material that can be used to adhere or stick one surface to another. Adhesive is the generic term that includes others such as cement, glue, mucilage and paste. *Note: Originally, adhesive was based on egg whites as well as proteins derived from the collagen in animal products such as hides and bones*
- **Abrasion Resistance:** Ability of an adhesive to resist degradation due to mechanical wear by hard and rough objects (mechanical erosion) thanks to the ability to dissipate the applied mechanical energy.
- **Adhesion:** Power of an adhesive layer to hold the parts of an assembly together. The two surfaces are held together by interfacial forces, which may consist of valence forces or interlocking action. Quantitative tests are available for measuring the adhesive strength under various environmental conditions; measured in units such as pounds per square inch (psi).
- **Adhesion Failure:** Separation of two bonded surfaces that occurs at the adhesive/substrate interface.
- **Adhesion Promoter:** Material used to improve adhesion between materials. May be used in two different modes: (1) by pre-treatment of a substrate, and (2) as a component in adhesive formulation capable of enhancing adhesion durability due to the improvement in substrate wetting and formation of chemical bonds across the film/substrate interface (aka **bonding agent**)
- **Aging / weathering:** to an environment for an interval of time. Change of a material with time under defined environmental conditions, leading to the improvement or deterioration of properties.
- **Antioxidant:** Compounding material used to retard deterioration caused by oxidation.
- **Bonding Time:** The period of time taken for the assembly to achieve sufficient firmness to bear the load exerted on it.
- **Bond Strength:** Unit load applied in tension, compression, flexure, peel, impact, cleavage, or shear, required to break an adhesive assembly with failure occurring in or near the plane of the bond. Measured in pounds per square inch (PSI).
- **Carrier:** The item put into the adhesive to make the adhesive components (solids) deliverable. The adhesive is made into a solution generally with solvent of water as means of making the solids sprayable or coatable on the part.
- **Cohesion:** State in which the particles of a single substance are held together by primary or secondary valence forces observed in the tendency of the substance to stick to itself.

- **Cohesive Failure:** Failure within the adhesive under a stress. The measurement of when the internal strength of the adhesive is not as great as the forces applied to it. Adhesive remains bonded to both substrates.
- **Cohesive Strength:** the internal strength of material, how strong a material bonds internally to itself.
- **Core Size:** general term used in pre-applied type adhesives, referring to the core of center of a roll of film or web adhesive. Often measured by diameter in inches or millimeters.
- **Cross-linking:** Formation of chemical bonds between polymer chains leading to the formation of a three dimensional network. Final materials are called thermosets.
- **Cure:** Change of the properties of a resin by a chemical reaction, which, for example, may be condensation, polymerization, vulcanization or addition; usually accompanied by the action of either heat or catalyst or both, and with or without pressure. Fully cured materials exhibit maximum physical, thermal and chemical properties in use.
- **Cure-time:** Time required for completing the cure process.
- **Creep:** Effect of strain and/or time on the shape of the adhesive layer.
- **Delamination:** The separation of layers in a laminate because of adhesive failure.
- **Dry Time:** The amount of time needed to remove the carrier from the solids. May be accomplished with or without a drying oven or drying device
- **Dry Weight / Wet Weight:** When a part is sprayed there is a weight associated with the adhesive after the carrier is dried or flashed off (dry weight) and the of the adhesive before the carrier is flashed or dried off (wet weight).
- **Elongation:** Amount in percent that a specimen will stretch before material break will occur. Delamination is expressed as a percentage of the original length.
- **Filler:** Solid material, often inert and usually in finely divided form, which may be added in relatively large proportions to a polymer to improve properties and/or decrease compounding cost.
- **Glass transition temperature: (Tg)** the temperature at which a material becomes crystalline. Above (TG) material is more free moving and below (TG) it is more brittle or crystallized.
- **Gram Weight Designation:** The amount of adhesive evenly distributed over a defined area. Typically used for water-base spray adhesives or film and web adhesives to indicate exactly how much adhesive should be applied or is in a given area.
- **Green time:** Time between application and solidification of the adhesive. During the green time, it is still possible to position parts.
- **Laminate:** To unite layers of materials with an adhesive.

