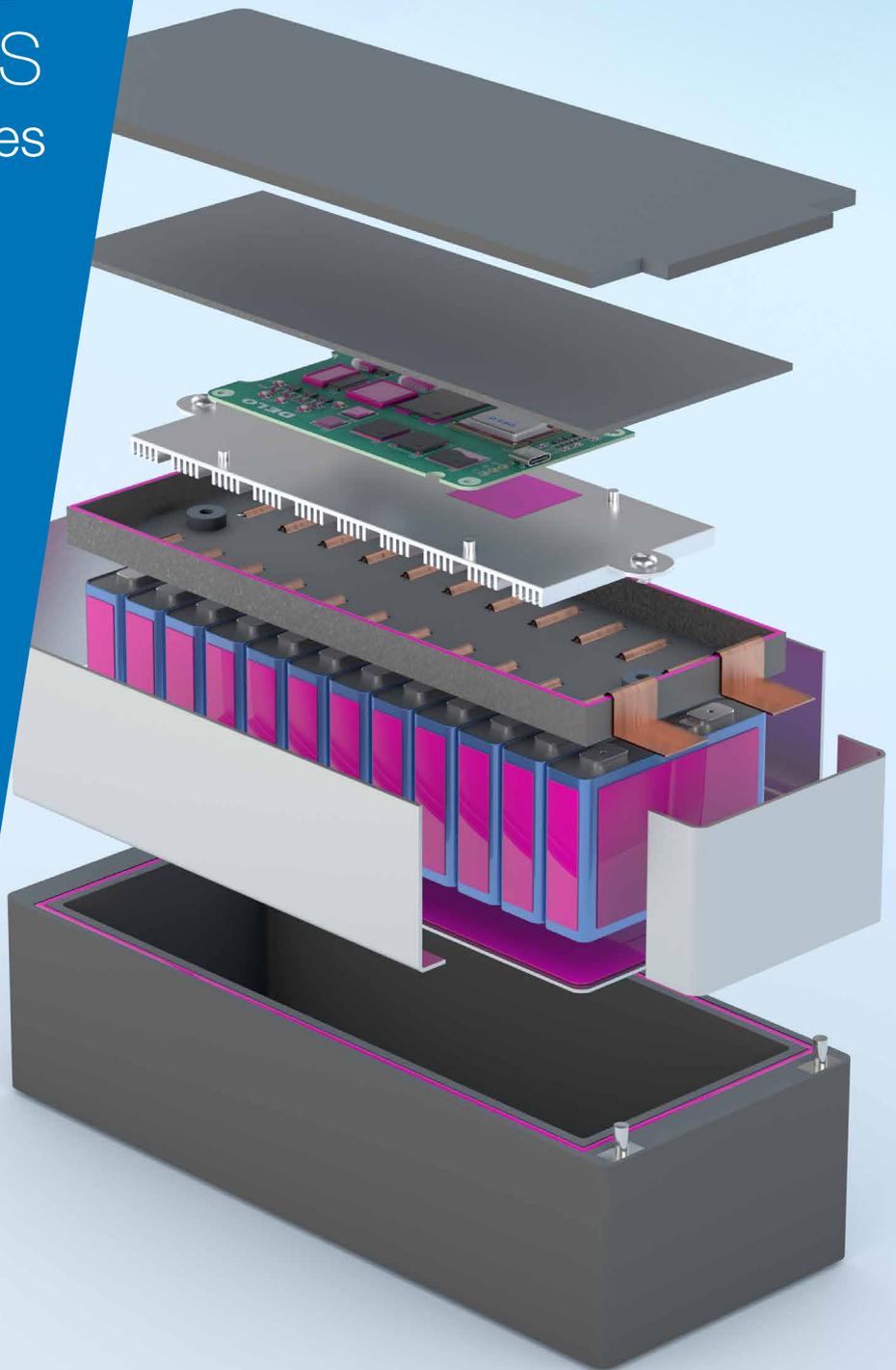


ADHESIVES AND
ENCAPSULANTS
for automotive batteries



Bonding applications in lithium-ion batteries

Improving lithium-ion batteries with DELO adhesives

DELO's adhesives, sealants and encapsulants play a significant role in lithium-ion batteries. Our portfolio of automotive battery adhesives fulfills various bonding and life cycle requirements for 48 V hybrid, plug-in hybrid and all-electric battery concepts.

