Innovative light-curing structural bonding solution

tesa® L-tape:
Maximizing design freedom of electronic devices

Abstract

Liquid adhesives are widely used for industrial bonding tasks as they provide high bonding strength for most applications. However, with the continuing trend toward more complex product designs of electronic devices and the need for more efficient assembly processes, liquid adhesives are facing certain limitations. Long curing times can slow down the assembly process and achieving clean bonds on complex bonding areas can be a significant challenge for liquid adhesives. tesa® L-tape combines the efficient handling properties of pressure-sensitive adhesives with the structural bonding performance of high-performance liquid adhesives. Thus, this makes tesa® L-tape applicable for demanding applications where liquid adhesives can't be used.

Introduction

One of the most widely used joining techniques in the production of consumer electronic devices is adhesive bonding. The use of liquid adhesives or filmic pressure-sensitive adhesives (PSA) allows slim and lightweight designs, fast processing cycles, and the option to quickly separate bonded parts for the purpose of repair and recycling.

While liquid adhesives can provide high ultimate bonding strengths, they come with several processing challenges, such as the need to control oozing of the liquid out of bond lines and uneven coverage after curing. Additionally, liquid adhesives are, by definition, very soft when the parts are joined, and require clamping and fixation measures until the adhesive has finally developed sufficient stiffness. All this can change relatively simple bonding tasks into rather complex and time-consuming processes.

Compared to liquid adhesives, filmic PSAs can be conveniently applied in the required shapes and geometries, and provide high immediate bonding strength directly after joining, so that the bonding process can be very clean and fast. On the other hand, adhesive strength of PSAs usually does not reach the high ultimate bond strength of liquid adhesives after curing.

As bonding areas become smaller and slimmer due to designs trends in electronic devices, requirements for adhesives, in terms of high and reliable bonding strength, continuously increase, so that for demanding bonding tasks even high-performance PSA tapes reach their limits and reactive structural bonding tapes are needed. In contrast to conventional PSA tapes, these filmic adhesives are activated and cured in an additional step to further increase cohesion and bonding strength.

This additional curing of structural bonding tapes is most commonly triggered thermally by joining the parts to be bonded at elevated temperature and pressure. Available solutions in the market come with the limitations that those adhesives either need to be formulated in a way that makes them non-tacky at ambient conditions or in a way that requires cold storage. In the first case, additional heating steps are required to fix the tape onto one of the parts before final bonding. For adhesives that need to be stored at low temperatures, there are always risks of partial pre-curing, along with all the challenges of a strictly controlled supply chain and short shelf life.

tesa® L-tape now combines the advantages of PSA tapes and liquid adhesives: adhesion is good at the same level as PSA tape after bonding, and is then improved to the same level as structural adhesives by an internal curing reaction (Fig. 1). This allows easy handling without compromising on high ultimate adhesion strength.

