Structural Bonding
Requirements, Adhesives and Applications
Adhesives have become an essential assembly element in industrial production, and perform a multitude of functions. Comparable performance can be achieved with no other joining technique. Numerous tests have incontrovertibly proven the superiority of adhesives over screws, rivets and welds.

In addition, a great deal of weight and therefore energy can be saved by using adhesives. Therefore, bonding technology is now used in fields where adhesives would have been unimaginable only a few years ago, such as in mechanical engineering and even heavy-duty structures with high mechanical loads.

**Satisfied customers:**

*Bonding of carbide elements to produce saw blades: high resistance to elevated temperatures and chemicals*
DELO’s adhesives for structural bonding...

... are ideal for many applications and requirements:

**DELO-ML**
1C methacrylate, anaerobic and partly light- or UV-curing
- For metal bonding and metal/mixed joins
- Easy, one-component processing
- Fast firmness to touch within a few minutes
- Good resistance to elevated temperatures and chemicals
- Tension-equalizing, flexible, impact resistant variants

**DELOMONOPOX**
1C epoxy resin, heat-curing
- For high-strength bonding
- High resistance to elevated temperatures and chemicals
- Excellent mechanical properties
- Often used as a replacement for conventional joining methods like riveting, welding or hard soldering
- Easy, one-component processing

**DELO-DUOPOX**
2C epoxy resin, room-temperature-curing
- Especially for very large or temperature-sensitive components
- Easy, “one-component” processing in the DELO-AUTOMIX system
- High resistance to chemicals
- Good mechanical properties
- For bonding components with high strength requirements

**DELO-PUR**
2C polyurethane, room-temperature-curing
- Easy, “one-component” processing in the DELO-AUTOMIX system
- For bonding metal and plastic
- For peel-resistant and tension-equalizing bonding
In order to be able to fully exploit the advantages of adhesives, the design of the join must match bonding technology. Proper design of the components for bonding can

- Prevent costs,
- Speed production processes, and
- Expand the range of suitable adhesives.

**Adhesive-friendly design means:**

- Provision of sufficiently large bonding surfaces
- Even distribution of tensions
- Only compression, tensile and shear stress if possible
- Avoiding peel and bending stress
- Avoiding eccentric force transmission
- Avoiding plastic component deformation

<table>
<thead>
<tr>
<th>Unfavorable design</th>
<th>Adhesive-friendly design</th>
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<tbody>
<tr>
<td><img src="image1" alt="Unfavorable design 1" /></td>
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<td><img src="image16" alt="Adhesive-friendly design 8" /></td>
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Adhesive-friendly design of bonded connections
It is not only essential to choose the right adhesive. The finish of the component surface is also of great importance for the achievable bond strength, and even more so for the durability of the bond. In general, the surfaces to be bonded are to be dry, as well as free of dust, grease and other contaminations.

The objective of surface pretreatment is to create even and defined surfaces as the basis for:
- Even and proper wetting of the component surface with adhesive
- Improved adhesion
- A reproducible, permanently strong connection

DELO-SACO sand blasting / DELO-SACO SIL E primer

SACO = Simultaneous abrasion (SA)nd blasting) and COating of the surface (see figure above).
- For use on metal, plastic and ceramic
- For preparing difficult to bond materials
- Enables excellent bond strength

To get a perfect bond between the component and the adhesive after DELO-SACO treatment, the DELO-SACO SIL E primer is applied to the coated substrate surface by brushing, dipping or spraying. After evaporation, the adhesive can be applied.

DELOTHEN cleaners

For removing contaminatants and degrease the surface, DELOTHEN is sprayed directly onto the surface to be cleaned from a distance of 20 – 30 cm. After evaporation, the adhesive can be applied.