Our adhesives have a variety of uses ranging from the bonding of heat sinks and battery cells, to the protection of certain components by encapsulation. DELO adhesives are not only used to perform structural tasks, but they are also used for heat dissipation. As an alternative to gap fillers or thermal pads, our line of thermally conductive adhesives is designed to dissipate heat generated during battery operation. They are also flame-retardant, adding to the overall safety of battery packs.

In power electronics, electrically conductive adhesives skip soldering process steps and offer freedom of design. Sealing and performance requirements are met over a broad range of temperatures.

With the increasing number and variety of electric cars on the market, suppliers benefit from DELO's expertise in speeding up production with its adhesives. In addition to classic heat or room temperature curing processes, DELO's light curing and light fixation products offer greater efficiency in higher volumes.

Encapsulation

Module fixation

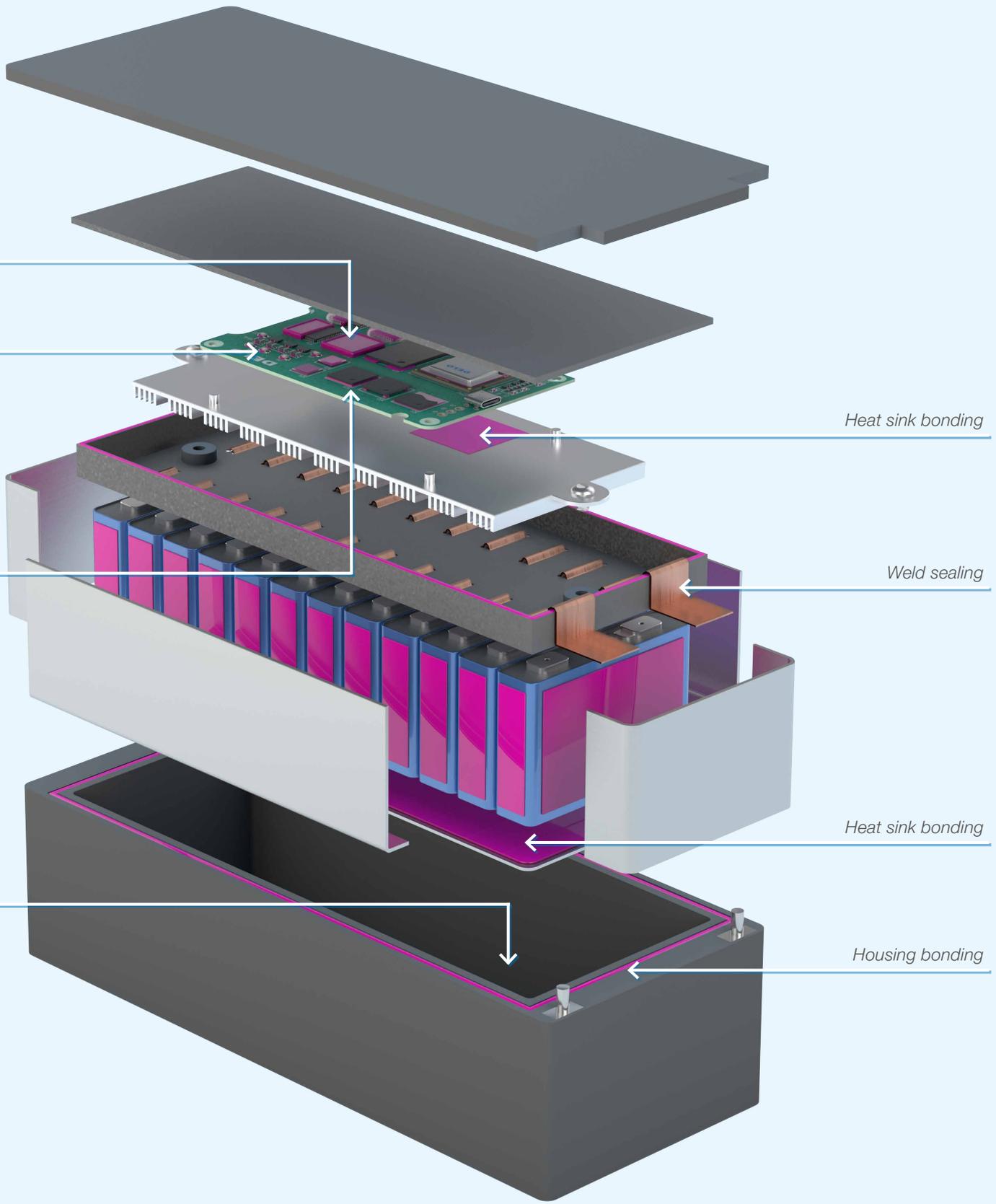
Electroconductive bonding

ONSERT bonding