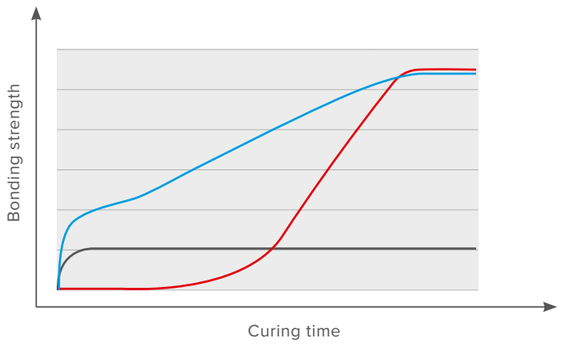
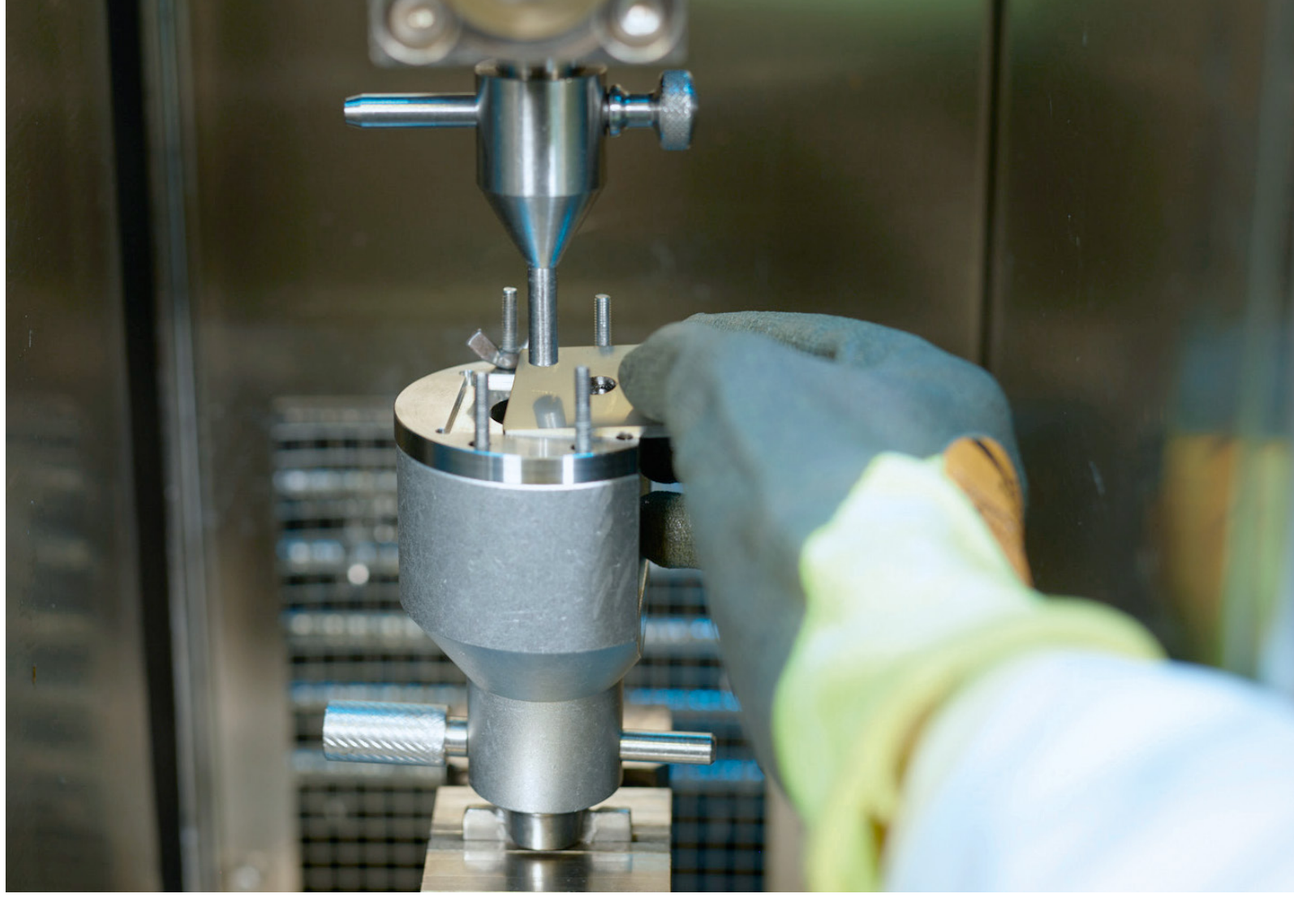


Fig. 1

Schematic diagram of the curing time of different adhesive technologies



Product description

tesa® L-tape combines the advantages of simple and convenient processability of a PSA tape – such as preparation of adhesive geometries with the smallest dimensions, tackiness at ambient conditions, and high thermal stability – with the advantages of increased bonding performance of structural bonding tapes or liquid adhesives.

This is achieved by a newly developed formulation which is sufficiently soft in the inactivated form, so that it is tacky and allows for easy processing in combination with an intermediate backing layer, as is the case in PSA tapes (Figure 2).

Directly before or after the final joining of the parts, the adhesive tape is activated by simple irradiation with standard-range UV or blue light (see part 2 – processing).

In the uncured state, the adhesive consists of a polymer matrix and curable acrylate components. The formulation is balanced in a way that provides PSA-like adhesion and is dimensionally stable to allow easy cutting and handling. Upon irradiation with curing light, a photoinitiator activates the curing of the acrylate components, making the polymer network denser and building up higher cohesion. This reaction takes place at room temperature at sufficient speed, so that ultimate bonding strength levels are achieved within 24 hours (Figure 3).