Brochures:
- Cleaners – Preparation of bonding surfaces
- DELO-SACO – Simple blasting technique
DELO’s adhesive takes a ride on a coaster

DELO’s epoxy resins are used in the linear motors of the “blue fire Megacoaster” catapult rollercoaster in the Europa-Park Rust, Germany. The linear motors used were developed and patented by Intrasyx, Munich, and Fersch Wickeltechnik, Attenhofen, Germany. On the one hand, the stators are bonded. In addition, GRP angles outside the stators are connected that are later used to screw the stators to the bottom of the rollercoaster.

High requirements
The rollercoaster trains are accelerated to 100 km/h in 2.5 seconds on an 80-meter-long launch track. The acceleration values reached by this rollercoaster correspond to those of a modern Formula 1 car. Therefore, the adhesive must fulfill high requirements and provide safety.

DELOMONOPOX AD295
- Lamination of stators for linear drives
- Bonding of elbow fittings to the stators

DELO-DUOPOX AD895
- Bonding of installation plates to the elbow fittings of the stators
- Bonding of the electric drive gearbox to the bottom of the stators
- Bonding of steel installation rails
DELO adhesives are used in space – in the aerospace project ROKVII (Robotic Components Verification on ISS).

ROKVII consists of a robotic manipulator with two hinges, a camera that follows the movements of the robotic manipulator and another camera that observes Earth.

So that the robotic manipulator can move flexibly, it is equipped with two hinges driven by motors. DELO developed the epoxy adhesive that holds these motors together. Not only are the magnets bonded to the stator, but the stator is also bonded into the motor housing. The adhesive fulfills the requirements of space use, and is now used in all motors manufactured by the DLR (Deutsches Zentrum für Luft- und Raumfahrt = German Aerospace Center). In addition, this adhesive family is also used for other applications such as in car engine compartments.

High requirements

The one-component, heat-curing DELOMONOPOX AD295 epoxy resin is used. The adhesive is ideal for bonding metals, temperature-resistant plastics, ferrites and ceramics.

It is particularly suitable for high-strength, tough-hard connections with high resistance to static and dynamic stress, even at elevated temperatures. It meets the requirements of the ECSS Q-70-02 thermal vacuum outgassing test used to screen space materials.
DELO’s adhesives in action

Securing of screws in differential gears

DELO-ML 5327
- High-strength connection
- Excellent chemical resistance
- Normal temperature range from −60 °C to +200 °C
- Accelerated curing in combination with DELO-QUICK 5002 enables short cycle times
- For high force transfer

Bonding of rotor package to shaft

DELO-ML DB133
- Immediate firmness to touch by light fixation; anaerobic curing of adhesive in shadowed areas
- High impact resistance
- Excellent chemical resistance
- Tension-equalizing with an elongation at tear of 130%
- Ideal for laminar bondings

Bonding of magnets in stator housings

DELOMONOPOX AD289
- High impact resistance
- Fills gaps
- Excellent chemical resistance (for example, to oil, gasoline, brake fluid)
- Normal temperature range up to +200 °C
- High static and dynamic loading capacity

Bonding of magnesium

DELOMONOPOX AD286
- High-strength connection
- Good chemical resistance
- High temperature resistance and stability
- Vibration-resistant
- High-viscous, run-resistant

Bonding and securing of screws in the differential gear of a combine harvester

High-strength bonding of a rotor package to a shaft (steel-to-steel bonding)

Bonding of magnets into the stator housing of an electric motor

High-strength bonding of top shell, bottom shell, and side panels of intake manifold modules for engines
Attaching of banister elements

DELO-DUOPOX AD895
- Fills gaps, suitable for small and large bonding gaps
- Good chemical resistance and aging resistance
- For interior and exterior use
- Efficiency: Flexible modular system in banister construction. The additional process steps required for welding, such as grinding or polishing, are avoided.

