

The Adhesive Bonding of Makrolon®

- Polycarbonate (PC)
- Secondary finishing

General

There are various different ways in which molded parts in polycarbonate can be glued together. Most of these methods permit a joining area of excellent quality to be obtained. Compared with joining by welding, however, very little use is made of adhesive bonding. This is because of the higher outlay generally involved and the wish to avoid the use of solvents.

Adhesive bonding is the preferred method of joining polycarbonate for

- joining operations that involve large, cumbersome parts, such as sheets¹⁾
- small series
- uneven surfaces, where a two-component adhesive also serves as a filler compound
- applications in which elastic adhesives constitute a form of damping element

Prior to bonding, the surfaces to be joined should be thoroughly cleaned to remove any dirt and other foreign materials.

To do this, they should be washed in hot water, to which slightly acidic, neutral or slightly alkaline rinsing agents (pH value of between 4.5 and 7.5) have been added, as appropriate.

Very greasy or oily surfaces should be cleaned with aromatic-free benzene fractions or by using ethyl alcohol, isopropanol or isobutyl alcohol.

¹⁾ See also in the Internet under

www.sheet.bayerpolymers.com

(Technical Information/Solid sheets/Technical information)

→ "Makrolon® - Bonding & Fastening"

Bonding with solvents and solution adhesives

If parts in Makrolon® are to be bonded, then the solvents methylene chloride (dichloromethane), 1,2 dichloroethane and 1,3 dioxolane are particularly suitable.

Prior to bonding, the contact surfaces of the molded parts are slightly dissolved with one of the solvents for 5 to 10 seconds and then pressed together under a constant, high pressure for an appropriate period of time, e.g. one hour at 5 to 10 bars.

A slightly better bond is achieved through the use of solution adhesives which are obtained by dissolving 5 % by weight polycarbonate in the solvent, for example, and then applying in a thin layer to the part.

In the case of Makrolon®, methylene chloride gives adhesive bonds that have a shear strength up to 30 % higher than 1,3 dioxolane and cure more rapidly.

Transparent bonds, however, can be achieved more readily with 1,3 dioxolane.

A bond that has been achieved with a solution adhesive will emit slight quantities of solvent vapor for a long time.

From the health point of view (see under "Safety advice"), it is therefore recommended that 1,3 dioxolane be used for bonds in indoor applications.

The emissions can be avoided by conditioning the bonded parts at a temperature of 50 to 70 °C, in a vacuum where necessary (bubbles will start to form at higher temperatures). A conditioning time of at least 24 h will be required; the precise time should be established in each individual case.

Bonding with two-component adhesives

A number of companies have developed special two-pack adhesives which also bond polycarbonate successfully.

Two-component adhesives will additionally permit polycarbonate to be bonded to a large number of other materials.

Two-component adhesives are simple and quick to use compared with solvents and solution adhesives. The surfaces to be joined do not need to be such a good fit.

The automotive industry uses two-component adhesives which are elastic in the hardened state for applications such as bonding transparent polycarbonate headlamp diffusers to reflectors made of opaque, colored polycarbonate with a metabolized inside surface.

Two-component adhesives for polycarbonate based on epoxy resin must not contain any low-molecular amines. Polymeric amino amides can be used as hardeners. Residual amino groups must be prevented from reacting with polycarbonate by ensuring that they react as completely as possible with the epoxide groups.

Two-component and single-component polyurethane adhesives have also proved successful for joining polycarbonate. Here again, care must be taken to ensure that the adhesives do not contain any solvents or amines.

Silicone adhesives are particularly suitable as joint-filling systems in applications like industrial glazing and glazing for horticultural buildings.

Cyan acrylate adhesives are particularly suitable for very rapid polycarbonate bonding. These adhesives should only be used to bond low-stress parts which are not exposed to hydrolytic stressing in service.

When polycarbonate parts are bonded, no additional stresses are introduced into the parts being joined, as a rule. This advantage of bonding over a number of welding methods can be exploited for molded parts that need to be optimized in respect of achieving a minimum of inherent stress.

There are a series of adhesives on the market that are suitable for Makrolon®.

Since the composition of the adhesives is known only to the manufacturers, the companies concerned should be contacted for details.

When processing solvents and solution adhesives, it is important to observe the general precautions for the handling of solvents.

In the case of two-component adhesives, the precautions specified by the individual manufacturers should be observed.

The adhesive manufacturers can be found in the Internet under

www.klebstoffe.com
(Industrieverband Klebstoffe e.V.)

www.feica.com
(Association of European Adhesives and Sealants Manufacturers)

Safety Notice

When handling the recommended adhesives and solvents, it is essential for the advice contained in the Safety Data Sheets for these products to be observed.

The Safety Data Sheets will be made available by the individual suppliers.

Further up-to-date information on the individual solvents is also available on the internet, in the GESTIS hazardous substances database (GESTIS = information system on hazardous substances for the German statutory accident insurance and accident prevention organizations) at

www.hvbg.de/d/bia/gestis/stoffdb/index.html.

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Under the recommended processing conditions small quantities of decomposition product may be given off during processing. To preclude any risk to the health and well-being of the machine operatives, tolerance limits for the work environment must be ensured by the provision of efficient exhaust ventilation and fresh air at the workplace in accordance with the Safety Data Sheet. In order to prevent the partial decomposition of the polymer and the generation of volatile decomposition products, the prescribed processing temperatures should not be substantially exceeded.

Unless specified to the contrary, the values given have been established on standardized test specimens at room temperature. The figures should be regarded as guide values only and not as binding minimum values. Please note that, under certain conditions, the properties can be affected to a considerable extent by the design of the mold/die, the processing conditions and coloring.

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