Freedom to Design with Adhesives and Bonding Tapes

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Strength, durability, longevity and versatility. These are all words that describe the functionality of adhesives and bonding tapes in assembly, yet some manufacturers still doubt their effectiveness in design.

Manufacturers face plenty of challenges in assembly, many of which can be solved by using adhesive or bonding tape solutions. These challenges include bonding small parts, lightweighting, overcoming design constraints presented by mechanical fasteners, and considering environmental impacts while increasing product life cycle.

Despite lingering reluctance, more people are turning to adhesives and bonding tapes as ideal alternatives to traditional joining methods to solve challenges for all sorts of applications, particularly plastic bonding.

Manufacturers have found that adhesives and bonding tapes provide better durability, improved aesthetic value, and a wider variety of options in design than more traditional mechanical fasteners or attachments, especially when working with plastic materials that may have low surface energy.

Some plastic materials are intrinsically difficult to bond with a structural adhesive or high performance bonding tape, but using the right adhesive or bonding tape can provide a solution for joining these tough materials, while reducing or eliminating tedious surface preparation steps. Adhesives and bonding tapes can interact in unique ways with various plastic materials in order to create a robust, lasting bond.

Mechanical Fasteners vs. Adhesives & Bonding Tapes in Bonding Plastics

Though manufacturers are often comfortable using traditional joining methods, these are often not the best options for joining plastic in design.

In using mechanical fasteners, like rivets and bolts, the manufacturer risks damaging the plastic because all of the load-bearing stress is held at one small point where the fastener is. Mechanical attachments, such as clips, screws, etc., can be used with almost any surface, but they require additional steps to mold or create features for the attachment. Additionally, using these attachments can lead to stress concentrations, which may cause the plastic to crack and/or fail prematurely, or result in unsightly surfaces.

Adhesives and bonding tapes are able to distribute the stresses across the entire bonded joint area, evenly distributing the load. This distribution of stress ultimately leads to higher strength joints, especially with thinner substrates that are more prone to damage and fatigue failure induced by force-concentrating joining methods such as rivets or bolts.

End users often consider the appearance of products when making a purchase decision. Mechanical fasteners or attachments are generally very visible when used to connect two substrates. The obvious presence of fasteners interrupts the aesthetic of a product by calling

attention to the joining points. Adhesives and bonding tapes, on the other hand, are virtually invisible and provide a cohesive, polished finish.

To avoid mechanical fasteners and their limitations, some manufacturers try to use techniques like friction or ultrasound welding to join plastics, but these methods often incur extra costs, and may require extensive tooling. These issues are especially inconvenient for products that are updated frequently or have short runs. Furthermore, these methods may not work with all combinations of plastics or composites. Solvent welding is also an option, however that method typically relies on hazardous or noxious solvents. It can also lead to weakening of the substrates or unsightly effects such as crazing.

Conversely, adhesives and bonding tapes are simple and easy to apply, and can be pre-applied in areas that would be inaccessible to mechanical fasteners or with geometries not suitable to friction or ultrasonic welding, opening up new options for designing with plastic.

Adhering to Plastic

There are a few different mechanisms that allow adhesives and bonding tapes to bond plastic materials.

First, adhesives and bonding tapes can interlock mechanically with a substrate's surface when the adhesive or bonding tape flows into the microscopic texture of the surface. After dwell or cure, it is difficult to remove the adhesive or tape because it's caught in the topography of the surface.

For some adhesives, even higher strength plastic bonds can be achieved by creating a network of cured adhesive within the plastic. Some types of liquid adhesives are capable of swelling the plastic, allowing diffusion of uncured monomer into the plastic surface (similar to the action of solvent welding adhesives, but with drastically reduced volatile content). The adhesive can then cure to form a robust bond with the plastic, because the adhesive polymer chains are actually entangled the plastic substrate itself.

In addition to these factors, various chemical interactions between the adhesive and the surfaces being bonded also contribute to adhesive strength—from weaker interactions such as Van der Waals forces to covalent bonds.

