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Elastomeric Adhesives for Flexible Bonding Solutions

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I am sitting in the train looking out of the window and see photovoltaic parks. At the destination point, I look upwards and notice a glass elevator, and think about how all of these things are made. Are there any structural adhesive applications? Can I use flexible products for these types of applications? Yes and yes! Flexible adhesives are used to bond the windows in the train body, the elevator wall elements, and the solar panels.

Within the last few decades, adhesive technology has given engineers new opportunities to optimize and innovate their constructions and final goods. The benefits of adhesives include increasing safety, saving energy and material due to lighter constructions, giving more design freedom as different materials can be joined, reducing the cycle time during production, and installing a reliable process by using fully automated production processes.

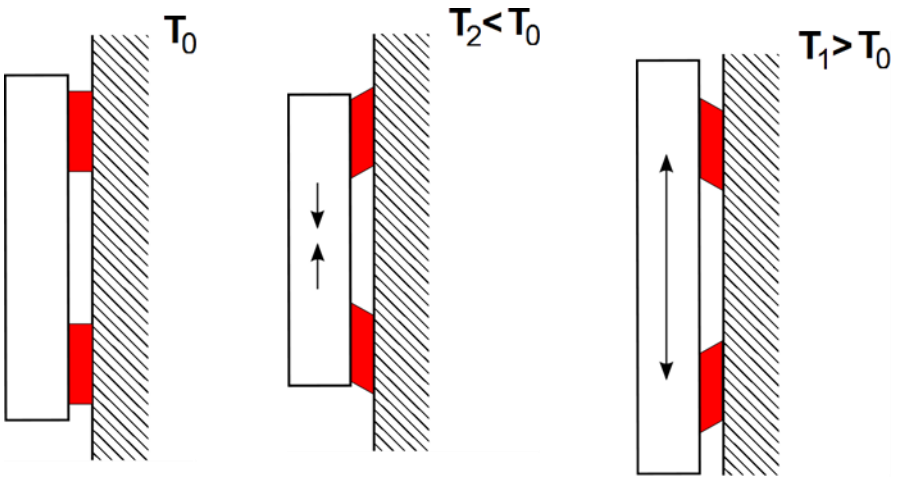
Before giving examples for the above-mentioned benefits, it's important to explain some basic concepts of flexible adhesive bonding.

Flexible bonding means on one hand that a minimum of two parts are bonded together to hold in place. On the other hand, it means that these parts are bonded together with a flexible, perhaps rubber-like adhesive to allow the bonded parts to tolerate relative movements.

These movements will be influenced by the type of materials being joined as well as the operating environment such as changes in ambient temperature. For example, in window bonding applications, the coefficient of thermal expansion of the metal frame is higher than that of the glass pane. As a consequence, movement is induced by changes in temperature as the metal expands or contracts more than the glass. These temperature changes may be relatively modest (e.g., indoor applications or day/night cycles) or more significant (e.g., outdoor applications subject to seasonal weather patterns). The greater the change in temperature, the larger the relative movement.

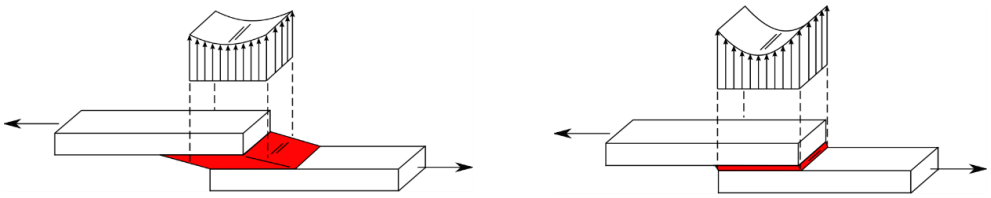
The use of a flexible adhesive reduces the stress within the construction as the adhesive absorbs the movements of the parts. An important point is that due to a uniform product application (bead application vs. single screws) over the bond area, the stress distribution onto the parts is more even and stress peaks are lower (less risk that parts will be deformed or break).

To get these benefits for the construction, it is necessary to have a gap between the two parts that can be filled with a flexible adhesive to get high elasticity and even stress distribution in the joint.



1. Bonding = Parts to be bonded
2. Elastic = *While relative part movements are tolerated*

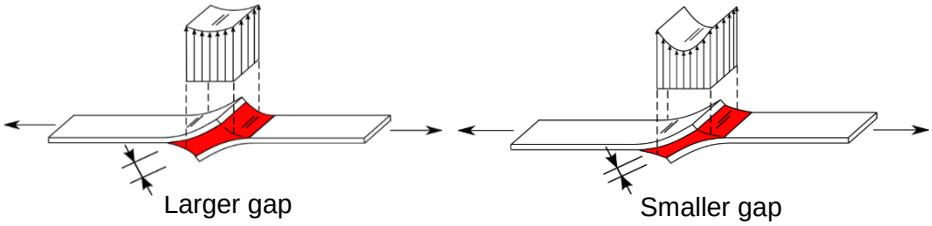
To find the right bond design, it is mandatory to get in contact with experienced experts who are able to calculate the joint dimensions (needed bond gap) under the different ambient conditions, like the size of the parts; the properties of the used materials (CTE = Coefficient of Thermal Expansion); the temperature range where the final good will be used (indoor/outdoor; summer/winter); the mechanical forces that the parts will experience (snow accumulation, wind, angle of mounted parts); and the adhesive properties (strength/elongation of the cured product).