Discuss your project and your requirements with our experts:

esc-experts@DELO.de



Carrier bonding for high-voltage systems

For high-volume applications like bonding cylindrical cells into a carrier, battery manufacturers benefit from DELO's vast portfolio of high-speed adhesives. These UV-curing acrylates bond in seconds and make time-consuming batch curing process a thing of the past. In addition to their integrated flame retardancy and superb adhesion to flame-retardant plastics, these adhesives offer integrated protection against vibrations, improving the overall acoustics of the battery pack.



Applications

- ▶ Bonding of retainer bars onto a battery cell
- ▶ Bonding of cylindrical cells into carrier
- ▶ Bonding of busbar to carrier

Product features

- ▶ Flame-retardant
- ▶ Compensation of CTE mismatch
- ▶ Integrated vibration protection
- ▶ Improvement of acoustics
- ▶ Good adhesion to flame-retardant plastics



Your main benefit

Unmatched portfolio of high-speed UV acrylates

Assembly process

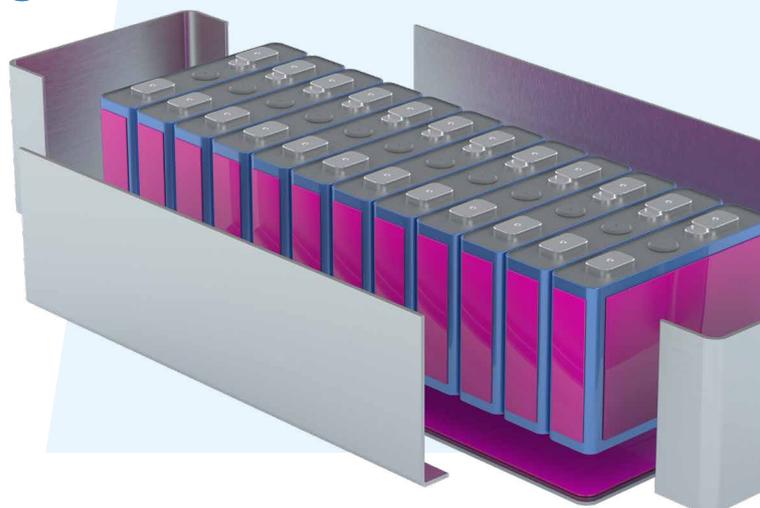
- ▶ Easy dispensing process
- ▶ Curing on demand with (UV) light
- ▶ Curing in < 10 s