- **Lap Sheer:** Shear stress acting on an overlapping joint
- **Melt Point:** The point at which the material actually begins to flow
- **Mil Thickness:** Typically used with film adhesives to define the thickness of an adhesive layer.
- **Minimum Bondline Temperature:** Some adhesives can be activated by heat. These adhesives are often used in composite bonding and the adhesive in the composite must reach a certain temperature before its adhesive characteristics are usable. The lowest temperature that the adhesive characteristics become usable is called **minimum bond line temperature**. This is important in determining the effect on the composite parts, which are being assembled.
- **Open Time:** Applied period of time during which the dry adhesive layers may still be bonded together. Affected by many factors, including temperature, substrate, adhesive used and amount of adhesive.
- **Peel Adhesion:** Adhesives strength resistance to be stripped from a bonded joint with the stripping force applied at a predetermined angle and rate.
- **Peel Strength:** The amount of force required to peel a material off a substrate. Peel strength is expressed in Pascals (Pa).
- **Pigment:** Fine solid particle used to colored products and substantially insoluble in the vehicle. *Note:* In contrast, a dye is soluble.
- **Plasticizer:** A compounding material used to enhance the deformability of a polymeric compound. A plasticizer is soluble in the polymer and decreases the glass transition temperature (T_g) value; it softens and adds flexibility to the product.
- **Polyurethane (PU):** Polymer made by the reaction of polyols with a multi-functional isocyanate. Its molecular structure may cross-link and become a thermosetting plastic, or stay linear and remain thermoplastic.
- **SAFT (Sheer Adhesion Failure Temperature):** The temperature at which the internal strength of the material fails at a given force.
- **Pressure Bonding:** This term is typically used in conjunction with a **pressure sensitive adhesive (PSA)** and contact type adhesive. Refers to the condition in which physical contact is sufficient to bond two substrates together. Pressure is most commonly “hand applied force” or “mated” equipment for stronger and more even applied force.
- **Pretreatment:** Refers to various means of achieving an increase in dyne level or surface tension of a given substrate thereby making for stronger bonds and substrates which are easier to adhere to.
- **Pot life: (aka Thermal Stability):** The amount of time of polymer can sit at given temperature without losing physical performance.

- **Release Liner:** Typically used with PSA films or dispensed adhesives as a carrier for the adhesive. May also be used in conjunction with web adhesives as a carrier to prevent “blocking” or stopping the web adhesives from sticking to itself over time.
- **Residual Moisture:** In some cases such as vacuum-forming a small amount of carrier (ex: 5% water) will create desirable tack or adhesion aid. This is referred to as residual moisture.
- **Set Time:** Time from application of a 2 mm bead @ 350F until craft paper is destructed rather than the adhesive failing cohesively.
- **Shear Strength:** The shear force required to break a specimen divided by its cross-sectional area; the force being applied parallel to the cross-sectional area. Expressed in pascals (Pa)
- **Shelf Life:** The period of time during which an adhesive stored according to the manufacturer's instructions (packaging, temperature, humidity) retains its expected properties.
- **Specific Gravity (SG):** The expression of the weight of an adhesive as it relates to water. Water has an SG of 1.0 and weighs 8 lbs per gallon. Materials lighter than water will float and have specific gravities <1.0; materials that weigh more than water will sink in water and have specific gravities >1.0.
- **Solids Content:** How much actual adhesive is contained in the liquid adhesive – liquid is generally just the carrier so a high solids content material will have much more adhesive left on the substrate after drying than a low solids content material. *Note: % solids is generally what you should be paying for and solids content should be a important factor in considering any liquid adhesive.*
- **Softening Point:** The point at which it begins flow or sag (malleable, no resistance)
- **Surface Tension:** Measured in terms of dyne level, this is a measurement of the amount of energy at the bonding surface of a substrate. In general the higher the dyne level the easier an adhesive can bond to the substrate.
- **Substrate Failure:** Failure of the substrate material itself, upon subjecting bonded adhered surfaces to a stress.
- **Surface Tension:** Measured in terms of dyne level, this is a measurement of the amount of energy at the bonding surface of a substrate. In general the higher the dyne level the easier an adhesive can bond to the substrate.
- **Ultimate Adhesion:** The maximum adhesion available from a pressure sensitive adhesive; determined by the force necessary to remove a strip of tape from a surface after an extended period of time.
- **Viscosity:** The measurement of resistance to flow or degree of thickening of a fluid. Some adhesives flow very easily, whereas other types of adhesives are so thick they hardly flow at all. Water and thick butyl mastics represent the extremes of viscosity. Usually expressed in poise (or centipoise)

