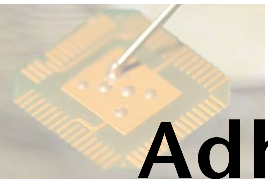
Polytec PT
Polymere Technologien



Adhesives

SELECTOR GUIDE

For Electronics,
Medical and Optics

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Typical Parameters to Describe an Adhesive

Usually all adhesives are optimized for specific applications. Adhesives must fulfill the requirements in the finished bond, but also they must be workable in a vast variety of production processes. So naturally, adhesives differ in many of their parameters or specifications. There are single and two component materials, adhesives which are cured at room- or elevated temperatures, by UV radiation, by the presence of humidity, etc. The focus in this paper will be on room- or elevated temperature curing Epoxy adhesives.

In the following the most important parameters – as they usually appear in data sheets – will be described.

Single- and Two Component Adhesives

It seems banal to distinguish between single and two component adhesives. However – read the following. It's just a little more complex…

Two component adhesives consist of two parts (often called Part A and Part B) and must be mixed before use. They in general have a very long shelf life, often cure at modest temperatures and may be mixed in portions according to the current needs. In production environments two component adhesives may be mixed on automated mixing systems; whereas mixing by hand is not recommended in general because of the high risk of mixing errors in day to day production.

However even mixing on automated production systems needs a closer look:

If one deals with unfilled materials there is usually no problem.

Materials however filled with particles like e.g. silver, nickel, carbon (all electrically conductive) or Al_2O_3, BN (thermally conductive) have a tendency of the filler to settle to the bottom of the container over time during transport or storage and the adhesive when put on the mixing unit may exhibit a varying filler ratio during the dispensing process. If the material is supplied in standard cans then one may stir the material before mixing. However, if the material is supplied in "production ready" cartridges or syringes then stirring before use is not possible. It is rather difficult to homogenize material inside cartridges. In other words: Filled Adhesives supplied as two component version in cartridges may pose a serious problem if it is intended to use these materials "production ready" on an automated mixing system.

There is a standard solution to this problem. This is the use of so called premix and frozen single component adhesives which are "production ready" filled into cartridges. Here a two component adhesive is mixed at the manufacturer's site, degassed for bubble free consistency and then frozen to a temperature below -40°C. At this low temperature not only the cure process of the adhesive is basically stopped but also the sedimentation of the fillers is completely stopped. Or in other words: In a frozen adhesive everything is frozen!! The adhesive is then shipped packaged in dry ice and after reception at the customer the cartridges must be stored in a refrigerator at < -40°C. The benefit for the user is obvious: there is no mixing anymore, no sedimentation, always the same viscosity after thawing and the cartridges are basically bubble free. Bubble free packaging is a kind of an art and requires sophisticated knowledge and machinery. The typical storage time for frozen epoxies is one year at < -40°C.

Single component room temperature (RT) adhesives consist of one part only and may be transported and stored at room temperature. They usually need higher temperatures (> 130°C) to cure and the shelf life is limited in general to 3 – 6 months. If filled with particles, basically the handling and sedimentation problems are the same as described above. If supplied in standard containers single component filled adhesives must be well stirred before use. In general single component particle filled RT adhesives are not supplied in cartridges because of the sedimentation problem. Within the shelf life the crosslinking of the adhesive slowly moves on and the viscosity may double. For practical purposes this however usually does not pose a problem.

"Pot Life" versus "Work Life"

The **"pot life"** is defined as the time it takes until the viscosity has doubled (at RT) after mixing a two component adhesive or after thawing a single component frozen adhesive.

As mentioned above for a single component RT adhesive pot life and shelf life are basically identical.

The "pot life" of an adhesive may vary between a few minutes and more than 6 months. Since the viscosity of the material may double during the "pot life" this will have an effect on the dispensing or application process.

There are application methods like screen printing or volume dispensing which are rather insensitive to changes in viscosity. If these application techniques are used then the adhesive often may be processed for a much longer period of time than the pot life as it is listed in data sheets.

The time available to process (apply) an adhesive is called "work life".

Application techniques which are more sensitive to changes in viscosity like e.g. air pressure-time dispensing may allow less time only than the pot life to apply (or process) the material.

The work life – or the time available to apply an adhesive – depends on the pot life but also on the application method.

The above rules of course require that the adhesive after being put on the processing machine will remain at room temperature. If the adhesive is heated up by e.g. hot lamps or motors in the vicinity or the adhesive container then both the work life (and the pot life) may be significantly reduced.

Cure Schedule

This is the most crucial of all process steps in the use of adhesives.

By experience we know that approx. 75 % of all production problems in processing adhesives can be related to curing issues.

Why is this? The cure process is rather simple:
You have to expose the epoxy adhesive for a certain period of time to a certain temperature. Point! End of process!

Heating of the epoxy may be achieved with a variety of techniques:
Convection air oven, hot plate, hot air, IR radiation, microwave, eddy current, etc.

During the cure process resin and hardener molecules crosslink and thus form a three dimensional network. Data sheets provide usually several temperature/time combinations of how to cure a given epoxy.

For example our silver conductive adhesive Polytec EC 101 offers the following combinations:

- **95°C / 60 min.**
- **120°C / 15 min.**
- **150°C / 10 min.**
- **180°C / 40 sec.**

Does this mean that the features of the finished bond are always the same independent of the cure schedule chosen?

Definitely not !!

The properties of the cured epoxy (or the bond) depend strongly on the cure schedule!

It makes a major difference whether a material is cured at a high temperature in short time or at a low temperature in long time. High temperature/short time curing leads to best bond strengths, highest glass transition temperatures, optimum resistance against liquids, moisture, chemicals, etc., lowest electrical and thermal resistances in the case of electrically and/or thermally conductive epoxies, but also to some brittleness of the bond. The opposite applies when cured at low temperature for a long time.

So the question: What is the right cure schedule cannot be answered in general. It depends on the specific application which schedule to use. Also very often the cure schedule is dictated by the cycle time of the production process or the max. temperature that can be applied with regard to other components etc.

Hence the temperature/time cure schedules as given in data sheets should be understood as recommendations and not as stringent rules. It is within the responsibility of the user to develop the optimum cure schedule for his application.

There are two important rules to consider when curing an epoxy adhesive.

Rule no. 1:
The higher the temperature the shorter will be the required cure time.

Rule no. 2:
An Epoxy cured at e.g. 100°C would need the double cure time if the temperature only was 90°C (just 10 % less) and vice versa would only need half the cure time if it was cured at 110°C in order to achieve the same degree of crosslink.

Qualification Tests of Bonded Samples

It is strongly recommended to carefully control the cure process in particular when preparing samples in the lab. If the cure process is not well controlled in the lab then the prepared samples which are usually tested in elaborate qualification test procedures (like e.g. 85/85 test, THB, temperature cycling, etc.) may exhibit very different features compared to production parts if the cure process in production differs from the process in the lab.

So, qualification tests could prove rather useless later on. Considering the time it takes to conduct these tests this could be a very costly mishap.

Another important point to consider: The cure temperatures listed in the data sheets mean the temperatures at the bond line (or adhesive). Depending on the parts which are put into e.g. an oven it may take quite some time – depending on the thermal mass – to heat up the parts themselves and – depending on their thermal conductivity – it takes time until the temperature really creeps to the bond line. But the bond line temperature is the only relevant temperature for the cure of the epoxy!

In critical applications it is recommended to measure and record the increase of the temperature directly at the bond line.

Convection air ovens:

Cure processes in convection air ovens often are a reason for varying results of bonded parts or percentage failures of the processed components. These ovens show a temperature on the outside display. This is the temperature which is present at the sensor inside the oven at one singular location. However these ovens – depending of the loading – often exhibit temperature differences of more than 10°C within their volume. It is highly recommended to separately measure the temperature distribution inside such ovens when loaded with parts. And of course never open the door of such an oven while a cure process takes place.

Remember: A 10°C lower temperature than expected would require the doubling of the cure time!!