Typical product properties

| | DELO PHOTOBOND | DELO DUALBOND L+H | DELO-DUOPOX DB |
|--|------------------|-------------------|---|
| Viscosity range (shear rate 10/s) [mPa·s] | 30,000 – 120,000 | 30,000 – 120,000 | 20,000 – 250,000 |
| Classification | UL 94 V-0 | UL 94 V-0 | UL 94 V-0 |
| Compression shear strength [MPa] | up to 28 (PC/PC) | up to 28 (PC/PC) | up to 32 (Al/Al) up to 40 (Glass/Al) |
| Elongation at tear [%] | 130 – 275 | 130 – 275 | 2 – 20 |
| Shore hardness D | 60 | 60 | 50 – 80 |

Structural heat sink bonding of battery cells

Battery cells for low-voltage systems are often mechanically connected to a housing or a heat sink, requiring additional gap fillers or thermal pads for heat dissipation. DELO's structural TCAs (thermally conductive adhesives) allow for battery cells to be bonded into the housing while simultaneously connecting them to the thermal management system, efficiently dissipating heat. This simplifies the production process, eliminating the need for gap fillers or thermal pads.



Applications

- ▶ Structural bonding of battery cells to housing
- ▶ Structural bonding of battery cells to heat sink

Product features

- ▶ Thermal conductivity
- ▶ Structural bonding
- ▶ Tough-elastic
- ▶ Temperature stability
- ▶ Flame-retardant

Assembly process

- ▶ Simple mixing ratio of 2 : 1
- ▶ Processing time suitable for small series and fully automated systems
- ▶ Easy room temperature curing
- ▶ Optional, quick heat curing at modest temperatures
- ▶ Adhesive does not require cooling during transportation and storage

Your main benefit

Combining structural connection and thermal management in one step



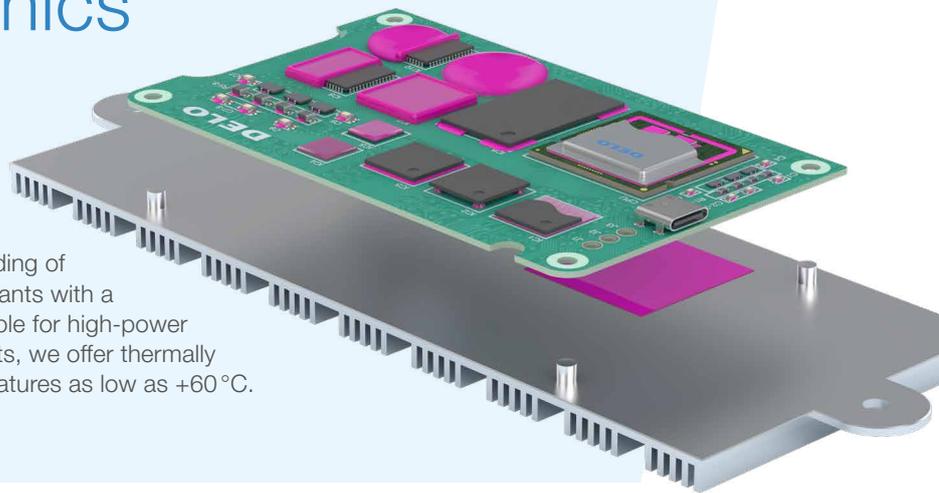
Typical product properties

DELO-DUOPOX TC (2C epoxy)

| | |
|--|-----------------|
| Thermal conductivity [W/m·K] | 1.1 |
| Tensile shear strength (Aluminum/Aluminum) [MPa] | 18 |
| Young's modulus [MPa] | 3,700 |
| Elongation at tear [%] | 2 |
| Processing time [min] | 30 |
| Initial strength (room temperature) [h] | 4 |
| Final strength (room temperature) | 90 % after 24 h |
| Heat acceleration (optional) | 60 min @ +80 °C |

Structural heat sink bonding of power electronics

When connecting heat sinks to PCBs, thermal conductivity is key. Our portfolio includes one-component epoxy adhesives with thermal fillers that offer 50 percent higher thermal conductivity when compared to our products for heat sink bonding of battery cells (see p. 5). Users also benefit from variants with a high glass transition temperature (T_g) that are suitable for high-power applications. For temperature-sensitive components, we offer thermally conductive adhesives that can be cured at temperatures as low as +60 °C.