- **Weathering:** Surface deterioration of a rubber article during outdoor exposure. The use of antioxidants, UV light stabilizers, etc. permits adhesives to have a greater weathering examples (cracking/crazing)
- **Wet Out:** The ability of the liquid adhesive to be evenly / effectively applied onto a given substrate
- **Yield Point:** In tensile testing, yield point is the first point on the stress-strain curve at which an increase in strain occurs without an increase in stress
- **Yield Strength:** The load in pounds per square inch where the material under test begins to change dimensions and will not completely recover when the load is removed. Yield strength will normally be lower than ultimate strength. Generally speaking, the more rigid a material is, the closer will be yield and ultimate strengths. Furthermore, the more resilient a material is, the greater the spread between yield and ultimate strengths.

Types of Adhesives Used for Automotive Interiors

There are many different types of adhesives that cover a litany of different applications. There are too many to cover in this introductory paper. As a general guideline a majority of the adhesive applications for interiors will fall into the following three broad categories: **hot melt adhesives**, **liquid adhesives** and **pre-applied adhesives**. Each one of these types of adhesives has a broad range of process and performance characteristics. Following is a broad definition of each of these types of adhesives followed by some of the common terms used when researching them.

- **Hot Melt Adhesives:** 100% solids thermoplastic or polyurethane based adhesives that are solid at room temperature and liquefy when heat is applied. These materials form nearly instantaneous bonds due to rapid cooling.
- **Liquid Adhesives:** Typically water or solvent based materials, which are sprayed or roll-coated, these materials tend to be low viscosity materials. % solids, which are the actual adhesive measurement in relation to the water, typically represent these materials or solvent, which is the carrier for the adhesive.
- **Gasket and Sealants:** Typically rubber based compounds that are used for water-management or NVH or sound-dampening/ deadening applications
- **Pre-Applied Adhesives:** Hot melt adhesives sprayed or extruded into a sheet/film form which is then used for heat-reactivated or pressure bonded assemblies.

Types of Hot Melt Adhesives

There are four main types of hot melt adhesives used for interior trim applications. Each of these has unique properties that lend themselves to automotive various interior trim applications. Below is a brief description of this adhesive technology.

Typical packaging of these adhesives tends to be drums, pails, and blocks of various sizes such as pillows, co-extrusions or sticks.

- **APAO (Amorphous Poly Alpha Olefin):** These adhesives are a category of olefins, which are low in molecular weight and (non-crystalline) amorphous. They are commonly used on low-surface tension plastics such as polypropylene and polyethylene.
- **PSA (Pressure Sensitive Adhesive):** These adhesives are permanently tacky at given temperatures. These are commonly used on ABS / Polycarbonate plastics or higher surface tension plastics.
- **Polyamide: (nylon and dimer acid based materials):** These adhesives tend to be harder more crystalline adhesives based on the use of dimer acids. Best for high-temperature applications with load bearing requirements.
- **Hot Melt Polyurethane: (cross-linking hot melt):** These adhesives are thermosetting hot melt reactives that cure with moisture from the environment after processing. These materials once applied do not re-melt or flow under heat and pressure. Hot melt polyurethane adhesives are commonly used for high temperature applications with sustained or load bearing requirements.

Glossary of Terms Associated with Hot Melts:

- **Foamability:** Ability of a material to accept an inert gas and hold it in solution.
- **Hot Melt Adhesive:** 100% solids adhesive requiring heat to raise the temperature of the adhesive to a workable viscosity.
- **Hot Tack:** A characteristic of hot melts, in which they have holding power even while in the liquid hot state.
- **Initial Bonding:** State of bonding achieved after a certain amount of time when the fixings holding the assembly together can be removed, although the final load cannot yet be exerted on the assembly
- **Joint gap:** Space between the parts to be assembled.
- **Joint Thickness:** The distance between the parts to be stuck together (= thickness of the layer of adhesive average).
- **Melt Point:** The point at which the material actually begins to flow.
- **Open Time:** Time from application of a 2-mm bead @ 350F until there is too little tack to pull fibers from Kraft paper.
- **Polyamide, PA:** Formed by the reaction of a diamine and a diacid. Nylons are commercial polyamides characterized by toughness, solvent resistance, and sharp melting point.
- **Pot Life:** The length of time an adhesive remains usable for mixing. Usually an important factor with adhesives mixed together that begins curing almost immediately (aka: **shelf life**).
- **Ring & Ball Softening Point:** The point at which a specified size ball bearing drops below the level of a matched washer to define when a material softens
- **Pot life: (AKA: Thermal Stability):** The amount of time of polymer can sit at given temperature without losing physical performance.
- **Softening Point:** The point at which it begins flow or sag (malleable, no resistance).
- **Set Time:** Time from application of a 2-mm bead @ 350F until craft paper is destructed rather than the adhesive failing cohesively.
- **Tack:** Property of an adhesive that enables it to form a bond of measurable strength immediately after adhesive and adherent are brought into contact under low pressure.
- **Tack Free Time:** Time to cure to the point of losing immediate stickiness