The general rule here is to add generously time in the cure process. It is not too uncommon to double the cure time over the cure schedule as provided in the data sheet.

Customers are encouraged to contact Polytec PT or its distributors with questions regarding the cure process.

Temperature Specifications

Epoxies and Polyimides are organic compounds which will decompose or evaporate at higher temperatures. Low temperatures – even down to 4K – will lead to extreme brittleness of the adhesives and thus may crack bonds due to the difference in the thermal coefficient of expansion. The adhesive itself is usually not affected by these low temperatures. However in standard applications high temperature specifications are the most critical.

In the following four important temperature specifications are explained:

- **Degradation Temperature**
- **Maximum intermittent operating temperature**
- **Maximum continuous operating temperature**
- **Glass (transition) temperature**

Degradation Temperature

The degradation temperature is considered the temperature at which the adhesive starts to decompose. This temperature is determined by a so called TGA (Thermo Gravimetrical Analysis) method. A sample of cured adhesive is put into a precision balance and then the temperature of the adhesive is increased at a rate of e.g. 20°C/min. While the temperature climbs the weight is monitored as function of the temperature. As the temperature grows the adhesive begins to decompose und thus looses weight. The temperature at which a weight loss of 10% – of the organic adhesive portion – is reached defines the degradation temperature.

Maximum Intermittent Operating Temperature

The degradation temperature minus 50°C is called "intermittent operating temperature". The cured adhesive may be exposed to this temperature for a short period of time (e.g. 5 min. – 15 min) without detoriating its functionality in the bond. However the adhesive may not be exposed to this temperature for an extended period of time. In such case it may slowly lose its functionality.

Maximum Continuous Operating Temperature

The degradation temperature minus 150°C is defined as continuous operating temperature. In general the adhesive may be exposed to this temperature for an indefinite period of time.

Glass (Transition) Temperature (Tg)

At a temperature usually below the maximum continuous operating temperature a cured adhesive will change its state from "glassy" hard to "rubbery" soft. At this temperature many other parameters of the material change as well. Above Tg the bond strengths will move to much lower values, the thermal coefficient of expansion will approximately triple and the shore hardness will be reduced significantly.

Remember:

The Glass Temperature (or Tg) of course depends on the specific adhesive. But… often much more important – it also strongly depends on the selected cure schedule.

For example:

One adhesive may vary its glass temperature between 50°C and > 100°C just based in the cure schedule. This behavior stresses again the importance of a tight control of the cure schedule – in particular in production.

Typical Tg's for Polytec PT adhesives are as follows:

- **Polytec EC 101: 85°C**
- **Polytec EP 653: 124°C**

In General

Depending on the applications, adhesives may be operated continuously above their maximum continuous operating temperatures or – for shorter time periods – above the maximum intermittent operating temperature.

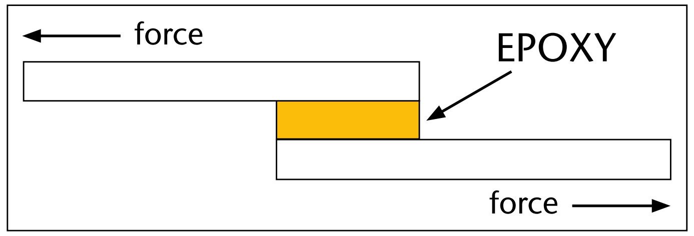
Those temperature specifications in adhesive data sheets provide a good approximation for practical use. But they are in no way hard numbers graved into stone and should be verified by the user for his specific application.

Lap Shear Strength

The lap shear strength is determined by bonding two substrates (e.g. Aluminium Specimens) with standardized surface conditions with a defined overlap together and then pulling them apart until the bond breaks. The max force needed is called lap shear strengths and measured e.g. in N/mm². In general the lap shear strengths is a measure of the "bond strengths" of adhesives. However in real life very often the bond strength is more influenced by the surface condition and the type of material (metal, plastic, ceramic, glass, etc.) of the bonded parts.

The following conversions apply:

1 PSI (pound per square inch)	**= 6,894 x 10^{-1} N/cm²**
	= 6,849 x 10^{-3} N/mm²
	= 7,03 x 10^{-2} kp/cm²



Consistency: Viscosity / Thixotropy

Today's adhesives cover the full viscosity range from flowable (like water) to nearly solid like modeling clay. The application determines which viscosity will be best suited. The viscosity is measured with Rheometers – usually at a well controlled temperature of 23°C. The physical dimension of the viscosity is mPas (Milli Pascal seconds) or in older publications cps (Centipoise). The dimensions of mPas and cps however are identical. So 1 mPas = 1 cps. The table below lists the viscosity data of some standard liquids.

Water	**1,7 mPa s**
Glycerin	**1499 - 1700 mPa s**
Oil	**300 - 3000 mPa s**
Epoxy	**100 - 80000 mPa s**

The viscosity strongly depends on the temperature. Therefore it is necessary to tightly control the temperature upon measurement. An adhesive – before cure – consists of long freely flowing chains of hydrocarbons similar to oil in a car engine. And so the viscosity behaves. Heating up the adhesive will significantly lower the viscosity before the hardening starts.

This viscosity dependence on the temperature is often taken advantage of when adhesives are dispensed. If the parts, where later on the adhesive will be dispensed into or onto are heated up to about 40°C – 50°C then this will significantly reduce the adhesive's viscosity and may allow a much better flow of the adhesive when appropriate.

Liquid, low viscous adhesives which usually are unfilled may be well described and compared by giving their viscosity number at 23°C.

Adhesives filled with particles not only show a higher viscosity but also exhibit another effect which is called "thixotropy". Typical examples of thixotropic materials are soft butter or ketchup. Thixotropic materials feature a stable form at rest – they do not flow – but become liquid when a shear force is applied like striping with a knife across butter. So it is possible to dispense these materials by applying a shear force e.g. in an air-pressure dispenser or by a squeegee in a screen printer. After the material is dispensed and the shear force is gone the adhesive will keep its shape. There is a so called thixotropic index to describe the amount of a material's thixotropy. However this index is usually of no good practical use when selecting an adhesive. Therefore you won't find a thixotropic index very often in adhesive data sheets.

It is highly recommended to contact your adhesive supplier and use his competence in selecting an optimal adhesive for a given application. Often adhesives are tailored to specific application methods like e.g. – screen printing, stamping or air dispensing.

Filled Adhesives

Besides the vast number of unfilled adhesives there exists today a myriad of adhesives filled with all kinds of particles. Filled adhesives play an important role in the adhesive industry since many features or specifications can only be achieved by adding fillers.

In the following we will discuss electrically and thermally conductive adhesives in particular.

Electrically- (and also Thermally-) Conductive Adhesives

In order to achieve electrical conductivity with an adhesive, fillers have to be added. The standard filler material for electrically conductive adhesives are silver (Ag) particles. But also Copper (Cu), Gold (Au), Nickel (Ni), etc. particles may be use to make an adhesive electrically conductive. The specific electrical volume resistivity is usually measured on a four point probe and thus determines the bulk volume resistivity of the material. Silver filled epoxies show volume resistivities in the range of 10^{-3} to 10^{-5} Ω x cm.

In practical applications like e.g. die attach, chip bonding, etc. we usually deal with thin bond lines in a thickness range of 50 µm or below.

And here is a tricky problem:

In bond line thicknesses below approximately 100 µm the specific electrical volume resistivity no longer is a material constant but it becomes a function of – or it depends on – the bond line thickness. The general rule is that this resistivity increases (gets worse!) the thinner the bond line gets. This makes it usually difficult or impossible to calculate the electrical resistance of a real bond just based on the (bulk) specific volume resistivity and the geometry (area and thickness) of the bond line. Because of this it will not help to consult the physics book and just do a linear calculation. And the general rule "the thinner – the better" does not apply.

We recommend that for real life bonds the electrical resistance of a bond is directly measured (note the bond line thickness!!!) and then the specific electrical volume resistivity (which will depend on the bond line thickness) should be determined in a back-calculation based on the electrical resistance of the bond.

