5 REASONS PRESSURE SENSITIVE ADHESIVES FAIL

A GUIDE TO PREVENTING PSA FAILURE

Pressure sensitive adhesives (PSAs) play major roles in many applications, providing creative ways for companies to assemble parts, remove buzz, squeak, rattle, eliminate mechanical fasteners, and more. Unfortunately, when a PSA fails, so does the whole gasket, seal, insulation, heat shield, or other die cut part it's attached to.

It's easy to tell when a PSA fails as the adhesive will no longer bond to the surface of your application. However, it's not always apparent why this failure happened. This guide is intended to help you get to the root of why the adhesives on your parts may be failing and give you the ammunition you need to prevent it from happening again.

READ IT TO LEARN:

- Two types of bond failure
- Three primary categories of PSAs
- Five factors to consider to prevent PSA failure
- The basics of peel, tack, and shear testing

Types of Bond Failure

Before we get into the reasons why bond failure occurs, it's good to know the different ways that it can happen. There are two primary types of bond failure for PSAs: adhesive and cohesive.

ADHESIVE FAILURE

Adhesive failure, also known as delamination, is the most common form of bond failure. The adhesive cleanly pulls away from one substrate and stays attached to the other.

COHESIVE FAILURE

Cohesive failure can be defined as the physical separation of the adhesive material. Rather than delaminating from the applied surface, the adhesive "splits," leaving adhesive residue on both the application surface and the backing substrate.

While a bond failure usually falls within one of these two categories, there are times when the two types of failures will occur in conjunction with one another.

The following pages highlight five common causes of bond failure.

REASON #1

Wrong adhesive

Sometimes the reason for PSA failure is simple: the adhesive that was chosen was incapable of meeting the necessary functional requirements. In other words, because due diligence wasn't done during the part design stage, it was set up to fail. This is preventable with the right converting partner and proper up-front planning.

Before your part design is complete, be sure you can answer the following questions.

- Where and how will the part be used?
- What kinds of stress will the adhesive be subject to?
- What kinds of environmental factors will the adhesive be subject to?
- How long do you need the adhesive to last?
- What substrate(s) do you need the adhesive to stick to?

With these questions answered, your converter should be able to help you identify the adhesive that will work best for your application.

3 PRIMARY PSA CATEGORIES

RUBBER:

Lower-cost PSAs made of natural rubber and tackifying resins that are typically used for indoor applications with lower surface energy substrates.

ACRYLIC:

PSAs made of synthetic resins are slower to achieve a full bond, but demonstrate high resistance to environmental factors and high temperatures.

SILICONE:

Higher-cost PSAs made with synthetic elastomers that feature high temperature resistance and are primarily used to adhere to silicone rubber and sponge.

REASON #2

Inadequate surface preparation

One key way to prevent bond failure is to make sure that substrates are clean, dry, and at room temperature before affixing your pressure sensitive adhesive backed part.

Most surfaces can be adequately cleaned using a 50/50 mixture of isopropyl alcohol and water. 3M highlights the following exceptions:

HEAVY OILS

may require you to use a cleaner or degreaser before the general cleaning procedure.

PAINTS, PLASTICS, AND METALS

may require abrasive techniques to remove dirt and oxide while leaving micro scratches and smoothing out surfaces to improve adhesion.

LOW SURFACE ENERGY

may require the use of adhesion promoters to properly prime surfaces.

POROUS SURFACES

may need to be sealed with varnish or other hard surface coatings to create a unified surface that can be cleaned and wiped dry.

UNIQUE MATERIALS

may require material-specific solutions. Hydrophilic surfaces like glass and stone may require a silane coupling agent for your cleaning solvent. Oxidation-prone materials like copper and brass may need a lacquer or varnish for better adhesion. Plastics and rubbers that contain plasticizers need adhesion promoters to improve bond strength.

REASON #3

Improper application

Even the ideal pressure sensitive adhesive won't succeed if it's not applied properly. A good bond requires full wet-out to properly flow and cover a surface. Full wet-out requires the right combination of pressure, time, and temperature.

These three parameters all interact with each other to help you achieve this full wet-out. It's like a triangle with each aspect at a corner; if you shift away from one parameter, you need more of the other parameters to achieve a good bond.

This triangle gives you some options to attain full wet-out, even if one area is lacking. Increased pressure allows you take less time because the added pressure mechanically pushes a PSA into a surface. Additional time allows the PSA to naturally flow across a surface without extra help. Warmer temperatures reduce PSA viscosity and accelerate adhesive wet-out. Much like how water flows a lot quicker than molasses, a less viscous adhesive will require less time or pressure to properly fill every nook and cranny on a substrate. The key is that you balance the three parameters so that you can achieve a fully functional PSA bond.

PRESSURE:

The uniform application of an external load on the PSA mechanically forcing the adhesive film into the micro porosity of the substrate

TIME:

How long the PSA has to flow, or wet-out across the surface

TEMPERATURE:

The temperature of the PSA during application

REMEMBER:

Parts placed into service before a complete wet-out will not achieve full adhesion and can fail in service.

REASON #4

Unconsidered environmental factors

Once the part is in use, there are several environmental factors that can lead to PSA failure. These include:

UV LIGHT:
Adhesives without UV stabilizers become brittle over time.

SOLVENTS:
The chemicals found in cleaners and other solvents can break down some PSAs over time.

WEATHERING:
Prolonged exposure to the elements is a potential risk for some PSAs, especially for those used in outdoor applications.