Applications

- ▶ Thermal conductive bonding of power electronics to heat sink

Product features

- ▶ Thermal conductivity
- ▶ High strength
- ▶ Electrically insulating
- ▶ High reliability

Assembly process

- ▶ Low-temperature heat curing (+60 °C) for temperature-sensitive components
- ▶ Higher temperature curing (+150 °C) for shortest cycle times
- ▶ Multiple viscosities for control of the dispensing process
- ▶ Optional light fixation



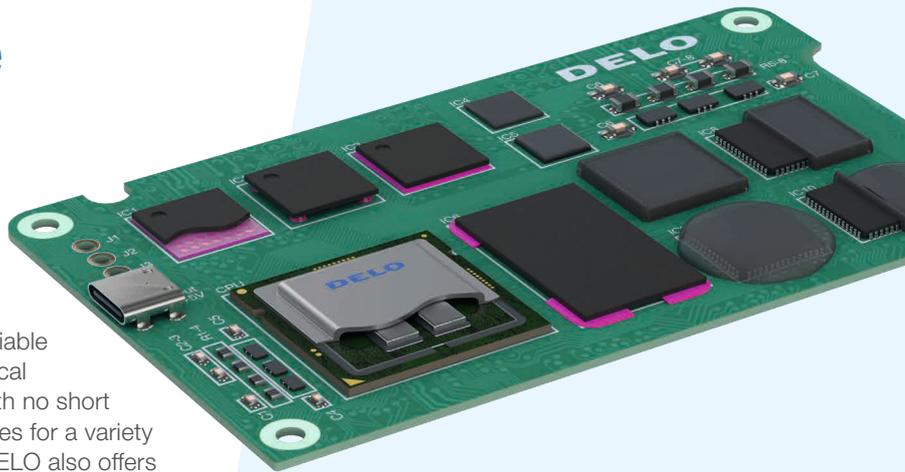
Your main benefit

High bonding strength combined with outstanding thermal management

Typical product properties

| | DELO MONOPOX TC |
|--|---|
| Thermal conductivity [W/m·K] | up to 1.7 |
| Compression shear strength (Aluminum/Aluminum) [MPa] | up to 56 |
| Viscosity (shear rate 10/s) [mPa·s] | 10,000 – 280,000 |
| Heat curing | from +80 °C to +150 °C (10 min to 30 min) |

Electroconductive bonding



With billions of RFID chips assembled annually using DELO's products, we have transferred our electrical conductivity expertise to battery electronics. DELO's reliable anisotropic conductive adhesives (ACA) connect electrical components and ensure insulation between bumps, with no short circuiting. Our large ACA portfolio offers different particles for a variety of material properties and conductivity requirements. DELO also offers non-conductive die attach adhesives. All of our adhesives are suited for high-speed thermode curing, allowing for cycle times as low as one second.

Your main benefit

Broadest portfolio of electrically conductive adhesives



Applications

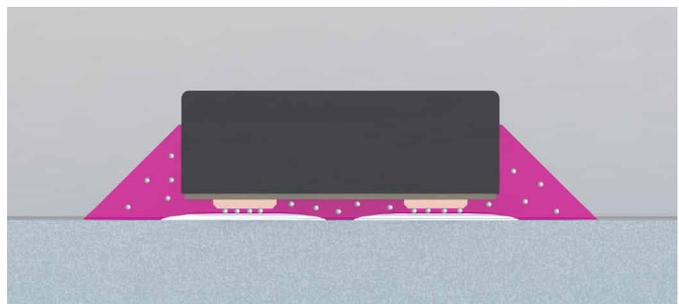
- ▶ Electrically conductive bonding of electronic components
- ▶ Non-conductive bonding of electronic components