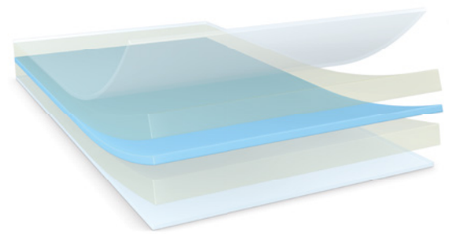
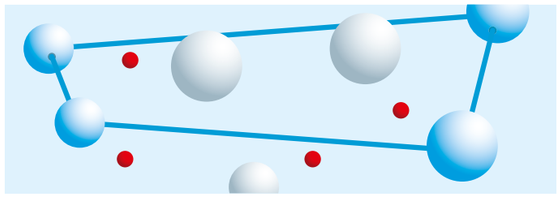


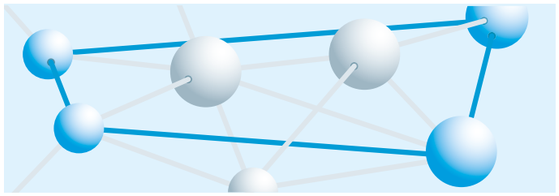
Fig. 2

Product design of tesa® L-tape

Uncured



Cured



tesa® L-tape consists of three main components:

- The **base polymer** that gives the tape **dimensional stability**
- The **reactive acrylate** that has not formed a network with the base polymer yet. This gives the tape high **flexibility** and enables excellent **substrate wetting**
- The **photoinitiator** that triggers the **cross-linking** reaction once the tape is exposed to curing light

With light irradiation, the reactive acrylate forms a **dense network** with the base polymer. This gives tesa® L-tape **high cohesion** and provides strong and reliable **bonding performance**.

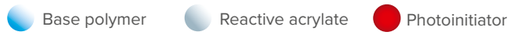


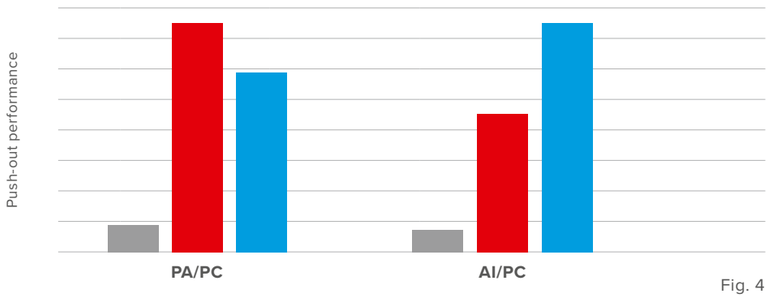
Fig. 3

The curing reaction is designed to allow an open time of at least five minutes after activation before joining the two parts (see part 2 – processing). This offers the big advantage that activation can be done even before bonding, so that any part can be bonded independently of color and light transmissibility. After bonding, the curing reaction proceeds at ambient conditions and leads to an increase in adhesive strength that is on the same level as high-performance liquid adhesives. To be able to meet high demands on impact resistance, tesa® L-tape is designed in a way that maintains sufficient flexibility and avoids the adhesive becoming too stiff and brittle after curing.

In terms of adhesive performance, tesa® L-tape significantly exceeds the bonding strength of a high-performance PSA and achieves the same level as liquid adhesives. Push-out strength on plastics or metal–plastic combinations, such as PA to PC or Al to PC, reaches high levels of up to 7 MPa.

The product design of tesa® L-tape can offer additional benefits in reworking and debonding at end-of-life or for repair. The combination of high cohesion and a stabilizing PET backing helps to enable removal after heat-induced separation of bonded parts.

Performance PA vs. Al



Comparison of bonding strengths of different adhesive technologies

Fig. 4

Application process description

tesa® L-tape can be handled and processed like any other PSA tape and cut into desired geometries with very small widths. Extra attention only needs to be taken in terms of avoiding exposure to light with a wavelength < 470 nm to prevent premature initiation of curing. It is not necessary to store and transport rolls or processed parts at controlled low temperatures.

Die-cuts of the tape can be applied to the surface of the component using established processes for PSA tapes using with slight pressure. The resting time of five minutes after irradiation allows flexibility in the activation process to suit different needs. The various options are described in Figures 5, 6 and 7:

Fig. 5

Activation on die-cut level before bonding
The adhesive is irradiated before applying it to either of the two parts. After irradiation, the die-cut is placed onto the first part, and subsequently the other side of the adhesive is adhered to the second part. Both steps need to be done within five minutes. After bonding, the curing proceeds and is finished after 24 hours.

Activation after bonding of the first part
The tacky adhesive die-cut is placed onto the first part. This step may be done during final assembly of both parts or in advance at an earlier stage. Before attaching the second part, the adhesive is activated by curing light. By activating the adhesive before bonding, parts do not need to be transparent. Again, final curing is done within 24 hours.