All of these bonding mechanisms are dependent upon forming intimate contact between the adhesive and the surface of the bulk plastic or other substrate being bonded. This can be an issue when very low surface energy substrates resist the flow of adhesives or tapes over the surfaces.

Bonding Hard-to-Bond Plastic

Adhesives and bonding tapes are proven solutions to problems that mechanical fasteners can present, however some plastic materials are naturally more difficult to bond due to their chemical composition. These plastics are described as having low surface energy (LSE).

For optimum adhesion, the adhesive or bonding tape must flow, or "wet out," on bonding surface, providing close contact and maximization of the attractive forces between the adhesive or bonding tape and the substrate. These low surface energy plastics are typically difficult to wet out; so standard bond mechanisms reviewed above cannot function optimally.

Examples of LSE materials are polyolefin (polypropylene, polyethylene, TPO), silicone, acetyl, polyester (PBT), polystyrene, PTFE, as well as some paints and coatings (PVDF). To bond these materials, extensive surface preparation steps such as priming, corona, flame or plasma treatments, acid etching, or solvent based adhesion promoters are typically required.

The goals of these treatments are to create a higher surface energy layer that allows better wet out of adhesives and tapes and additional possibility for surface interactions, and hence better bonding. However, these surface treatments can incur additional costs, complexity, and may present environmental concerns or safety issues.

Luckily, adhesive technology has advanced to the point where high performance adhesives and bonding tapes are available that can bond low surface energy (LSE) plastics and minimize tedious surface preparation steps.

Adhesive & Bonding Tape Solutions for Bonding Plastics

Some specially developed two-part structural adhesives are able to bond LSE plastics without priming or surface treatments in numerous applications – from decorative panels to protective equipment. These adhesives also create bonds that can withstand weathering. These products are designed to have higher load-bearing capabilities, especially useful for smaller joints that will experience high stress. Structural adhesives allow for positioning activities such as aligning or inserting parts prior to cure. Their chief disadvantage is that, like other two part adhesives, they require some dwell to build initial strength.

Another solution for bonding LSE plastics is using specialized pressure sensitive bonding tapes. Unlike adhesives, pressure sensitive adhesives do not cure or undergo a chemical change when applied. These bonding tapes adhere immediately when pressure is applied, but continue to flow onto the surface, achieving an even higher level of strength over time. These bonding tapes are typically formulated to be a layer of pressure sensitive adhesive, sometimes with a reinforcing scrim internal to the tape. They are supplied on liners for ease of handling.

Another advantage of bonding tapes is that you do not have to bond the adhesive to both substrates at the same time. The bonding tape can be applied to the first substrate without removal of the liner. At a later time, the liner is removed and the part is applied to the second substrate. This is especially helpful when supplying parts to an end customer or end user.

New acrylic pressure sensitive adhesive technology allows manufacturers to bond to a wide variety of LSE plastics without priming or surface energization. These acrylics are ideal for light to medium-weight bonding applications with low static loads, especially where easy, quick assembly and excellent aesthetics are desired. They do require fairly thin and consistent bond lines, however, and do not provide structural load-bearing strength.

Adhesives & Bonding Tapes Provide Undeniable Strength

Mechanical fasteners and attachments or welding are traditional methods that manufacturers are used to, but modern design and sustainability factors render these methods less effective than bonding with adhesives and tapes.

Not only do adhesives and bonding tapes provide solutions to the aesthetic and functional disadvantages of traditional joining methods, they are now also able to join hard-to-bond materials and even eliminate surface preparation steps such as priming or surface activation.

Though some manufacturers may be skeptical of adhesives and tapes, their strength is often drastically underestimated. With the huge amount of adhesives technology that has been developed, there is something available for every application imaginable. From thin, aesthetic mounting of trims and labels to high load bearing insertions in parts that will see high stresses, there are adhesive or tape options for virtually every application.

Strength, durability, longevity, versatility – see what adhesives and bonding tapes could do for you and your application.

Visit 3M.com/assemblysolutions for more information on how 3M can help solve your assembly challenge.

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