And once again: In general one cannot just use the electrical specific volume resistivity of bulk material and calculate through the geometrical formulas the electrical bond resistance. Another effect of course will be the contact resistances between substrate and adhesive and then adhesive and chip. These resistances significantly contribute to the overall electrical bond line resistance.

It's important – so once again:

When dealing with electrical specifications of adhesives then measure the electrical resistance of real life bonds. Comparing just the numbers of different adhesive data sheets is a little shortsighted. Usually only the (bulk) specific electrical volume resistivity was determined. But this number does not necessarily tell much about the electrical resistance which can be achieved in a real bond.

All understood?

Metal surfaces with low or high electrical contact resistances

The lowest electrical contact resistances may be achieved on precious metals like e.g.

- **Gold**
- **Silver**
- **Platinum**
- **Palladium**
- **metal oxides like e.g. ITO (Indium tin oxide)**
- **usual metal oxides on thin film solar cells**
- **thick film pastes like gold-palladium or silver-palladium**

Also pretty low contact resistances are achieved on certain lead free solders like e.g.

- **Tin/Silver alloy**

and on metals like e.g.

- **Nickel**
- **Copper**

Copper however tends to oxidize and so form copper oxide under the bond. The adhesion of copper oxide to copper is not really very good. Usually when copper is used as substrate a nickel/gold layer is put on top of copper.

Only high and often unstable electrical contact resistances are achieved on less-precious metals like e.g.

- **Aluminum**
- **Brass**
- **Lead**
- **Leaded solder**
- **etc.**

these materials in general are not suited for being bonded with electrically conductive adhesives.

Thermally Conductive Adhesives

Basically all electrically conductive adhesives are good thermal conductors as well. Thermally conductive – but electrically insulating adhesives are filled e.g. with aluminum (Al), alumina (Al_2O_3) or Boron Nitride (BN). Among all these fillers Al_2O_3 is mostly used for thermally conductive but electrically insulating materials.

Once again!

The same rules like with electrically conductive adhesives apply, as to distinguish between specific thermal volume conductivity and the thermal conductance (or its reciprocal: thermal resistance) of a real bond. It may even be more difficult to compare the specific thermal volume condutivity of adhesives from data sheets of different manufacturers. There are several methods of how to determine these thermal parameters. So just by picking a convenient method an adhesive may show a superb thermal bulk conductivity in a data sheet. But in reality such a material may finally be just horrible in its thermal performance in a real bond. Here it is even more important to compare the thermal resistance of real bonds instead of just looking at data in data sheets.

And again – remember: The specific thermal volume conductivity is a function of the bond line thickness (below ca. 100 µm bond line thickness).

Usually the electrical performance of electrically conductive adhesives is much better than actually needed. With regard to the thermal resistance this is very different. In high power applications where a large amount of thermal energy must be dissipated it is often necessary to really exploit the limits of an adhesive and to apply the appropriate processing.

Index of Refraction

Optical epoxies usually show an index of refraction in the range of n = 1.5. So they provide a good index match when bonding glass or optical fibers together.

Shrinkage

Most adhesives shrink upon cure. Our epoxies are all solvent free. So the shrinkage is rather low. In general the shrinkage for epoxies lies in the range of 1 – 2 % by volume. For electrically conductive adhesives this small shrinkage is a prerequisite to make them electrically conductive. The shrinkage just moves the silver particles a little closer together which then generates the conductivity. An uncured silver filled adhesive is not conductive in general.

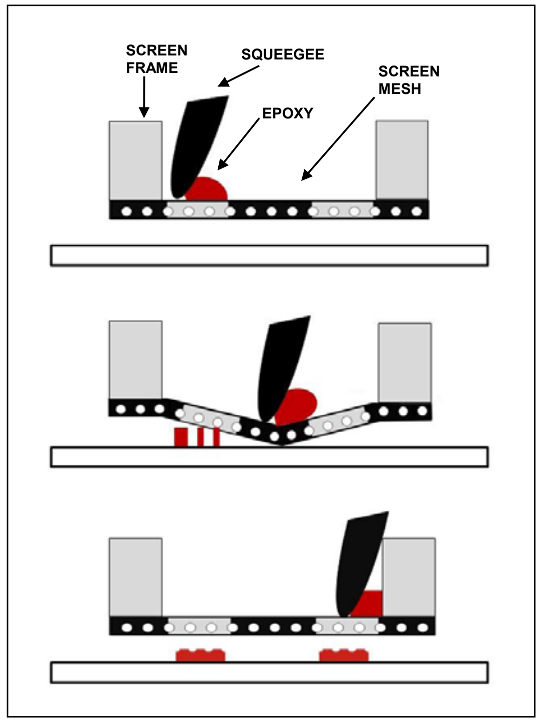
Typical Application / Dispensing Methods

Screen and Stencil Printing

In screen printing the adhesive is pushed through a silk – or metal screen by a squeegee. The so called mesh size (mesh count per inch) usually lies in the range of 180 – 325 mesh. The screen is coated on the bottom side however with pattern like openings in the coating to let the adhesive selectively flow through. The substrate lies in a distance of about 0.5 – 1 mm below the screen. When the squeegee moves across the screen on the upper side it pushes the screen downward such that the screen touches the substrate. The movement of the squeegee also applies a shear force on the adhesive which then gets rather liquid (remember the thixotropy) and flows through the openings in the screen on to the substrate. When the shear force ends the thixotropic adhesive will maintain its shape on the substrate and will not flow anymore.

Screen printing is an ideal application method, well suited for mass production. While on the screen, the adhesive will up to the pot life double its viscosity. However, very often one may process the adhesive well beyond its pot life because this application method is very tolerant to the increase in viscosity. In screen printing it is not uncommon to achieve a work life which is more than the double of the pot life. Adhesives often may be used for more than a week on the screen.

If the screen is replaced by a metal stencil then it is called stencil printing. In stencil printing one may achieve e.g. line widths of less than 100 µm.



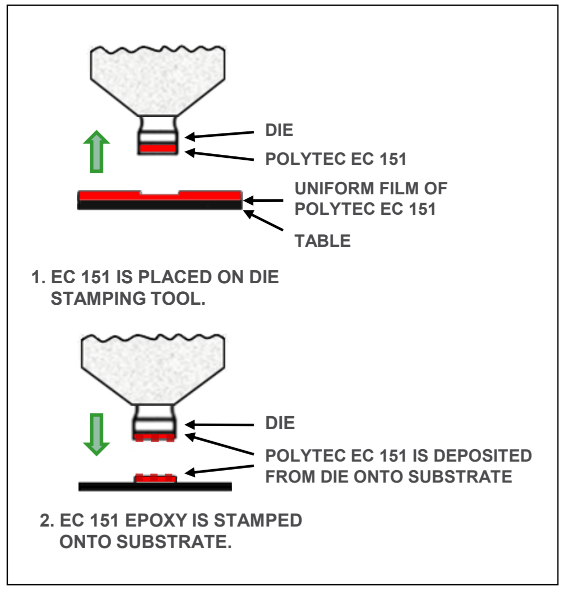
Stamping

In stamping adhesive is wiped in a thin layer (ca. 300 µm) in a cup. A metal stamp with an area, that is approximately 20% less than the (later) glued surface, is dipped into the adhesive layer in the cup. When pulled up about half of the adhesive thickness (150 µm) remains on the stamp. Then the stamp touches the substrate and again when pulled up about half of the adhesive (75 µm thickness) is transferred to the substrate – the rest remains on the stamp.

This technique is very precise and also well suited for mass production. Unlike in screen printing the substrate needs not necessarily to be flat but may have components on already.

In stamping it is crucial that the adhesive does not pull strings when moved upwards. This could lead to shortages on semiconductor chips if electrically conductive adhesives are used.

Therefore the user should make sure with his adhesive supplier that the adhesive is suited for stamping technique. Also unlike in screen printing, stamping will be more sensitive to increases in viscosity.