Fig. 6

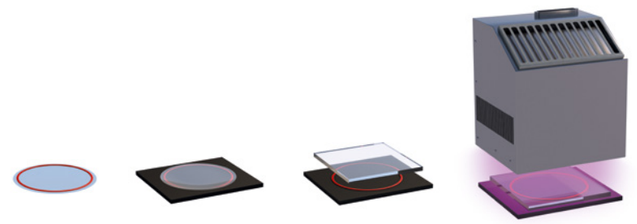


Fig. 7

Activation after bonding – only for transparent substrates
For glass or other transparent parts, an additional option is activation after bonding. In this case, both parts are joined just as with regular PSAs. Irradiation then takes place after bonding.

Applications

The versatile bonding process and the easy handling make tesa® L-tape extremely valuable in assembly processes with high demands on efficiency and quality. Combined with high bonding strength and reliable performance, it is ideally suited for the most demanding applications in the consumer electronics industry. tesa® L-tape can be used for most mounting applications where thermally triggered structural bonding tapes cannot be used due to temperature restrictions or if the bonding performance of PSAs reaches its limits. Furthermore, tesa® L-tape is an alternative solution whenever liquid adhesives cannot be used due to their known drawbacks in the bonding process.

Mounting applications in electronic devices are becoming increasingly demanding. Bonding areas of a submillimeter width have to withstand the harshest conditions, such as extreme temperatures, elevated humidity, water, sweat, perfumes and more, to protect enclosed electronic components. The conformability and the high adhesion of tesa® L-tape to multiple surfaces provide reliable bonding for displays, microphones, and speakers in electronic devices. The excellent shock absorption helps to prevent glass damage from shocks or vibrations in edge-to-edge devices.