Types of Liquid Adhesives

There are four main types of liquid adhesives used in interior trim applications. Each of these has unique properties that lend themselves to automotive various interior trim applications. Below is a brief description of commonly used liquid adhesive technologies.

Typical packaging of these adhesives tends to be drums, pails, quarts or spray cans.

- **One-Component Water Based (or Waterborne) Materials:** Drying ovens or drying time is normally associated with these materials while the water carrier of the adhesive is removed after application. A majority of these materials are thermoplastic (non-crosslinking) in nature
- **Two-Component Water Based Materials:** The addition of a crosslinking second component makes these materials thermosetting (crosslinking). These materials make high temperature resistant bonds, but require controlled ratio mixing and management of pot life concerns
- **One-Component Solvent Based Materials:** These materials flash-off or dry faster than one-component waterbased materials and are often used on low surface energy substrates because the solvent that flashes off will “etch” a materials surface. Require special handling and ventilation due to health concerns
- **Waterborne Pressure Sensitive Materials:** Drying ovens and dry time are associated with these materials which can be used to cover large areas (either spray or rollcoat) to make an entire surface ‘tacky” or “sticky”. Used for covering large areas with 100% coverage.

Terms used with Liquid Adhesive

- **Activator:** Chemicals, which can be applied directly to a surface, substrate or mixed with an adhesive to speed up the solidification of an adhesive.
- **Carrier:** The item put into the adhesive to make the adhesive components (solids) deliverable. The adhesive is made into a solution generally with solvent of water as means of making the solids sprayable or coatable the part.
- **Contact Adhesive:** Solvent based adhesive but with added properties which produce an immediate bond. One-part adhesives need no mixing. Adhesive is applied to both surfaces, let dry, and then pressed together to create an instant bond. Makes good bonds in most materials but is not structural in strength.
- **Contact Pressure:** Pressure applied to the assembly to achieve a bond in contact adhesives.
- **Core Size:** general used in pre-applied type adhesives and refers to the core of center of a roll of film or web adhesive. Core size is often measured by diameter in inches or millimeters.
- **Dry Time:** The amount of time needed to remove the carrier from the solids. With or without a drying oven or drying device.
- **Dry Weight / Wet Weight:** When a part is sprayed there is a weight associated with the adhesive after the carrier is dried or flashed off is called dry weight. The weight before the carrier is flashed or dried off is called wet weight.
- **Gram Weight Designation:** The amount of adhesive evenly distributed over a defined area. Typically used for waterbase spray adhesives or film and web adhesives to indicate exactly how much adhesive should be applied or is in a given area.
- **Minimum Bondline Temperature:** Some adhesives can be activated by heat. These adhesives are often used in layers or in composite bonding. The adhesive must reach a certain temperature before its adhesive characteristics are usable. The lowest temperature that the adhesive characteristics become usable is called minimum bondline temperature. This is important in determining the effect on the composite parts, which are being assembled.
- **Moisture Content:** Amount of water in a material determined under prescribed conditions, and expressed as a percentage of the mass of the moist specimen, that is, the mass of the dry substance plus the water present.
- **Residual Moisture:** In some cases such as (vacuum-forming) a small amount of carrier (ex: 5% water) will create desirable tack or adhesion aid. This is referred to as residual moisture.
- **Solids Content:** How much actual adhesive is contained in the liquid adhesive – liquid is generally just the carrier so a high solids content material will have much more adhesive left on the substrate after drying than a low solids content material. % solids is generally what you should be paying for and solids content should be an important factor

in considering any liquid adhesive.