Product features

- ▶ Reliable die attach
- ▶ Anisotropic electrical conductivity possible
- ▶ Good adhesion to FR4 and metals

Assembly process

- ▶ Excellent dispensing behavior
- ▶ Quick and easy thermode curing for ACAs
- ▶ Oven process for NCA possible



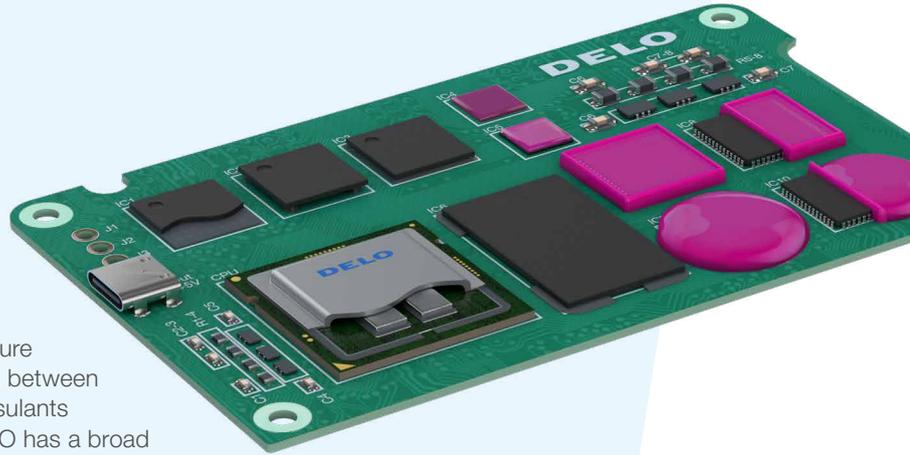
Conductive particles in ACA fillet

Typical product properties

| | Electrically conductive DELO MONOPOX* | Non-conductive DELO MONOPOX* |
|---|--|---------------------------------|
| Viscosity range (shear rate 10/s) [mPa·s] | 28,000 – 95,000 | 33,000 |
| Conductive particles | various metals | – |
| Curing time with thermode [s] | 1 – 6 | 6 |
| Curing temperature [°C] | +190 to +230 | +180 |
| Storage time (–18 °C) | 6 months | 6 months |

* modified 1C epoxy

Chip and PCB encapsulation



In battery applications, chips, SMD components or larger parts of the PCB need to be protected from mechanical and chemical influences. A high temperature resistance, as well as compensation of thermal stress between the PCB and its components, is required from encapsulants and casting compounds. For these applications, DELO has a broad portfolio that fulfills typical automotive requirements. We offer a variety of assembly process options, including different patterns of dispensing like glob top or dam & fill to give freedom of design. Our curing processes are designed for speed with the use of either light fixation or quick heat curing.

Applications

- ▶ Protection of electronic components on PCB
- ▶ Mechanical stress decoupling

Product features

- ▶ Excellent chemical and mechanical resistance
- ▶ High-temperature stability
- ▶ Good adhesion to FR4 and metals
- ▶ Low, FR4-adopted CTEs, compensating thermal stress
- ▶ Electrically insulating

Assembly process

- ▶ Excellent flow behavior
- ▶ One- or two-component products available
- ▶ Light fixation options
- ▶ Quick heat curing