Back-cover mounting on smartphones

Lens mounting on smartwatches

Mounting of components in smartphones

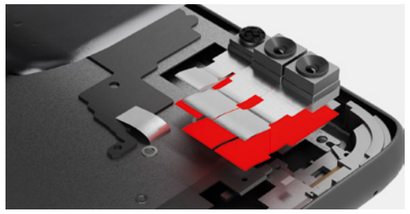


Fig. 8

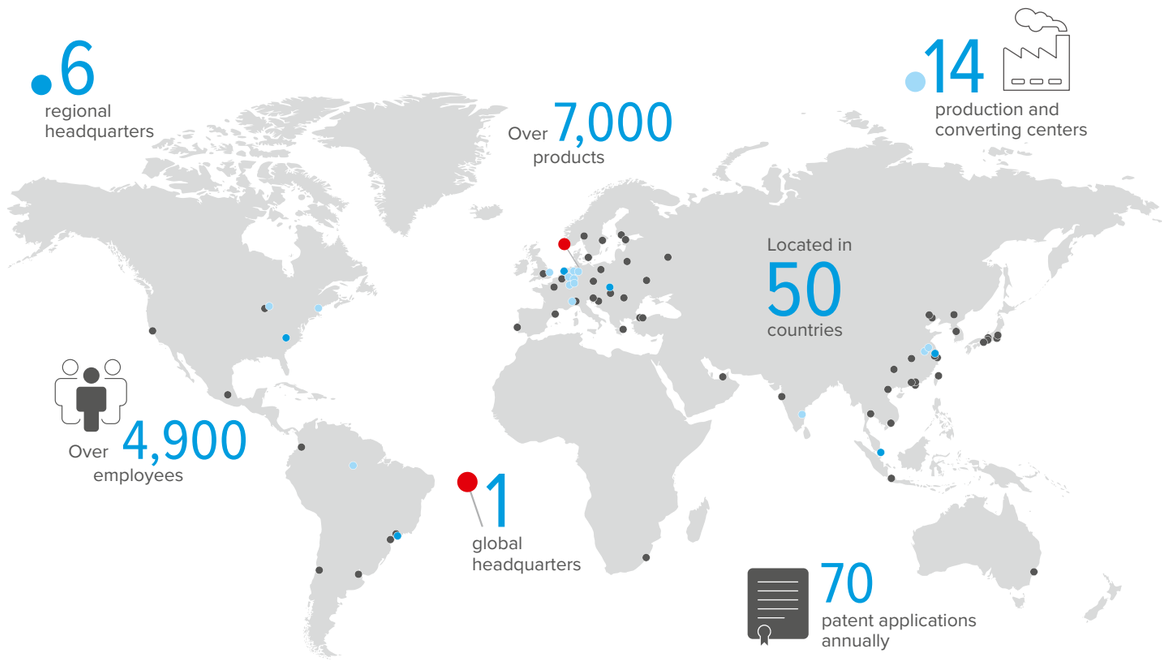
Summary

The unique properties of tesa® L-tape enable completely new assembly processes and device designs. tesa® L-tape combines the advantages of PSAs in terms of easy handling and efficient processing, with the high bonding strength and reliability known from structural bonding tapes or liquid adhesives. Components can be bonded at moderate pressure with an immediate bonding strength, enabling direct handling of the parts without additional clamping. The high and reliable adhesion to hard-to-bond substrates and the excellent shock absorption properties of tesa® L-tape help to increase the durability of electronic devices.

Global presence

A global partner providing local support

We are one of the leading global manufacturers of self-adhesive tapes. Our product solutions prove their performance in countless industrial sectors around the globe. Our sales offices, R&D centers, and production facilities offer worldwide support. The nearest office is just a call away – contact us.



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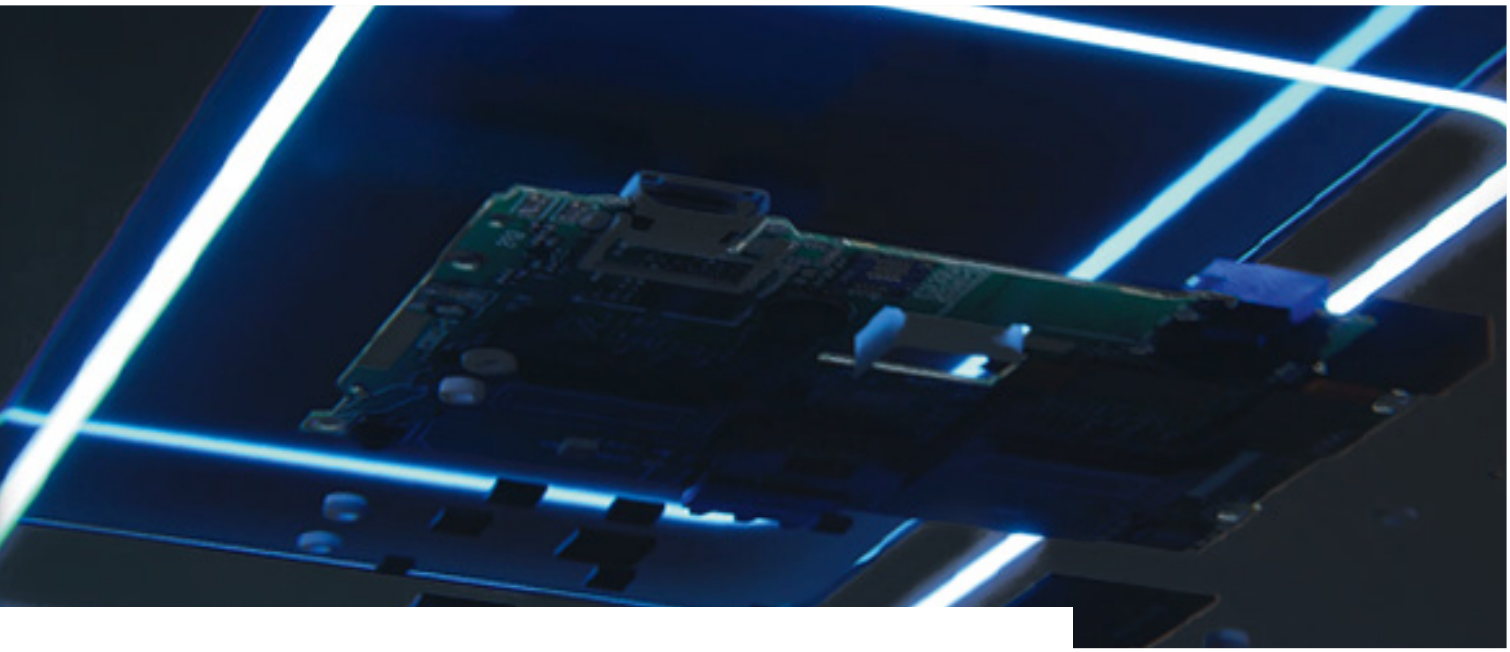

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