Pressure-Time Dispensers

In a pressure-time dispenser an adjustable air pressure is applied for a certain time to a cartridge which holds the adhesive. While the pressure is on, adhesive flows out of the dispensing needle on the other side of the cartridge. That's basically all.

These dispensers are widely used in industry. They are low cost and accurate and may be used just manually or integrated in automatic systems. In general the adhesive is supplied in cartridges. So, the user just has to put the cartridge in his dispenser and begin dispensing. The procedure is really failsafe.

Since the adhesive will increase in viscosity over time, the amount of material being dispensed may be reduced as the process proceeds. So pressure-time dispensers are somewhat more sensitive to changes in viscosity and the work life may be less than the pot life. However one may adjust pressure and time in order to keep the dispensed volume constant. This may be done by hand or automatically in modern automatic dispensing systems.

Volume Dispensers

A volume dispenser works rather similar to a pressure-time dispenser. However the dispensed quantity of adhesive is determined by a certain displaced volume of material. As consequence volume dispensers are much less sensitive to changes of the adhesive's viscosity because independent of the viscosity always the same volume is dispensed. With these dispensers the work life usually is much longer than on pressure-time dispensers. On the other hand volume dispensers are a bit more expensive but may perform better when – in particular – integrated in automatic dispensing systems.

Jet Dispensers

We all know ink-jet printers which are nothing else but ink-jet dispensers of ink. The inks used in these machines must be very low in viscosity. Some adhesive are low enough in viscosity such that they may be dispensed with these systems.

More interesting nowadays are Jet dispensers which can process viscous and even thixotropic adhesives like e.g. silver filled electrically conductive epoxies. With these machines dots of adhesive can be "spit" from a distance to the substrate. The dots of silver filled epoxies may be as small as 350 µm in diameter. Because those dots are dashed at a distance on to the substrate the substrate surface needs not to be even at all. The rate of "spitting" is high enough to also dispense closed lines or basically any shape you want. Usually a jet dispenser is combined with an automatic x-y table.

Toothpick Method

Sounds not really scientific – but hey…. In the lab it is a proven method of adhesive dispensing. If one just needs in a lab environment a quick way to assemble some chips, this method works. It is a little bit like stamping.

For any kind of production application this method is definitely not recommended.

How to Select the „Best" Adhesive

Adhesives – as we have seen – differ in many of their specifications. So it is usually a quite complex task to select the right material for a given application. We recommend to contact Polytec PT and discuss this issue with one of our experienced specialists. Our engineers carry decades of experience in all aspects of adhesive technology.

However in order to feel more comfortable in choosing an appropriate epoxy one may basically distinguish between two major aspects:

1. **How will the adhesive be processed in production later on?**
2. **What are the requirements of the finished bond?**

Let's take a closer look at question no.1. In order to respond to this question one should be clear about the following:

Which dispensing or application method is going to be employed?

For how long must the material remain workable in the dispensing system?

Which maximum temperature may later be applied for the cure process? In particular, when other components on the circuit are limited in their max. temperature.

What is the cycle time of the process?

All these questions are process related but should be addressed first. It makes no sense to pick a "super" adhesive which later on cannot be used in the planned production process.

So answering such production related questions will determine the min. pot life, viscosity/thixotropy, cure cycle, etc. The number of adhesives which are suitable in such a process will be considerably limited through these production related constraints.

Next of course one has to look at the requirements of the cured adhesive in the finished bond. Polytec PT will support its customers to make the best pick.

Some practical processing tips

Storage

Two component adhesives should be stored at room temperature. The containers must be closed well in order to prevent evaporation of lower molecule ingredients.

Storage of these materials at around freezing level or slightly above (normal refrigerator temperatures) is not recommended. At these temperatures there is always the risk that epoxies start to crystallize. The movement of the adhesive molecules is considerably reduced – but is still there – and so over time little crystals may form. This crystallization effect happens sometimes in winter when epoxies are transported at low temperatures and thus crystallize within days.

RT single component adhesives may be stored in refrigerators if expressly recommended in the data sheet.

Frozen epoxies (usually single component materials) must immediately after reception at the shipping deck be taken out of their dry ice containers and transferred to the special storage refrigerator where the storage temperature is less than -40°C. Interestingly there exists no crystallization problem upon storage at -40°C. This may sound paradox at first but at this low temperature there is basically no movement of the adhesive molecules any more. So for the molecules there is no chance to form crystals. The period during the freezing- and later thawing process is too short to enable the formation of crystals.

Removal of Crystals

If there are obviously crystals present in two component adhesives this is no reason to panic. Such crystals can be removed easily. Just put the closed containers into an oven at a temperature of around 50°C, keep them there for about hour and then take the containers out, and after cool down open the container and separately stir both parts well. If stirring is not possible e.g. because the epoxy is inside a glass bottle then just shake the closed bottle. This procedure nearly always removes such crystal in the epoxy.

Unfortunately one cannot apply this method to single component RT epoxies because here the heating would start the curing process and thus harden the epoxy.

Frozen epoxies in general show no crystallization at all.

Preparation of Adhesives before Use

Filled adhesives which were stored at room temperature must be stirred well before use. The filler particles will sediment (sink to the bottom) over time and so in order to get a smooth consistency stirring these materials before use is absolutely necessary.

There is one exception to this rule: Polytec PT offers special two component, electrically conductive epoxies which show so little sedimentation that they are supplied in cartridges and dedicated to be processed on automatic mixing systems.

All other filled epoxies must be stirred before use. Therefore room temperature and filled epoxies if supplied in cartridges must be stored on a roller mixer in order to keep them homogenized and prevent filler sedimentation. Stirring inside the cartridge is obviously not possible.

Here again frozen epoxies have a major benefit. There is no sedimentation at all in frozen cartridges. The cartridges are just taken out of the refrigerator, thawed in about 20 – 30 minutes and put on the machine.

Thawing Process

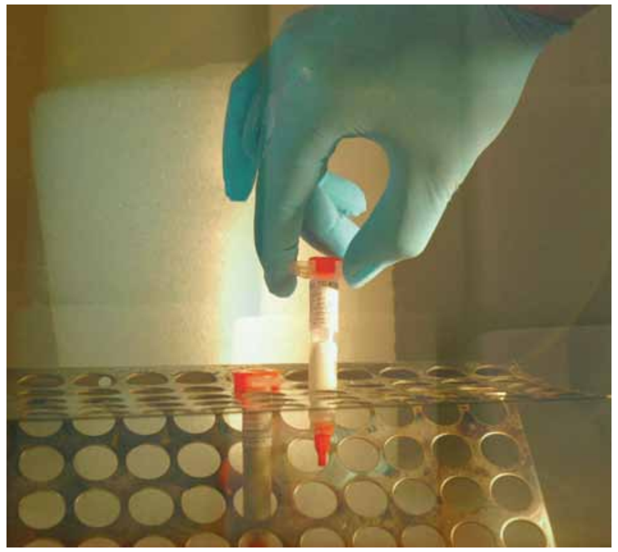
One simple – but nevertheless – important rule must be observed when taking cartridges out of the refrigerator:

The cartridges must only be touched by hand (protected by special gloves of course) at the flange of the cartridge. The reason is to avoid a local expansion of the cartridge wall by uncontrolled heating. If the cartridge wall is locally heated it will expand and in consequence suck air into the cartridge. This may create extra air bubbles inside the cartridge and thus lead to voids during dispensing. The adhesive inside cartridges is basically bubble free packaged in a sophisticated packaging process at Polytec PT. Uncontrolled thawing might then partly spoil the bubble free packaging.

A good thawing process is really simple and works as follows:

- **Wear gloves.**
- **Grip the cartridge at the flange.**
- **Take it out of the refrigerator.**
- **Put it into a rack or metal cylinder with an opening of appropriate size.**
- **Let it thaw for 20 – 30 minutes.**
- **Grip the thawed cartridge as you like and put it on the machine.**

This simple procedure assures that no further bubbles are created in the cartridge.