Your main benefit

Industry-leading expertise in high-reliability encapsulation

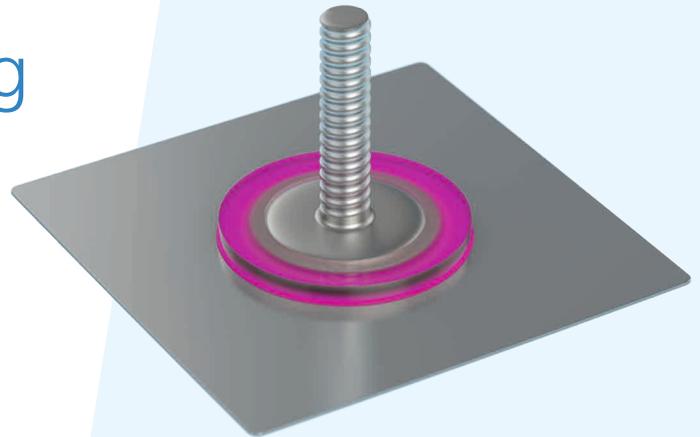


Typical product properties

| | DELO MONOPOX (1C epoxy) | DELO-DUOPOX (2C epoxy) |
|---|-------------------------|------------------------|
| Viscosity range (shear rate 10/s) [mPa·s] | 18,000 – 165,000 | A: 25,000 B: 5,500 |
| Tensile strength [MPa] | > 60 | up to 70 |
| Compression shear strength (FR4/FR4) [MPa] | 50 | 55 |
| Glass transition temperature (T _g) [°C] | > +180 | > +160 |
| Coefficient of thermal expansion (CTE) [ppm/K] | 13 – 40 | 16 |
| Heat curing | 5 – 20 min @ +150 °C | 5 min @ +150 °C |

ONSERT combining screwing and bonding

ONSERT technology combines bonding with elements of fastening. The fastener, equipped with a transparent, polycarbonate base plate, is combined with a screw. By using light-curing adhesives, the base plate can be bonded to many surfaces within seconds. This fast and reliable technology is well established in the aerospace and automotive industries. It is used for cable holders or attachment components in lightweight electric vehicles. DELO has adopted this technology for battery assembly, providing a smart and flexible solution for the fixation of battery modules.



Application

- ▶ Module fixation to bottom plate with integrated thermal management system (TMS)

Product features

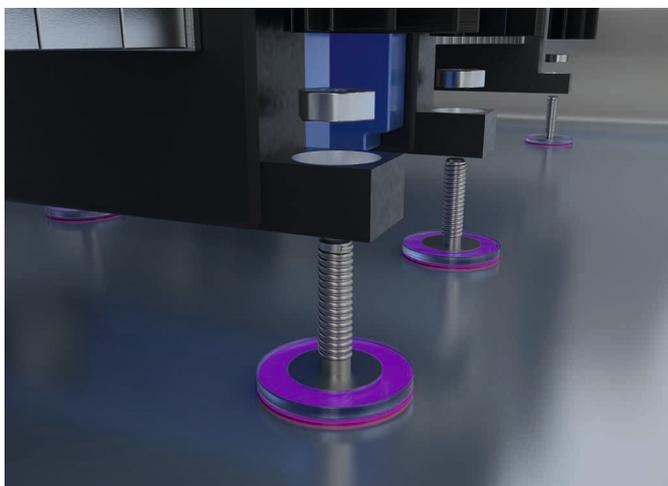
- ▶ Good adhesion to metal and plastics (pull-off strengths of up to 2,000 N with a base diameter of 25 mm)
- ▶ Removable connections
- ▶ Design freedom

Assembly process

- ▶ Rapid light curing (< 4 s)
- ▶ Immediate direct processing
- ▶ Optional secondary humidity curing for shadowed areas
- ▶ No final curing process required

Your main benefit

A unique and flexible fastening solution



A module is bonded to a bottom using threaded ONSERT bolts

Advantages

Compared to screwing / riveting:

- ▶ No drilling or die cutting
- ▶ No hole
- ▶ No additional sealing
- ▶ Gastight
- ▶ Intact coolant channels
- ▶ TMS design freedom

Compared to stud welding:

- ▶ No heat impact
- ▶ No welding spatters
- ▶ No warpage
- ▶ Thin wall thickness
- ▶ No challenge of welding different metals
- ▶ TMS design freedom

LED curing lamps

DELOLUX LED lamps are the leading technology in fast curing. They allow optimal adjustment to any adhesive used. These lamps offer high energy efficiency and can achieve a lifetime of more than 20,000 hours, which is significantly higher than that of conventional discharge lamps. For optimal curing, lamp wavelengths are adjusted to the adhesive properties. The lamps stand out for their low power consumption. Their power can be set individually. All these additional features guarantee cost-efficient production processes.