Elastic bonding

Non-elastic bonding

In addition to calculating the joint dimensions, it is also important to think about the design of the bond line for aesthetics; the compatibility of the adhesive and the substrates; environmental factors, such as water, snow, dust, dirt and chemicals; and the durability needed for the bonded joint. For example, does the final product need to last for many years such as a solar panel? Other things to consider include applying the adhesive in a fully automated process (serial production) and following safety procedures for application.

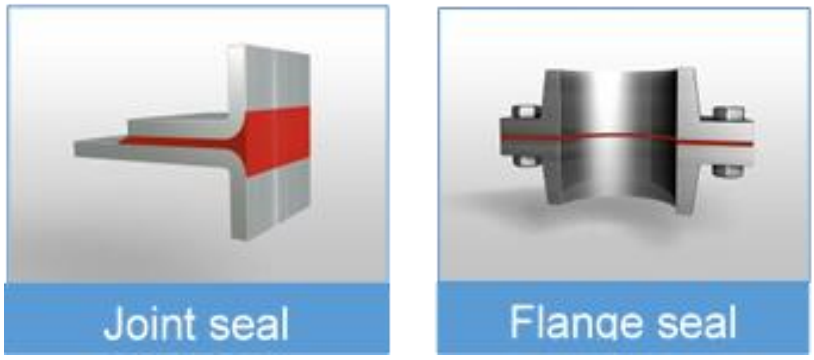


Larger gap

Smaller gap

1. Larger gap = More even stress distribution
2. Larger gap = Higher elasticity

A joint or a flange seal are typical examples of bond design



The use of adhesives in manufacturing provides benefits to manufacturers as well as advantages to end customers using the products.

Window bonding:

In the past, windows and glass planes found in automobiles and trains were plugged into a groove of a rubber profile and, with a similar groove, mounted into the car or train body. The application was done manually and for every single type of window, an extra rubber profile was needed.

Today, using modern flexible adhesive, the window is bonded into the car or train body. The adhesive is applied by robot and the window is also mounted automatically. Due to the presence of an adhesive bond between the body panels and the glass, the glass can take on structural functions – and overall, the vehicle becomes stiffer. As a result, it is possible to reduce the thickness of the body panels while maintaining the original vehicle stiffness. Reducing the amount of metal makes the car or train lighter and less energy is needed to run them. Reducing the carbon footprint continues to be an important objective in the manufacturing of vehicles.

Adhesives for window bonding create a win-win situation for the manufacturer who produces faster with an automated process and cheaper using less material; and for the end user who uses less energy to drive the vehicle. The use of adhesives in modern trains also provides aesthetic benefits by creating an even-looking surface without edges or grooves.

Maintenance is possible in an easy way as only one adhesive is needed regardless of the shape of the window (no storage of different rubber profiles). A damaged window can be removed by cutting the adhesive with a knife. The fresh adhesive can be applied onto the rest of the cut bead (not necessary to remove all residues of the old adhesive), the new window will be set in: done. Products are available where the car can be driven away after one hour.

Solar panels:

To produce sustainable renewable energy, the solar panels (thermal, electricity) give the possibility of coming closer to a fossil-free energy production. For this technology, mainly metal frames are bonded together with glass panes. The bonding strength of the adhesive gives a durability connection of the materials for many years under harsh conditions. The solar panels are mounted on house roofs in different angles, on vertical walls or on racks which track the sun's movement to optimize exposure. All year, they are in contact with outside weathering conditions like wind, snow, rain and hail, and are constantly exposed to the damaging effects of ultraviolet (UV) radiation.

The solar panels bend in these conditions and the flexible adhesive tolerates these movements; in that case, the panels can produce energy over a long time. The production of the panels can be done in a fully automated process which means reliable panels can be produced at an acceptable price. By using adhesives in different colours, the bond line is not visible and gives the complete panel an aesthetic appearance.

Elevators:

Modern high-rise buildings, especially those in inner-city developments, are placing ever-increasing demands on the design and performance of elevators. The main function for an elevator is its reliable and safe operation. In addition, new elevator systems should need less energy during use – and the visual aspect is important, too. With the use of adhesives, the construction weight of the elevator car can be reduced to save material and operating expenses can be reduced during the lifetime of the elevator. Furthermore, bonding applications can speed up the production process and give more freedom for the elevator design.

Elevators can be found everywhere – in public buildings, hotels, hospitals, railway stations, department stores and residential buildings. In the production and also in the maintenance of an elevator system, it is important that it will be a safe and reliable transportation system. This will be achieved by using high-quality materials and a high performance adhesive system for joining and assembly.

