



Adhesive and Tape Solutions for Hard to Bond Materials

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As engineers seek to design products that are durable, high quality, long lasting, but still affordable, they are turning increasingly to materials beyond traditional metals for components and assemblies. These alternate materials can include a wide range of plastics, composites and rubbers in multiple forms including molded parts and foams.

By using plastics and polymeric-based composites to replace all-metal designs, designers have found a way to increase durability and aesthetic value in their assemblies while decreasing weight and cost.

For example, plastic materials including composites are lighter than traditional metal, so using them will typically result in lighter weight product. Also, plastics can decrease production costs because less finishing or painting is typically required with these substrates than with metals.

Despite the benefits of using plastics and polymeric-based composites, mechanical and thermal joining methods risk damaging these substrates. With that in mind, designers rely on adhesives and tapes as an alternative to those more traditional joining methods. This raises another set of challenges as some plastics, rubbers, foams and oily metals can be difficult to bond with adhesives and tapes.

This article will highlight some of the most common bonding challenges, and provide suggested solutions to incorporate these materials into today's designs.

Low Surface Energy (LSE) Plastics

LSE plastics and composites are becoming quite commonly used in assemblies. A few examples of these LSE materials include polyolefin (TPO); HDPE; PP; and some powder coats. These materials can be joined by thermal methods such as friction or ultrasonic welding, but those methods can require extensive capital and ongoing tooling which may not be ideal for shorter runs or frequent design changes. Also, there are some limitations in the geometry of joints, which could require tedious finishing steps, or lead the manufacturer to compromise on the appearance of the joined parts. Adhesive bonding is therefore desirable, but these materials are difficult to bond with adhesives and tapes. Surface modification techniques including primers, plasma or corona treatments have traditionally been used to energize the surface area. However, these methods can add unnecessary costs and safety issues.

Specialty adhesives such as 3M™ Scotch-Weld™ Structural Plastic Adhesive DP8010 Blue

can bond these materials in a variety of applications – from medical equipment to panels for small engine-based tools. Using a specialty adhesive is preferable to welding or other traditional bonding methods because changes can be made on the fly, and substrate combination options are virtually unlimited.

Pressure sensitive adhesives such as 3M™ 300LSE have been specifically designed for successful bonding to Polypropylene and most other plastics. They feature quick bonding performance, a wide window of suitable substrates, and a high tolerance of heat-humidity, and other environmental stress factors. 3M™ 300LSE is a proven solution for plastics assembly in a wide variety of markets, including electronics and automotive.

Rubber

Rubbers are used for all types of gaskets, shock-absorbing pads on equipment, and hosing. However, rubbers, especially ethylene propylene diene monomer (EPDM), are fairly difficult to bond and may require adhesives or primers with high solvent content.

That said, even rubbers such as EPDM and silicone could be bonded with a cyanoacrylate adhesive. This option is most suited to fairly small parts, typically only a few inches in surface area.

Larger rubber pads can often be securely attached to panels with a spray adhesive or tape. Typically those rubber pads or gaskets are blends of neoprene, nitrile or synthetic rubber that provide the desired properties. Because the rubber blend can vary greatly, identifying the best adhesive fit can be challenging. The base rubber along with tackifiers and solvent blends are key concerns when choosing an adhesive that can make a strong bond.

For a no mess attachment process, gaskets – even those with foamed rubber can be laminated with a transfer tape or a heat-activated acrylic foam tape. These tapes provide instant adhesion to the mating substrate in the final application.

Expanded Foam Panels

Expanded foam panels or shapes are commonly used in construction, transportation, and packaging because they are low weight, rigid, and have ideal insulation properties. They are commonly made of expanded polystyrene (EPS) or expanded polyvinyl chloride (EPVC). While not extremely low in surface energy, these foams are hard to bond because heat or solvents can easily damage them, and traditional bonding methods may cause them to cavitate.

However, expanded foams can be bonded using appropriate solvent- or water-based spray adhesives, low temperature melts, or pressure sensitive tapes. These adhesive

options are non-destructive and provide immediate tack with the chosen substrate, depending on application needs.