Fast

Short cycle times, high output and reproducibility



Reliable

Homogeneous intensity distribution ensures complete adhesive curing



Curing on demand

Adhesive only cures after exposure to light of the required wavelength > Precise positioning and fixation



DELOLUX 20 Version: A1/A2/A4

DELOLUX 202 Version: A1/A2

| | | |
|---|---|---|
| Description | high-intensity area lamp for even irradiation | high-intensity area lamp for even irradiation |
| Dimensions of lamp head [mm x mm x mm] | A1/A2: 112 x 112 x 121 A4: 112 x 112 x 180 | 209 x 67 x 121 |
| Light exit area [mm x mm] | 100 x 100 | 202 x 49 |
| Wavelength [nm] | 365; 400; 460 | 365; 400; 460 |
| Intensity [mW/cm²] | up to 4,000 | up to 2,000 |
| Cooling mechanism | active air cooling | active air cooling |
| Control | DELOLUX pilot and optional downstream PLC | DELOLUX pilot and optional downstream PLC |
| Reliability | intensity measurement with DELOLUXcontrol | intensity measurement with DELOLUXcontrol |

Microdispensing jet valves

Adhesive, application and desired degree of automation – these factors play a key role in the selection of suitable dispensing equipment. DELO's dispensing technology is precisely adapted to its high-tech adhesives to enable optimal production processes. Users benefit from cost-effective adhesive processing that can be integrated easily into the dispensing process. Jet systems must be compact and operate quickly and precisely. Precision is necessary for the accurate and reproducible application of tiny adhesive quantities, while speed allows fast processes, and a compact device can be integrated into any production system.



Fast

Permanent dispensing frequency of 200 Hz



Easy handling

Modular design for easy maintenance



Long-living

Actuator lifetime of > 1 billion cycles



DELO-DOT PN3

DELO-DOT D4

Actuator

pneumatically driven

piezo-driven

Min. dispensing quantity [nl]

~ 5

~ 2

Media viscosity [mPa·s]

aqueous up to 500,000

> 5,000 (thixotropic)

Permanent dispensing frequency [Hz]

140

200

Typ. actuator lifetime

> 1 billion cycles

> 1 billion cycles

Dimensions [mm x mm x mm]

90 x 20.5 x 156

86 x 17 x 52

Nozzle diameters [µm]

50 – 500 needle adapter 100, 500

100 – 400

Nozzle heating range

ambient temperature up to +100 °C

ambient temperature up to +100 °C

DELO

DELO Industrial Adhesives

China | Czechia | France | Germany HQ | Italy | Japan
Korea | Malaysia | Singapore | Thailand | USA

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 customer's responsibility to test the suitability of a product for the intended purpose by considering all specific requirements and by applying standards the customer deems suitable (e.g. DIN 2304-1). 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. Nothing contained herein shall be construed to indicate the non-existence of any relevant patents or to constitute a permission, encouragement or recommendation to practice any development covered by any patents, without permission of the owner of this patent. All products provided by DELO are subject to DELO's General Terms of Business. Verbal ancillary agreements are deemed not to exist.

© DELO – This brochure including any and all parts is protected by copyright. Any use not expressly permitted by the Urheberrechtsgesetz (German Copyright Act) shall require DELO's written consent. This shall apply without limitation to reproductions, duplications, disseminations, adaptations, translations and microfilms as well as to the recording, processing, duplication and/or dissemination by electronic means.

www.DELO-adhesives.com