MOISTURE:
Moisture can reduce surface adhesion for certain PSAs and lead to part failure.

TEMPERATURE:
High temperature can soften adhesives while low temperatures can make certain adhesives too stiff.

By considering the various environmental factors of your application, you can narrow down PSAs designed to perform despite these issues and take steps to mitigate their impact.

REASON #5

Stress

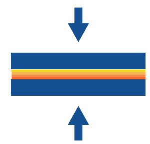
Most parts are subject to some form of external stress and pressure. When the amount of stress surpasses what the adhesive is designed to handle, failure can occur. Flexibility and adhesion levels are critical components to think about when selecting an adhesive. The specific type and amount of stress on the joint must be accounted for, especially in terms of one-dimensional stresses.

Pressure sensitive adhesives are set up for greater success when stress is two-dimensional. This allows the stress to be dispersed across an entire bond line instead of concentrating it on the leading edge of a bond line. However, some designs can only accommodate one-dimensional stress points that result in one of the following forms of joint stress.

Once you've identified which type of joint stress is most likely to occur for your application, you can look for adhesives that meet your required elasticity and strength needs.

TENSILE:

This stress occurs when one substrate is pulled directly away from the other so that the pull is exerted equally over the entire joint.



COMPRESSIVE:

Like tensile stress, compressive stress is applied in a straight, in-plane direction. However, this stress is applied toward the adhesive instead of having one substrate pulled away.

SHEAR:

Shear stress is also applied in a straight plane, except that the pull is directed across the adhesive and causes it to slide to one side.

CLEAVAGE:

This stress occurs between two rigid substrates when a prying force pulls at one edge of the adhesive bond, leaving the other end under little to no stress.

PEEL:

Peel stress is very similar to cleavage stress, except that is occurs when one substrate is flexible. As a result, more stress is applied to the leading edge of the adhesive bond as the adhesive tries to pull away along with the flexible substrate.

(see Appendix A for tips on how to test for peel, tack and shear)

Tests for Peel, Tack, & Shear

PEEL:

Adhesion strength is tested by measuring the force required to remove an adhesive tape from a surface. Once the tape is applied, you measure how much force is required to break the bond between the adhesive and the surface when it is pulled at both 90- and 180-degree angles at the same rate. While this test can't capture the true strength of adhesive bonds that build over time, it does provide a good initial comparison between PSAs.

TACK:

The immediate strength of an adhesive is judged through a pair of tests. The rolling ball test measures how far a stainless-steel ball rolls on a strip of adhesive. A probe or loop tack test lowers an adhesive sample to a touch probe and measures the force it takes to pull the adhesive away after contact. Both tests provide an idea of the initial stickiness of adhesives right after touch a substrate without external pressure.

SHEAR:

The cohesive strength of an adhesive is measured with a static shear test. This test requires a person to take a one-inch piece of adhesive and attaches it to a suspended substrate panel. The tape is then weighed down by a load weight. Once the load is attached, you measure the amount of time it takes for the adhesive to mover a set distance across the panel.

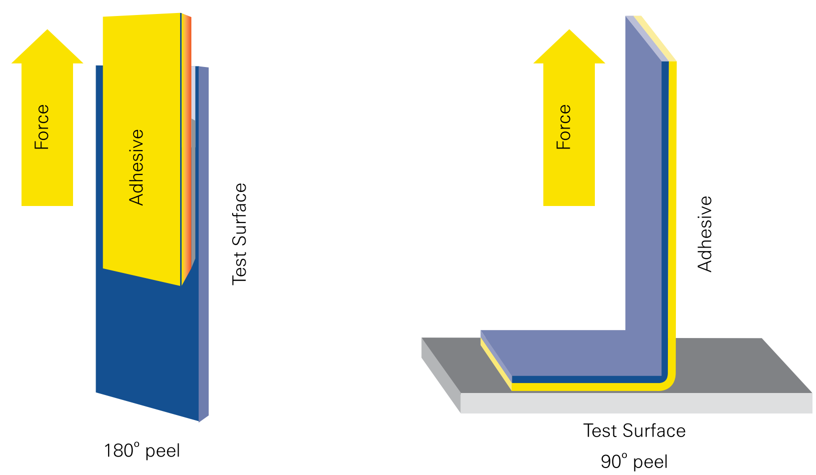


Fig A. Peel tests

CHOOSE
THE RIGHT PSAs
FOR YOUR DIE CUT COMPONENTS

A little knowledge can make a huge difference for your die cut PSA parts. By understanding the potential deterrents to adhesive success, you can identify all the factors that can make your parts fail and plan accordingly.

Of course, identifying potential challenges is one step. The next is to work with a flexible materials converter and precision die cutter that can supply your business with the right die cut PSAs for your specific applications. JBC Technologies works with companies during the design phase to prototype and test die cut parts so that you can evaluate PSA performance. Our rapid prototyping turns CAD data into finished parts without tooling, allowing you to perform engineering trials before you make a big investment.

Not only will JBC help you find the best PSA for your exact needs and budget, we also strive to help our customers solve problems and overcome design and efficiency challenges. We work with you to analyze your supply chain and manufacture these parts in creative ways that get our die-cut adhesives onto your parts in the most efficient manner.

ARE YOU
READY TO PARTNER
with JBC to help prevent PSA failure and improve supply chain efficiency?

Contact JBC today at 440-327-4522.
jbc-tech.com