Frozen adhesives supplied in cartridges exhibit several key advantages:

- **No Weighting**
- **No Mixing**
- **No Crystallization**
- **No Sedimentation**
- **No Bubbles**

This is why premixed frozen adhesives have become a standard in high quality production environments.

Surface preparation

Most surfaces in electronic packaging need no special preparation before adhesive is applied. The standard cleaning processes are usually fully sufficient.

In general surfaces should be free of oil, grease, dirt, old layers, rust, etc. before applying adhesive. Oil and grease may be well removed with organic solvents like e.g. ethanol, acetone, MEK (methyl ethyl ketone). Also waterborne special cleaners can be used. Sometimes ultrasonic bathes are a good choice for cleaning as well.

Most metals (exceptions are: chrome, platinum, titanium), ceramics, glass and many plastic materials may be bonded very well with epoxy adhesives.

However plastic materials usually do not provide the same good adhesion like metals or ceramics. It is therefore necessary to specify the type of plastic in order to determine its adhesion or whether it can be bonded at all. For example Teflon® and in general high temperature plastics are more difficult or impossible to bond. It is a good practice to activate the surface of plastic materials before bonding by e.g. flame pyrolysation, plasma or suitable primers.

Also it has to be kept in mind that most plastic parts are produced by injection molding. Often the injection mold is coated with a release agent. These agents are normally not defined but remain on the surface of the plastic part. Therefore a surface activation should be performed before bonding, just to always create a stable surface condition. Else the adhesion may vary in production due to changing surfaces.

A simple and quick test of the surface condition is the so called contact angle measurement.

Details may be found in our catalog: "Surface pretreatment".

Attention!!! Silicone!!!

If silicones are being processed or just are present in the vicinity of epoxy processing then there is the imminent risk that silicones may creep as an ultrathin layer on all surfaces nearby, contaminate such surfaces and severely deteriorate any bonding process later on. Silicones have the unique feature that they creep everywhere over time. In addition cross contamination of silicones and epoxies is described in literature. Varying bond strengths can be a result of silicone contamination. Also certain protective wear (e.g. clean room clothing) sometimes is siliconized and so may be the source of silicone contamination.

So keep epoxy (or other adhesives) and silicones away from each other. Avoid any silicones in the vicinity of adhesion processes.

Teflon® is a registered trademark of DuPont.

Cleaning

Remains of uncured adhesive on screens, hoses, or splashed on surfaces are rather easily removed with typical organic solvents like e.g. ethanol, acetone, MEK (methyl ethyl ketone).

If an epoxy however is partially or fully cured then it is a lot more difficult to remove remains. Therefore cleaning should always take place shortly after dispensing.

Rework, Removal of Cured Adhesives

There are several methods to undo an epoxy bond.

The methods are:

- Use of heat
- Use of mechanical force
- Use of epoxy solvents

The usually best suited way to undo an epoxy bond is heat. The bond is locally heated up (e.g. by a hot air gun) to a temperature of 120°C – 150°C. This will get the epoxy above its glass temperature and leads to a softening of the bond. As you may remember the bond gets "rubbery" above Tg. At this temperature the bonded parts may be separated by relatively low mechanical force. In particular when removing bonded chips one may after removal of a defective chip apply electrically conductive adhesive and even bond the new chip on remains of the old adhesive. It is in general not necessary to completely remove all old adhesive.

The use of mechanical force alone may be applied in rare cases, however the risk to damage the whole part is rather high. So this method isn't used very often.

Also the use of solvents on cured epoxy adhesives is a cumbersome procedure. Besides special epoxy solvents offered by certain suppliers methylene chloride is a solvent which often works. However handling these chlorinated hydrocarbons also is cumbersome. In particular safety issues with these solvents have to be taken into account. So solvents are not widely used either.

And so again: Do the cleaning before the epoxy starts to cure!

Safety First!

Please follow carefully the safety instructions of the respective safety data sheets (MSDSs).

These instructions exist to protect you!

Never use an organic solvent to clean skin from spilled adhesive!!!

If the human skin gets into contact with epoxy plus organic solvents at the same time the danger of irritation is increased by several orders of magnitude. If you get some epoxy on the skin just use water, soap or standard cleaning agents to wash off the epoxy.

Quality Assurance

Each manufactured lot of epoxy is tested against its standard specifications and recorded on the quality Test Report.

An example of a standard test report is shown on the next page.

Polytec PT
Polymere Technologien

POLYTEC PT GmbH
Polytec-Platz 1-7

D- 76337 Waldbronn

Datum/ Date: 28.06.2011

QS-Prüfbescheinigung/ QS- Inspection Certificate

Produkt: Polytec EC 101-frozen

Lot-Nr. / Batch-No.: 270611

Fertigungsdatum/ Manufacturing Date . 27.06.2011
Optimal haltbar bis/ Expiry Date: 27.06.2012 (bei / at: -40°C)

Aus Probennahmen ergaben sich folgende Prüfresultate / Inspection results

Prüfung **certified parameter**	**Prüfmethode** **test method**	**Sollwert** **Specified value**	**Einheit** **unit**	**Istwerte** **actual value**
1. Viskosität / Viscosity Thermo Haake, Rheostress 1 Messkörper PP35Ti, 23°C, Schergeschw. 84 sec^{-1} Thermo Haake, Rheostress 1 Plate PP35Ti, 23°C, shear rate 84 sec^{-1}	Rheometer	9000 - 15000	m·Pas	12140
2. spez.el.Volumenwiderst./ spec.el.Volume Resistivity nach Härtung 30 Min bei 150°C after curing 30 Min. at 150°C	Vier-Punkt-Messung Four-Probe-Test	$< 10^{-3}$	Ω·cm	$1{,}7 \cdot 10^{-4}$
3. Scherfestigkeit/ Die-Shear-Strength nach Härtung 30 Min bei 150°C after curing 30 Min. at 150°C	Die-Shear-Tester	> 50	N/mm²	64
4. Shore D- Härte / Shore D hardness nach Härtung 30 Min bei 150°C after curing 30 Min. at 150°C	Messuhr gem. DIN 53505 hardness tester acc. DIN 53505	> 80		86

Example

Verantwortlich/ responsible:

Dr. Joachim Kalka
Leitung Qualitätssicherung / Quality Manager

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Steuer-Nr.: 31194/25135

Creating Solutions Through Polymers **www.polytec-pt.de**

Polytec PT
Polymere Technologien

Electrically Conductive Adhesives

Type			Shelf Life / Curing / Pot Life				Optical Properties	Thermal Properties		Mechanical Properties			Electrical Properties	Processing Properties			Characterization
Polytec	Number of Components	Mix Ratio By Weight	Shelf Life Temperature	Shelf Life Months	Minimum Bond Line Cure Schedule	Pot Life	Color (Before/After Cure)	Continuous Operating Temperature [°C]	Glass Transition Temperature [Tg]	Die-Shear Strength [N/mm²]	Shore Hardness	Specific Gravity [g/cm³]	Volumen-Resistivity [Ω·cm]	Viscosity [84 RPM @ 23°C] [mPa s]	Consistency	Filler	
EC 101	2	1 : 1	at 4 – 6°C	6	95°C / 60 Mins. 120°C / 15 Mins. 150°C / 10 Mins. 180°C / 40 Sec.	2 Days	Silver	-55 / 200	80	50	D85	2,75	10^{-4}	12.000	Soft, creamy paste	Ag	Standard two component electrically conductive epoxy for die attach and substrate bonding in microelectronics, LED, medical, hybrid and optoelectronic applications. **USP Class VI compliant**.
EC 101-frozen	1	N.A.	at -40°C	12	95°C / 60 Mins. 120°C / 15 Mins. 150°C / 10 Mins. 180°C / 40 Sec.	2 Days	Silver	-55 / 200	80	50	D85	2,7	10^{-4}	10.000	Soft, creamy paste	Ag	Pre-mixed-frozen version of Polytec EC 101.
EC 101-ATC	2	10 : 1	at 4 – 6°C	6	95°C / 60 Mins. 120°C / 15 Mins. 150°C / 10 Mins. 180°C / 40 Sec.	2 Days	Silver	-55 / 200	80	50	D85	3,37	10^{-4}	12.000	Soft, creamy paste	Ag	Special two component version of Polytec EC 101. Optimized for automated mix and dispensing processes in large volume applications.
EC 201	2	1 : 1	at 4 – 6°C	6	150°C / 30 Mins.	4 Hours	Silver	-55 / 150	40	60	D55	2,4	$2 \cdot 10^{-4}$	13.000	Creamy paste	Ag	Highly flexible, two component electrically conductive epoxy for flexible circuitry and stress free IC Packaging in opto-electronic, medical and hybrid microelectronic applications.
EC 201-frozen	1	N.A.	at -40°C	12	150°C / 30 Mins.	4 Hours	Silver	-55 / 150	40	60	D55	2,4	$2 \cdot 10^{-4}$	13.000	Creamy paste	Ag	Pre-mixed-frozen version of Polytec EC 201.
EC 235	2	100 : 8,5	at RT	6	60°C / 60 Mins.	3 Hours	Silver	-55 / 175	N.A.	50	D65	2,8	$1 \cdot 10^{-2}$	13.200	Creamy paste	N.A.	Metall-filled epoxy for HF/EMI-Shielding or as low cost alternative to silver-filled adhesives.
EC 235-frozen	1	N.A.	at -40°C	6	60°C / 60 Mins.	3 Hours	Silver	-55 / 175	N.A.	50	D65	2,8	$1 \cdot 10^{-2}$	13.200	Creamy paste	N.A.	Pre-mixed-frozen version of Polytec EC 235.
EC 261-C	2	1 : 1	at RT	6	150°C / 30 Mins. 120°C / 4 Hours	4 - 5 Hours	Black	-55 / 230	110°C	60	D75	1,8	N.A.	30.000	Heavy paste	C	Carbon filled, electrically and thermally conductive Hi-Temp epoxy for assembly of electronic components, EMI/RFI and protection of copper and similar metal contacts.

N.A. = not applicable / RT = Room Temperature
„pre-mixed-frozen" adhesives will be shipped in specially insulated styrofoam boxes containing dry ice.

Thermally Conductive Adhesives

Type / Polytec			Shelf Life / Curing / Pot Life				Optical Properties	Thermal Properties			Mechanical Properties			Electrical Properties	Processing Properties			Characterization
	Number of Components	Mix Ratio By Weight	Shelf Life Temperature	Shelf Life Months	Minimum Bond Line Cure Schedule	Pot Life	Color (Before/After Cure)	Continuous Operating Temperature [°C]	Glass Transition Temperature [Tg]	Thermal Conductivity [$W \cdot m^{-1} \cdot K^{-1}$]	Die-Shear Strength [N/mm²]	Shore Hardness	Specific Gravity [g/cm³]	Volumen-Resistivity [$\Omega \cdot cm$]	Viscosity [84 RPM @ 23°C] [mPa s]	Consistency	Filler	
TC 301	1	N.A.	at 4 – 6°C	6	120°C / 45 Mins. 150°C / 10 Mins.	RT/1 Month 4 – 6°C/6 Months	Metal grey	-55 / 180	N.A.	3	60	D85	2	10^8	43.000	Creamy paste	Al	Standard single component epoxy with excellent thermal conductivity for Thermal Managment applications such as heat-sinking. Conveniently long pot and shelf life.
TC 351	1	N.A.	at 4 – 6°C	6	120°C / 45 Mins. 150°C / 10 Mins.	RT/1 Month 4 – 6°C/6 Months	Black	-55 / 200	110	1	N.A.	D80	1,9	N.A.	60.000	Thixotropic paste	Al_2O_3	Single component epoxy with good thermal conductivity. Typical applications are bonding of sensors in metal holders and fixation of single devices on PCBs.
TC 404	2	1 : 1	at RT	12	100°C / approx. 5 Hours	approx. 60 Mins. (10 g mixture)	Grey	-55 / 200	N.A.	N.A.	N.A.	D85	2	N.A.	16.000	Smooth paste	Al_2O_3	Bonding of mechanically stressed structural components like carbide tools.
TC 417	2	100 : 13	at RT	12	23°C / 24 Hours	ca. 60 Mins. (15 g mixture)	Grey / off-white	-55 / 180	90	1	N.A.	D85	1,83	N.A.	3.000	Flowable paste	Al_2O_3	Thermal management applications, potting of large volumes. Excellent chemical and moisture resistance.
TC 420	2	9 : 1	at RT	12	100°C / 30 Mins. 120°C / 15 Mins. 150°C / 5 Mins.	24 Hours	Off-white / brown	-55 / 200	90	1	40	D85	2,12	N.A	22.000	Soft paste	Al_2O_3	Thermal management applications in semiconductor, hybrids, optics, optoelectronics, aerospace and electronics industry.
TC 420-frozen	1	N.A.	at -40°C	12	100°C / 30 Mins. 120°C / 15 Mins. 150°C / 5 Mins.	24 Hours	Off-white / brown	-55 / 200	90	1	30	D85	2,12	N.A.	22.000	Soft paste	Al_2O_3	Pre-mixed-frozen version of Polytec TC 420.
TC 420-LV	2	9 : 1	at RT	12	100°C / 30 Mins. 120°C / 15 Mins. 150°C / 5 Mins.	24 Hours	Off-white / brown	-55 / 200	90	1	50	D85	2,12	N.A.	12.000 - 13.000	Soft paste	Al_2O_3	Low viscosity version of Polytec TC 420.
TC 420-LV-frozen	1	N.A.	at -40°C	12	100°C / 30 Mins. 120°C / 15 Mins. 150°C / 5 Mins.	24 Hours	Off-white / brown	-55 / 200	90	1	50	D85	2,12	N.A.	12.000 - 13.000	Soft paste	Al_2O_3	Pre-mixed-frozen version of Polytec TC 420-LV.
TC 430	2	100 : 4	at RT	12	150°C / 15 Mins. 100°C / 60 Mins.	6 Hours	White / yellow	-55 / 200	110	1,7	65	D85	1,35	$1 \cdot 10^{13}$	13.000	Soft thixotropic paste	BN	For applications where heat dissipation and insulating properties are required, like e.g. bonding of heat sinks, die attach (of power devices), thermally conductive underfill.
TC 430-frozen	1	N.A.	at -40°C	12	150°C / 15 Mins. 100°C / 60 Mins.	6 Hours	White / yellow	-55 / 200	110	1,7	65	D85	1,35	$1 \cdot 10^{13}$	13.000	Soft thixotropic paste	BN	Pre-mixed-frozen version of Polytec TC 430.
TC 451	2	100 : 6	at RT	12	23°C / 16 Hours 100°C / 15 Mins.	30 Mins.	Black	-55 / 180	110	1	N.A.	D90	2	N.A.	9.000	Flowable soft paste	Al_2O_3	Thermally conductive, high Tg bonding, potting, coating and sealing applications in the automotive and electronics industry.
TC 451-frozen	1	N.A.	at -40°C	12	23°C / 16 Hours 100°C / 15 Mins.	30 Mins.	Black	-55 / 180	110	1	N.A.	D90	2	N.A.	9.000	Flowable soft paste	Al_2O_3	Pre-mixed-frozen version of Polytec TC 451.

N.A. = not applicable / RT = Room Temperature
„pre-mixed-frozen" adhesives will be shipped in specially insulated styrofoam boxes containing dry ice.