- **Solvent:** Substance that dissolves other substances. Volatile (means evaporates readily) liquid added to adhesives to keep them in usable condition. Usually readily flammable. The adhesive bonds when the solvent evaporates (aka **diluents**).
- **Solvent Borne Adhesive:** Adhesive in which volatile organic compounds are the major solvent or dispersant.
- **Volume Shrinkage (%):** The amount of dimensional change during cure.
- **Wet Out:** The ability of the liquid adhesive to be evenly / effectively applied onto a given substrate.
- **Working Life:** This is the period of time between the mixing and setting of two- or multi-component adhesives and represents the period of time during which the mixture can be worked. Most cold-setting adhesive systems have a short working life (minutes or hours), whereas most warm-setting systems have a long working life (hours or days).

Gaskets and Sealants

Gaskets and sealants are used for two main purposes on interior trim assemblies. They are used for water management so stop water that may work its way into areas where there are openings between the exterior and interior of the vehicle. They are also used in areas where a vehicle may be susceptible to NVH (noise, vibration and harshness).

Gaskets: Gaskets are used for sealing in assemblies that must be taken apart and put back together and must still supply a seal after this has been completed a specified number of times. This product characteristic is often referred to as serviceability. Examples of parts needing gaskets are: door carrier plates / modules, lighting assemblies, some electronics.

Most gaskets for interiors are polyurethane based materials. The polyurethane gives the materials the added heat resistance and compression-recover characteristics needed for a serviceable seal. Polyurethane based materials all have “cure” times associated with their processing that can vary greatly from formula to formula.

- **One-component polyurethane:** These materials can be mechanically foamed for softness. Many of these can be applied un-foamed and come in a wide variety of durometers and packaging alternatives.
- **Two-component polyurethane:** These materials create their softness through chemical reaction by the mixing of two materials.

Sealants: Sealants are seals that are for one time use only. This means the whole assembly is replaced or the particular area that needs to be sealed will not be taken apart and put back together as part of its requirements. Examples of parts using sealants could be: speaker assemblies, some lighting assemblies, license brackets, and exhaust valves.

Most sealers for interiors are rubber based materials. Their thermoplastic nature allows them to be very soft and “custom” for or “compression set” against their mating assemblies. These materials are set almost instantly upon application.

- **Thermoplastic Sealers:** These sealants come as hot melt and room temperature applied materials. They have a wide variety of packaging and delivery system options.

Types of Pre-Applied Adhesives

Pre-applied adhesives can come in many forms. There are two main technologies used in interior trim applications today. In most cases these technologies are used as backings on fabrics or coverstock materials. These adhesives come made out of many of the same resins used in making hot melt adhesives; pressure-sensitive, polyolefins, polyesters are all popular in the making of web and film adhesives

There are some new technologies emerging in liquid dispensing for pre-applied technologies that will continue to improve and develop during the next several years that are worth researching.

Web adhesives: Web adhesives are typically hot melt adhesives sprayed in a controlled pattern. The width of the web and the coating weight are the major factors effecting the performance of these adhesives. These types of adhesives are generally heat reactivated under-pressure type adhesives.

Film adhesives: Film adhesives are typically thermoplastics extruded at a controlled thickness and width. These adhesives are typically pressure-sensitive or heat reactivated in nature.

Typical packaging of these adhesives includes rolls- sheets

Preformed tapes: Preformed tapes are generally elastomeric rubber extruded into a ribbon of a width and thickness suitable for specific application. Preformed tapes are usually used in the Building and Construction market, chemically compatible to glass, metal, or wood.

Typical packaging of these materials is in rolls or sheets

Adhesive Processes

The following is a listing of some common processes involved in many interior trim adhesive assemblies. Each of these processes can be used with many of the different technologies available.

- **Surface Treatments:** It is often necessary to bond plastic materials to metals or other plastic materials or simply print a plastic surface. In order to successfully accomplish this adhesives should be able to wet the surface of the material. Wet out depends on one specific property of the surface: Surface Energy (often referred to as surface Tension). Surface treatments are designed to increase a substrates surface energy and surface tension making a surface easier to wet out.