Bonding of aluminum profiles

DELO-DUOPOX AD894
- Adjusted flow behavior for tongue and groove connections
- High strength and excellent chemical resistance
- Efficiency: Tool costs can be saved by using easy to produce standard L-sections (instead of complete pipes)

Sealing of housings

DELO-PUR 9895
- Run-resistant
- Good resistance to chemicals
- Excellent equalization of tensions
- Fast firmness to touch

Installation of fixtures in ships

DELO-PUR 9694
- Run-resistant → Highly suitable for larger bonding gaps and bonding on vertical areas
- Good tough-elastic properties
- High strength even under static and dynamic stress
- High resistance to sea-water, no corrosion
- Excellent equalization of tensions
- Authorization by Germanischer Lloyd
# DELO’s adhesives for structural bonding at a glance

<table>
<thead>
<tr>
<th></th>
<th>DELOMONOPOX 1-component epoxy resins</th>
<th>DELO-ML Anaerobic-curing adhesives</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Very high strength</strong></td>
<td>✓ ✓ ✓ ✓ ✓</td>
<td>✓ ✓ ✓ ✓ ✓</td>
</tr>
<tr>
<td><strong>Elastic/tension-equalizing</strong></td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td><strong>High chemical resistance</strong></td>
<td>✓ ✓ ✓ ✓ ✓</td>
<td>✓ ✓ ✓ ✓ ✓</td>
</tr>
<tr>
<td><strong>High temperature of use</strong></td>
<td>✓ ✓ ✓ ✓ ✓</td>
<td>✓ ✓ ✓ ✓ ✓</td>
</tr>
<tr>
<td><strong>Color</strong></td>
<td>silver gray</td>
<td>yellow</td>
</tr>
<tr>
<td><strong>Viscosity [mPas] at +23 °C, mixture</strong></td>
<td>310,000</td>
<td>300</td>
</tr>
<tr>
<td><strong>Processing time [min] at room temperature</strong></td>
<td>3 g prep. (1 mixing tube) 100 g prep.</td>
<td>firm to touch 1 – 2 MPa 180/15 min 150/40 min 150/40 min 150/40 min 130/30 min</td>
</tr>
<tr>
<td><strong>Curing time</strong></td>
<td>final strength T [°C]/time 180/15 min 150/40 min 150/40 min 150/40 min</td>
<td>final strength T [°C]/time</td>
</tr>
<tr>
<td><strong>Tensile shear strength [MPa] DIN EN 1465 1.6 mm</strong></td>
<td>33 28 30 30 14</td>
<td>5 1 53 32 8</td>
</tr>
<tr>
<td><strong>Elongation at tear [%] DIN EN ISO 527</strong></td>
<td>2.8 3.2 1.4 1.4 1.6</td>
<td>5 15 33 28</td>
</tr>
<tr>
<td><strong>Storage life (after delivery in unopened original container)</strong></td>
<td>6 months at 0 to +10 °C</td>
<td>12 months at rt</td>
</tr>
<tr>
<td><strong>Container sizes</strong></td>
<td>EC 1, 1 kg tin, 38 kg hobbock</td>
<td>EC 1, 25 kg hobbock</td>
</tr>
</tbody>
</table>

1. EC = Euro cartridge
2. DCC = double chamber cartridge

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### DELOMONOPOX 1-component epoxy resins

- **Very high strength**
- **Elastic/tension-equalizing**
- **High chemical resistance**
- **High temperature of use**