Optical Adhesives

Type / Polytec	Number of Components	Mix Ratio By Weight	Shelf Life / Curing / Pot Life: Shelf Life Temperature	Shelf Life Months	Minimum Bond Line Cure Schedule	Pot Life	Optical Properties: Color (Before/After Cure)	Thermal Properties: Continuous Operating Temperature [°C]	Glass Transition Temperature [Tg]	Mechanical Properties: Die-Shear Strength [N/mm²]	Shore Hardness	Specific Gravity [g/cm³]	Processing Properties: Viscosity [84 RPM @ 23°C] [mPa s]	Consistency	Characterization
EP 501	1	N.A.	at 4 – 6°C	6	150°C / 10 Mins.	approx. 1 Month	White / transparent clear	-55 / 180	80	50	D85	1,2	16.000	Thixotropic paste	Single component adhesive with excellent adhesion to metals, ceramics, glass, FR4 and most plastics. Optically clear Glob Top material and protection layer against silver migration.
EP 601	2	100 : 35	at RT	12	23°C / 16 Hours 70°C / 60 Mins.	4 Hours	Transparent clear	-55 / 125	65	80	D80	1,15	460	Flowable liquid	Transparent, optically clear epoxy for applications in optics, fiber optics, optoelectronics, medical and semiconductor technology. **USP Class VI compliant**.
EP 601-frozen	1	N.A.	at -40°C	12	23°C / 16 Hours 70°C / 60 Mins.	4 Hours	Transparent clear	-55 / 125	65	80	D80	1,15	460	Flowable liquid	Pre-mixed-frozen version of Polytec EP 601.
EP 601-Black	2	100 : 35	at RT	12	23°C / 16 Hours 70°C / 60 Mins.	4 Hours	Black	-55 / 125	65	80	D80	1,15	460	Flowable liquid	Black-colored and optically opaque epoxy, designed for applications in optics, fiber optics, optoelectronics, medical, sensors and semiconductor technology. Also available as pre-mixed-frozen version Polytec EP 601-Black-frozen.
EP 601-LV	2	100 : 35	at RT	12	23°C / 16 Hours 70°C / 60 Mins.	4 Hours	Transparent clear	-55 / 125	65	80	D80	1,15	240	Flowable liquid	Low viscosity version of Polytec EP 601. Ideal for fine cavity filling and chip potting.
EP 601-LV-frozen	1	N.A.	at -40°C	12	23°C / 16 Hours 70°C / 60 Mins.	4 Hours	Transparent clear	-55 / 125	65	80	D80	1,15	240	Flowable liquid	Pre-mixed-frozen version of Polytec EP 601-LV.
EP 601-T	2	100 : 35	at RT	12	23°C / 16 Hours 70°C / 60 Mins.	4 Hours	Translucent	-55 / 125	65	80	D80	1,05	3.000	Thixotropic paste	Thixotropic, non-flow version of Polytec EP 601.
EP 601-T-frozen	1	100 : 35	at -40°C	12	23°C / 16 Hours 70°C / 60 Mins.	4 Hours	Translucent	-55 / 125	65	80	D80	1,05	3.000	Thixotropic paste	Pre-mixed-frozen version of Polytec EP 601-T.
EP 601-T-Black	2	100 : 35	at RT	12	23°C / 16 Hours 70°C / 60 Mins.	4 Hours	Black	-55 / 150	65	80	D80	1,16	3.000	Thixotropic paste	Black colored version of Polytec EP 601-T. Also available as pre-mixed-frozen version Polytec EP 601-T-Black-frozen.
EP 610	2	100 : 50	at RT	12	23°C / 16 Hours 80°C / 60 Mins.	6 Hours	Transparent clear	-55 / 150	N.A.	N.A.	A65	1,05	780	Low Viscosity	It is used for stress-free bonding of large optical components with different CTEs. This material is suggested for applications in the optics, fiber optics, optoelectronics, medical and semiconductor industry.
EP 610-frozen	1	N.A.	at -40°C	12	23°C / 16 Hours 80°C / 60 Mins.	6 Hours	Transparent clear	-55 / 150	N.A.	N.A.	A65	1,05	780	Low Viscosity	Pre-mixed-frozen version of Polytec EP 610.

N.A. = not applicable / RT = Room Temperature
„pre-mixed-frozen“ adhesives will be shipped in specially insulated styrofoam boxes containing dry ice.

Polytec PT
Polymere Technologien

Optical Adhesives

Type			Shelf Life / Curing / Pot Life				Optical Properties	Thermal Properties		Mechanical Properties			Processing Properties		Characterization
Polytec	Number of Components	Mix Ratio By Weight	Shelf Life Temperature	Shelf Life Months	Minimum Bond Line Cure Schedule	Pot Life	Color (Before/After Cure)	Continuous Operating Temperature [°C]	Glass Transition Temperature [Tg]	Die-Shear Strength [N/mm²]	Shore Hardness	Specific Gravity [g/cm³]	Viscosity [84 RPM @ 23°C] [mPa s]	Consistency	
EP 610-T	2	100 : 50	at RT	12	23°C / 16 Hours 80°C / 60 Mins.	6 Hours	Translucent	-55 / 150	N.A.	2,9	A65	1,05	3.000	Non-flowing paste	Polytec EP 610-T is the non-flowing, thixotropic version of Polytec EP 610. It is used for stress-free bonding of large optical components with different CTEs.
EP 610-T-frozen	1	N.A.	at -40°C	12	23°C / 16 Hours 80°C / 60 Mins.	6 Hours	Translucent	-55 / 150	N.A.	2,9	A65	1,05	3.000	Non-flowing paste	Polytec EP 610-T-frozen is the pre-mixed-frozen version of Polytec EP 610-T.
EP 630	2	100 : 10	at RT	12	120°C / 30 Min. 150°C / 5 Mins.	24 Hours	Yellow / amber	-55 / 230	120 - 130	90	D85	1,1	3.000	Pourable liquid	Exhibits excellent high temperature, chemical, electrical and moisture resistance. Especially designed for applications in the semiconductor, medical, hybrid, piezo and fiber optics industry, Passes > 900 autoclave steam cycles! **USP Class VI compliant**.
EP 630-frozen	1	N.A.	at -40°C	12	120°C / 30 Mins. 150°C / 5 Mins.	24 Hours	Yellow / amber	-55 / 230	120 – 130	90	D85	1,1	3.000	Pourable liquid	Pre-mixed-frozen version of Polytec EP 630.
EP 630-LV	2	100 : 10	at RT	12	120°C / 30 Mins. 150°C / 5 Mins.	2 – 3 Days	Yellow / amber	-55 / 230	120 – 130	90	D85	1,1	1.000	Liquid	Low viscosity version of Polytec EP 630. Used as epoxy impregnation, underfill,fill in the dam&fill technique and as encapsulant. Also available as pre-mixed-frozen version Polytec EP 630-LV-frozen.
EP 653	2	100 : 10	at RT	12	80° / 90 Mins. 120°C / 30 Mins. 150° / 5 Mins.	24 Hours	Yellow / amber	-55 / 230	120 – 130	80	D85	1,1	6.000	Flowable liquid	The ultimate epoxy in high temperature, chemical, electrical and moisture resistance. Designed for applications such as medical endoscopes, fiber optical connectors and many more in the semiconductor, hybrid, piezo and optronics industry. Passed > 500 autoclave steam cycles! **USP Class VI compliant**.
EP 653-frozen	1	N.A.	at -40°C	12	80° / 90 Mins. 120°C / 30 Mins. 150° / 5 Mins.	24 Hours	Yellow / amber	-55 / 230	120 – 130	80	D85	1,1	6.000	Flowable liquid	Pre-mixed-frozen version of Polytec EP 653.
EP 653-Black	2	100 : 10	at RT	12	80° / 90 Mins. 120°C / 30 Mins. 150° / 5 Mins.	24 Hours	Black	-55 / 230	120 – 130	80	D85	1,1	6.000	Flowable liquid	Black colored version of Polytec EP 653. Also available as pre-mixed-frozen version Polytec EP 653-Black-frozen.
EP 653-T	2	100 : 10	at RT	12	80° / 90 Mins. 120°C / 30 Mins. 150° / 5 Mins.	24 Hours	Yellow / amber	-55 / 230	120 – 130	80	D85	1,1	23.000	Creamy paste	Thixotropic, non-flowing version of Polytec EP 653. Also available as black colored version Polytec EP 653-T-Black.
EP 653-T-frozen	1	N.A.	at -40°C	12	80° / 90 Mins. 120°C / 30 Mins. 150° / 5 Mins.	24 Hours	Yellow / amber	-55 / 230	120 – 130	80	D85	1,1	23.000	Creamy paste	Pre-mixed-frozen version of Polytec EP 653-T.
EP 660	2	100 : 17	at RT	12	23°C / 16 Hours 120°C / 30 Mins.	45 Mins.	Yellowish / translucent	-55 / 240	120	N.A.	D80	1,12	1.000	Low viscosity	Low viscosity, High Temp epoxy impregnation and coating material. Typical applications are the impregnation and sealing of magnesium oxide fillers in tubular heaters / heating elements.