The use of adhesives enables elevator manufacturers to save on material – reducing the weight of a five-person car, for example, by up to 20 percent. With the use of adhesives, the car walls can be made out of thinner metal panels. These are stiffened on the outside by bonded omega profiles to ensure stability.

Traditionally, the reinforcing profiles are welded or riveted in place. With bonding, the car walls can be used as a final surface without the need to cover them due to visible spot welding or screws and rivets. Less energy is consumed with adhesives than with welding, and no special safety precautions are required at the assembly stage. Finally, bonded panels show a better noise and vibration absorption capacity than other panels, which has a noticeable impact in cabin comfort.

Because of the reduced car weight, the elevator system likewise requires less running power. The design options are also greater in scope. Adhesive bonding opens the door to many new styling possibilities, involving a broader range of materials such as glass, plastics or LED installations. In addition, bonding enables elevator car builders to simplify the assembly process, as the material combination is not limited to “weldable” substrates. On the other side, interior cladding is not a must if the appearance of the selected panel skin complies with the end customer’s aesthetic requirements.
The use of rivets or screws to fix the stiffening profiles also creates holes, which in turn increase the susceptibility of the mating metal components to corrosion. Adhesive bonding offers an enormous advantage here as it leaves the metal completely unimpaired.

Adhesive Technologies

The typical adhesive technologies used for flexible bonding applications are polyurethane (PUR), silane modified polymer (SMP) and silicone (Si).

Every technology has its own characteristics, some overlapping properties, and some specialties which only can be found in the single technology.

Polyurethanes	Silane Modified Polyamers	Silicones
• Slightly flexible bonding • 1- or 2-component - solution • Excellent gap filling (2C) • High strength • For medium to large surfaces • Good chemical resistance	• Flexible bonding • 1- or 2-component solution • Wide primerless adhesion on many substrates • High impact strength • Good UV and weather resistance	• Flexible bonding • 1- or 2-component solution • Outstanding temperature and UV resistance • Excellent chemical resistance

The PURs can provide good strength, are over-paintable and have a good price ratio. SMPs have good temperature- and chemical-resistance, and also have a very good adhesion profile on many substrates without using any additional surface preparation like primers.

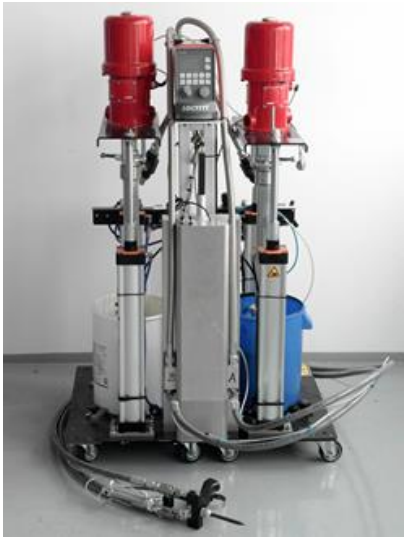
Silicones have outstanding temperature-, UV- and chemical-resistance. The products are available in one-component and two-component systems. One-component adhesives are easy to apply and need longer time to cure. Two-component systems have to be pre-mixed and cure very fast.

Sometimes, it is necessary to increase the adhesion behaviour of the adhesive to the substrate. A standard cleaning process with, for example, a solvent- or water-based cleaner may be not enough. To increase the adhesion to the substrate and to get a better durability of the joint, different primers are available.

It is also possible to use surface treatment methods like corona or plasma to create new active chemical groups onto the surface. Special plasma treatment (mainly atmospheric or vacuum) is very popular for serial application as it is easy to install and gives very good adhesion properties.

Metal parts can be sandblasted to increase the contact area and refresh the surface prior to bonding. You have to keep in mind that sandblasting is not cleaning. Cleaning means the parts have to be cleaned (remove oil, grease, dust, then the sandblasting process follows). After that, the parts have to be cleaned again (remove the dust from the sandblasted material). The time between sandblasting and bonding should be as short as possible, as the metal starts corrosion immediately after sandblasting.

Application can be done with a manually handheld applicator (mechanically or pneumatic). This application method is recommended for first trial, single applications, ramp-up serial application and small serial application.



To automate the bonding process, there are bigger pack sizes available such as pails or drums. Customized systems are available that can fulfill specific requirements.

Henkel provides the complete value chain for manufacturers, maintenance firms and components suppliers – opening up new opportunities for their own products, processes and services.

Among the flexible bonding adhesive technologies, Henkel offers anaerobic and anti-seize grades for mechanics such as bearings, flanges and bolts; cyanoacrylates for fast bonding of rubber and plastic parts and all sort of small elements; and rigid structural bonding adhesives like epoxies, acrylics and polyurethanes where high loads have to be transferred. For additional information, you can contact a Henkel adhesive specialist who will introduce you to the world of bonding.

For technical enquiries, contact Loctite Technical Hotline 1300 885 556 or email loctite.enquiries@henkel.com