- **Corona Treatment:** Corona discharge equipment consists of a high-frequency power generator, a high-voltage transformer, a stationary electrode, and a treater ground roll. Standard utility electrical power is converted into higher frequency power which is then supplied to the treater station. The treater station applies this power through ceramic or metal electrodes over an air gap onto the material's surface.
- **Plasma Treatment:** Atmospheric plasma is a low temperature source of atoms and radicals. These reactive species are delivered to a substrate to clean, remove, modify, or deposit a material of your choice. Plasma offers a broad range of surface chemistries. An inert gas, helium or argon, is fed to the source along with a few percent of gas molecules, such as oxygen, hydrogen, nitrogen, or carbon tetrafluoride, thereby generating O, H, N or F atoms to plasma treat the surface.
- **Liquid & solvent primers:** A liquid coating that is applied to a substrate that is designed to increase its surface tension or to increase a substrates surface energy.
- **Surface roughing:** A method of surface pre-treatment that exposes fresh substrate and delivers the highest surface tension a substrate has to offer. Roughing is also used to increase surface area to bond to, thus increasing bond strength.

- **Spray applied processes**

Spray adhesives use air or high pressure as a way to assist the application of the adhesive to the substrates. Liquid and hot melt adhesives most commonly use spray as a means of application. Different spray patterns are achieved for different purposes.

- A 100% smooth coating can be achieved, which will look a lot like paint once applied.
- A pebbled or spackled spray can be applied which allows for the evacuation of air in vacuum forming or for reduced adhesive usage where 100% coverage is not needed.
- Spray equipment for liquid adhesives is often the same equipment that applies paints, coating and other low viscosity materials.

- Spray equipment for hot melts are almost all pressure based systems that have various types of dispense tips that use air pressure to determine the type of adhesive pattern.

- **Roll Coat applied processes**

Roll coaters use various roller set-ups sitting in a reservoir of adhesive that transfers onto the roller. They then use a special blade, which controls the thickness of the adhesive on the roller. The adhesive is then transferred under pressure onto a part for adhesive application.

Roll coating typically uses adhesives lower viscosity. Liquids and hot melts are the most common adhesives used with roll coating.

- Typically, used to apply adhesive to flat or relatively flat parts. Can also be used to apply on to specific areas with a mask
- Roll Coating equipment comes in sizes from only a couple of inches wide to hundreds of inches wide depending on the application requirements.

- **Contact or Pressure Bonding processes**

- The adhesive is applied to both substrates to be joined together. The adhesive wets out on the substrates, is then dried and then joined together with a given force or pressure. In most cases the strength of the final bond is the strength of the adhesive adhering to itself.

- **Pre-applied processes**

Pre-applied adhesives come in several technologies and are very popular because in many cases they eliminate the need for adhesive application equipment. In general these adhesives are made to be applied to the backside of a cover stock or substrate and then reactivated by either pressure or heat and pressure.

- Web adhesives are hot melt adhesives put into a controlled density web or sheet and then used for pre-applied purposes.
- Reactive chemistries are emerging that can be pre-applied
- Thermoplastic chemistries are the most popular type of pre-applied adhesives available today.
- Pre-applied adhesives require equipment that can deliver heat and/or pressure onto the parts to be adhered to make the adhesive bond.

- **Screen printing processes**

Screen printing also known as zone applied adhesives. The adhesive is typically applied though a patterned mesh screen. The adhesive flows through the mesh or onto the roller and adhesive is only applied to selected areas on a part or substrate.

- This technology is generally used with very low viscosity materials
- Screen printing equipment consists of a method of applying adhesive in mass onto the mesh followed by a squeegee type device that pulls the adhesive over and pushes it through the mesh.
- **Bead applied processes**
Bead applied adhesives are used primarily where substrates are larger and mating to uneven surfaces. They offer localized bonding where 100% adhesive coverage is not required
- **Vacuum-forming processes**
Vacuum-forming adhesives in interior trims are used predominately for vinyl attachment to instrument panels and door trim assemblies. The adhesive is spray applied – dried and then heat-reactivated to create a bond on door bolster or door trim and coverstocks (such as: foamed backed vinyls/pvc)

Conclusion

Choosing the proper adhesive can be a confusing considering that many different types of adhesive will work for any given application. Each different type of adhesive brings with it different processing requirements, different product handling requirements along with different assembly and end performance characteristics. Sorting through these adhesive choices and determining which process may be the best for any given application can take years of experience to understand.

The Author

David K. Whiting
Bostik, Inc.

Global Transportation Business Unit
Advanced Engineering/Business Development
Email: dave.whiting@bostik-us.com
Work: 800-843-0844x2789
Cell: 586-612-1875

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