N.A. = not applicable / RT = Room Temperature
„pre-mixed-frozen“ adhesives will be shipped in specially insulated styrofoam boxes containing dry ice.

Polytec-2C-PAC

GET'S YOU MOBILE

Most of the Polytec optical grade epoxies are available in so called Polytec-2C-PACs.

Both components are pre-measured to the accurate mix ratio.

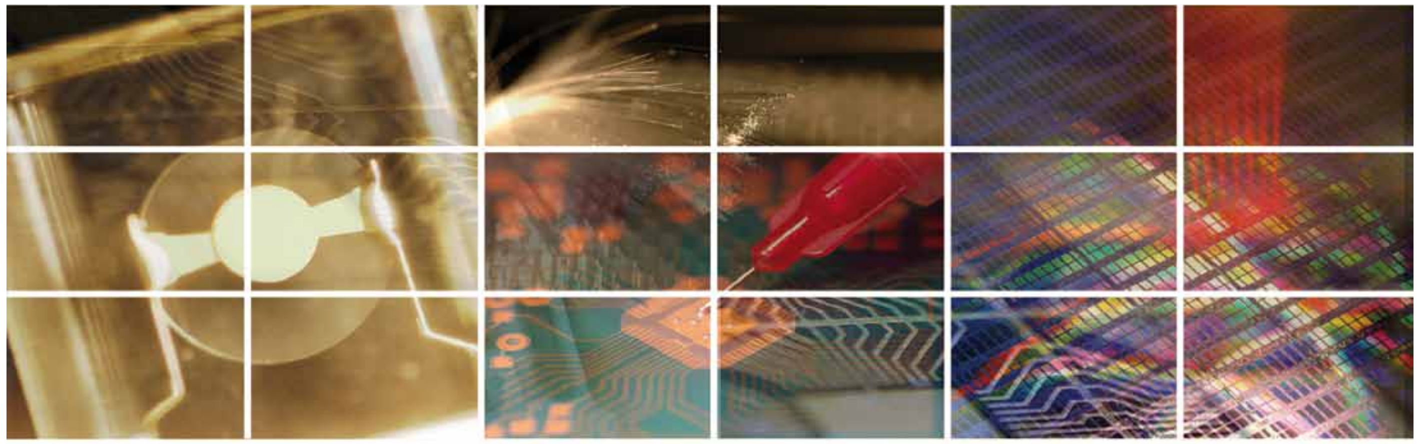
By removing the divider clip that separates both components the customer can mix both components very fast and convenient.

This allows even mobile usage of two component materials without scales, mixers etc.

Polytec-2C-PACs are ideal for easy fiber- and fiber connector bonding and potting applications – **wherever you are!**

Polytec-2C-PAC

- **Perfectly protected against moisture**
- **Accurate mix proportion**
- **Disposable packages**
- **Less waste**
- **Mobile and instant usage**
- **Safe and reliable**
- **Low cost**



Polyimide Adhesives

State-of-the Art-polyimides (and bismaleimides) offer an excellent thermal resistance compared to any other organic adhesives on the market.

Due to their extreme thermal stability it is possible to expose them up to 450°C for short time. The long term thermal endurance is usually greater than 260°C. All polyimides provide an outstanding chemical and moisture resistance.

Polyimides can be found in very unique, highly specialized applications in the semiconductor, photovoltaic, sensor, fiber optics and electronics industry.

They are available as silver filled – electrically conductive, ceramic filled – thermally conductive and unfilled – electrically insulating adhesives and coatings.

All polyimide materials may be modified and tailored to the needs of our customers.

Type	Typical Applications	Shelf Life at 4 – 6 °C	Continous max. Operating Temperature	Remarks
Polytec EC P-280	Assembly of electronic components. COB, LED, hybrids and piezo crystals.	4 – 6 Months	-55°C – 270°C	Electrically conductive Dispensing, Screen Printing
Polytec EC P-280-S	Assembly of electronic components. COB, LED, hybrids and piezo crystals.	4 – 6 Months	-55°C – 270°C	Electrically conductive Dispensing, Stamping
Polytec EP P-690	Fiber bundles, optics, Sensor potting and coating	6 Months	-55°C – 255°C	Electrically insulating Dispensing, Potting, Dipping
Polytec EP P-695	Fiber bundles, optics, Sensor potting and coating	6 Months	-55°C – 450°C	High Temp version of Polytec EP-690
Polytec TC P-490	Wafer passivation Sensors Thermal management	4 – 6 Months	-55°C – 270°C	Thermally conductive, electrically insulating Dispenser, Screen Printing
Polytec EP Thinner	Thinner for polyimids and epoxies	6 Months	up to 270°C	

Polyimides are very special materials – Please note the data sheets and material safety data sheets and work safely!

Polytec PT – Training Courses and Seminars

LIFELONG LEARNING

Polytec PT conducts on a regular basis trainings and seminars at the customer's or distributor's premises or in its facility in Waldbronn.
The focus of these seminars is, to provide the participants with profound knowledge of processing adhesives in industrial production environments.

Contents

- Adhesive Technology (selection and design)
- Electrically, thermally conductive and optical grade
- Reliabilty of adhesive joints
- Surface pretreatment
- Application methods
- Quality assurance
- Production issues
- Innovative techniques and brand new trends

Target Group

- R&D engineers
- Application engineers
- Persons in charge of production and process technique
- Q&A staff

Features

- In depth discussion with adhesive experts and scientists
- Intense one day and two days seminars, workshops and training courses
- Theoretical and practical lab events
- Complete documentation

Speakers

- Polytec PT adhesive experts
- Scientists from institutes and universities
- Specialists from the industry

Info & Registration
Infos regarding dates, venue, course fees and registration can be found on our website and the websites of our international sales representatives.

www.polytec-pt.com

ASK our Application Experts

1. **Your Application**
Please send us a detailed description of your application. Our application experts will support you to optimise all relevant process parameters.

2. **Our Competence**
From selecting the suitable adhesive, possible surface pretreatment to the best application method, our technical assistance will expedite your development process.

3. **...Here we go!**
Two components, single component or pre-mixed frozen, whether it will be standard or a modified material...
Rely on our competence!

Creating Solutions Through Polymers

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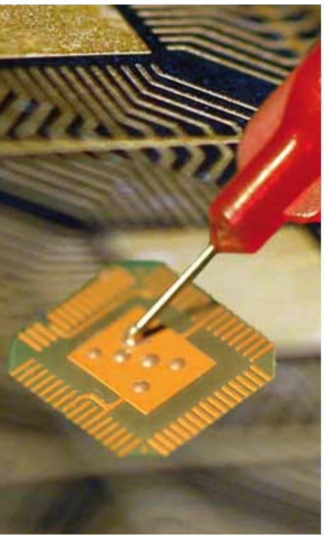

Polytec PT Headquarter – centrally located in the northern edge of the Black Forest

Waldbronn, an attractive spa town, is favorably located in the northern edge of the Black Forest, only a few miles away from Karlsruhe, close to both the autobahns A5 Frankfurt-Basel and A8 Karlsruhe-Munich.

More Info:
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