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<th>Processing time [min] at room temperature</th>
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<th>Tensile shear strength [MPa] DIN EN 1465 1.6 mm</th>
<th>Elongation at tear [%] DIN EN ISO 527</th>
<th>Storage life (after delivery in unopened original container)</th>
<th>Container sizes</th>
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<tbody>
<tr>
<td>silver gray</td>
<td>310,000</td>
<td>–</td>
<td>–</td>
<td>33</td>
<td>2.8</td>
<td>6 months at 0 to +10 °C</td>
<td>EC 1, 1 kg tin, 38 kg hobbock</td>
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<tr>
<td>gray</td>
<td>190,000</td>
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<td>28</td>
<td>3.2</td>
<td>6 months at 0 to +10 °C</td>
<td>EC 1, 25 kg hobbock</td>
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<tr>
<td>light beige</td>
<td>230,000</td>
<td>–</td>
<td>–</td>
<td>30</td>
<td>1.4</td>
<td>6 months at 0 to +10 °C</td>
<td>EC 1, 1 kg tin, 20 kg hobbock</td>
</tr>
<tr>
<td>light beige</td>
<td>pasty</td>
<td>–</td>
<td>–</td>
<td>30</td>
<td>1.4</td>
<td>6 months at 0 to +10 °C</td>
<td>50, 200 ml DCC 2, 20 kg comp. A+B</td>
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<tr>
<td>black</td>
<td>40,000</td>
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<td>–</td>
<td>14</td>
<td>1.6</td>
<td>6 months at 0 to +10 °C</td>
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<tr>
<td>yellowish / transparent</td>
<td>12,000</td>
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<td>16</td>
<td>6</td>
<td>12 months at rt</td>
<td></td>
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</tbody>
</table>

### DELO-ML Anaerobic-curing adhesives

- **Very high strength**
- **Elastic/tension-equalizing**
- **High chemical resistance**
- **High temperature of use**

<table>
<thead>
<tr>
<th>Color</th>
<th>Viscosity [mPas] at +23 °C, mixture</th>
<th>Curing time [min] at room temperature</th>
<th>Compr. shear strength [MPa] of joined connections</th>
<th>Elongation at tear [%] DIN EN ISO 527</th>
<th>Storage life (after delivery in unopened original container)</th>
<th>Container sizes</th>
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<tbody>
<tr>
<td>yellow</td>
<td>pasty</td>
<td>firm to touch (Znph screws) 5 – 10 24 h</td>
<td>5</td>
<td>n. d.</td>
<td>12 months at rt</td>
<td>200 ml</td>
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<td>15</td>
<td>n. d.</td>
<td>12 months at rt</td>
<td>15, 50, 200 ml</td>
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<tr>
<td>green</td>
<td>300</td>
<td>final strength 24 h</td>
<td>33</td>
<td>n. d.</td>
<td>6 months at rt</td>
<td>50, 200 ml</td>
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<tr>
<td>colorless</td>
<td>700</td>
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<td>28</td>
<td>130</td>
<td>9 months at rt</td>
<td>50, 200 ml</td>
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</table>

n. d. = not determinable
### DELO-DUOPOX
2-component epoxy resins

<table>
<thead>
<tr>
<th>03 rapid tix</th>
<th>AD821</th>
<th>AD840</th>
<th>AD894</th>
<th>AD895</th>
<th>AD897</th>
<th>9691</th>
<th>9692</th>
<th>9694</th>
<th>9695</th>
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<td>50, 200 ml DCC², 1 kg comp. A+B, 70 kg comp. A+B</td>
<td>50, 200 ml DCC², 1 kg comp. A+B, 74.6 kg comp. A+B</td>
<td>50, 200 ml DCC², 54 kg comp. A+B</td>
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### DELO-PUR
2-component polyurethanes

<table>
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<tr>
<th>03 rapid tix</th>
<th>AD821</th>
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All products are
- Solvent-free
- Compliant with RoHS Directive 2002/95/EC
The data and information provided are based on tests performed under laboratory conditions. Reliable information about the behavior of the product under practical conditions and its suitability for a specific purpose cannot be concluded from this. It is the user’s responsibility to test the suitability of the product for the intended purpose by considering all specific requirements. Type, physical and chemical properties of the materials to be processed with the product, as well as all actual influences occurring during transport, storage, processing and use, may cause deviations in the behavior of the product compared to its behavior under laboratory conditions. All data provided are typical average values or uniquely determined parameters measured under laboratory conditions. The data and information provided are therefore no guarantee for specific product properties or the suitability of the product for a specific purpose. Verbal ancillary agreements are deemed not to exist.

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