EPS foam in particular requires that the adhesive need only be as strong as the substrate, which often makes a lower-strength spray adhesive an appropriate choice. Spray adhesives using propellants and solvents that will not dissolve the EPS are critical. Additionally, a web spray pattern allows the adhesive to stand up on the surface and overcome irregularities and surface roughness from EPS beads that are used in construction. High temperatures from sun exposure can be a problem for insulation attachments on transportation vehicles, but the proper adhesive will allow the insulation to withstand these conditions.

Another option for adhering EPS foam is a low temperature melt adhesive. Standard hot melt adhesives are applied at temperatures around 350°F, which can melt expanded foam structures. Low temperature melts use polymer blends that melt at lower temperatures, but still provide the same heat resistance values as standard hot melt counterparts. Specialty low temperature melt adhesives can deliver exceptional control on three-dimensional or curved surfaces, and provide gap filling on rough or porous surfaces. Low temperature melts can adhere in seconds for a durable bond, and can be used in furniture and product assembly, packaging applications, foam spacers and countertop displays.

Oily Metal

Oily metal surfaces comprise another class of hard to bond surfaces. Production staffs typically prefer to join these substances with mechanical methods (e.g. rivets, screws) or thermal methods (welding) prior to a wash before painting. Partially this is because the use of traditional adhesives and tapes typically requires cleaning to remove oils from the metal surfaces prior to joining creating extra work.

Two-part structural acrylic adhesives are two-part formulations that provide fast cure and allow bonding to multiple substrates. These adhesives have the ability to absorb most processing and cutting oils from the surface of metals, which allows metals to be bonded without being cleaned first. This saves time during manufacturing because bonding can happen prior to final cleaning before the painting process. This method is often used in bonding metal frames for specialty vehicles and equipment of all types, such as trailers, equipment enclosures, sporting vehicles, etc.

Oily metals also present a significant bonding challenge for pressure sensitive adhesive bonds, because oily contamination on the substrate surface can interfere with robust bond formation. There are select classes of adhesives that are developed to tolerate oily contamination, including types similar to 3M 300LSE. This adhesive type has the unique ability to absorb surface oils and enable bond formation without extensive surface preparation. This allows the attachment of trim, labels, etc easily and quickly.

Choosing the right partner

Constant innovation by suppliers in adhesive development allows designers to manufacture lower cost, higher performing, lighter weight and more durable products than ever before. The universe of adhesives and tapes is expansive, so it is important to ask the following questions when deciding on the appropriate adhesive to use:

1. Assembly – What joints are necessary to construct the product?
2. Substrate – What are the materials that need to be assembled?
3. Process – How can adhesive or tape bonding be implemented in the manufacturing process?
4. End-use – How and where is the final product used?
5. Cost – Can improvements be made in the assembly process by using adhesives?

Another important factor to consider is joint designs that put the adhesive bond under shear, tension or compressive forces, as they are optimal for adhesive and tape bonding applications. These types of joints will spread the stresses over the entire bonded area, allowing all of the adhesive or tape to contribute to the joint strength. They also prevent concentration of force on a small area of the substrates. Conversely, designs that allow stresses to peel or pry the substrates apart will concentrate more stress at the leading edges of the peel or pry locations. These joints can have lower strength, but may still work for the application, especially if the substrates are weaker. Optimum bondline thickness will vary by application and adhesive; it is best to consult with your adhesive and tape supplier's technical staff to determine what is suitable for your design. FEA analysis and/or prototyping can assist in refining the specifics of joint design.

Transitioning to adhesives from thermal welding or mechanical fasteners can often come with a qualification period for the engineer. He or she will need to test out different types of adhesives with varying qualities to determine which is best for the project, especially when faced with hard to bond substrates. To reduce time and costs associated with this qualification phase, it's important to choose a partner that offers a wide range of technologies and will help narrow down options. The right provider will also give advice on testing protocol and perform screening tests, to help the engineer avoid incurring additional expense, or wasting money and time on adhesives that will not fit a particular project.

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