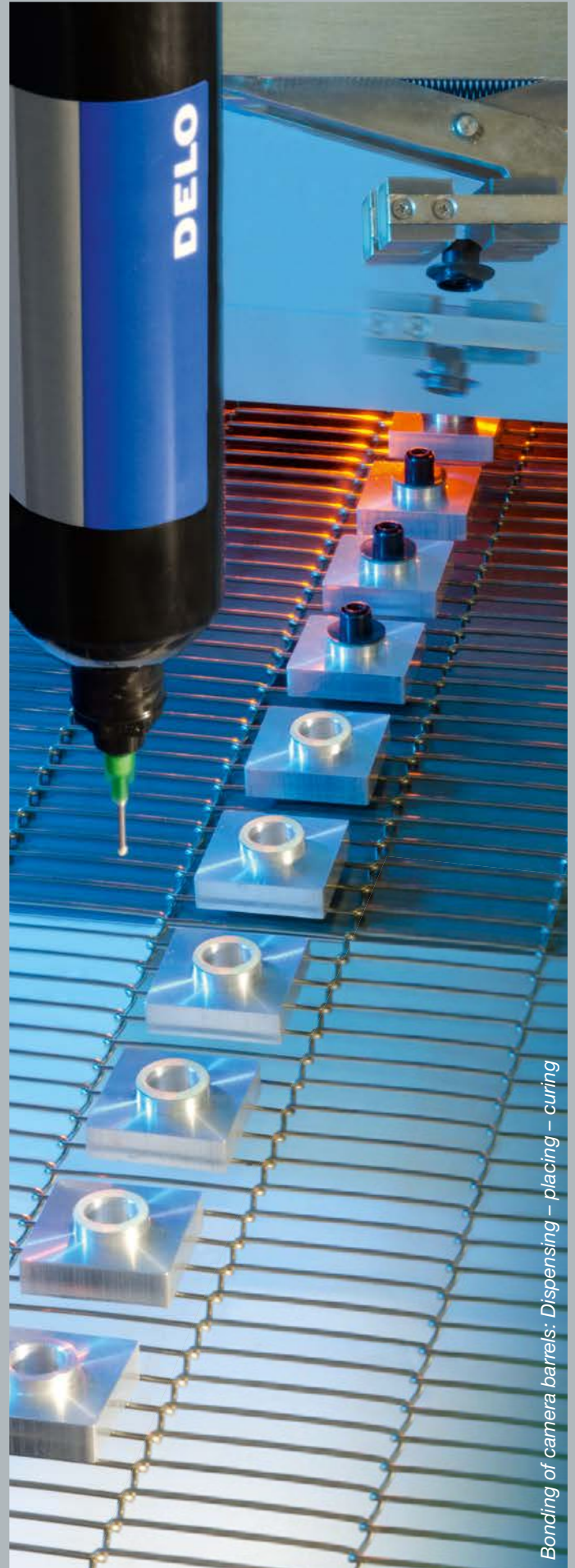


Heat Curing

Adhesives, Advantages,
and Application Areas



Bonding of camera barrels: Dispensing – placing – curing



Heat curing – fast and reliable

Heat curing – fast processes thanks to DELO

One-component, heat-curing adhesives already contain a curing component. However, this is thermally blocked so that the adhesive's ingredients do not crosslink at room temperature.

Heat curing has always been a reliable curing mechanism for adhesives, but extremely short curing times have not been possible until now.

Due to our commitment to continuous development, DELO has succeeded in perfecting the properties of heat curing, such as improved resistance to environmental influences, maximum reliability and short cycle times in production. In addition, heat-curing adhesives are easy to process.

DELO's adhesives are suitable for every kind of application area, including microelectronics, mechanical engineering, semiconductors, and motor bonding.

Flip-chip bonding

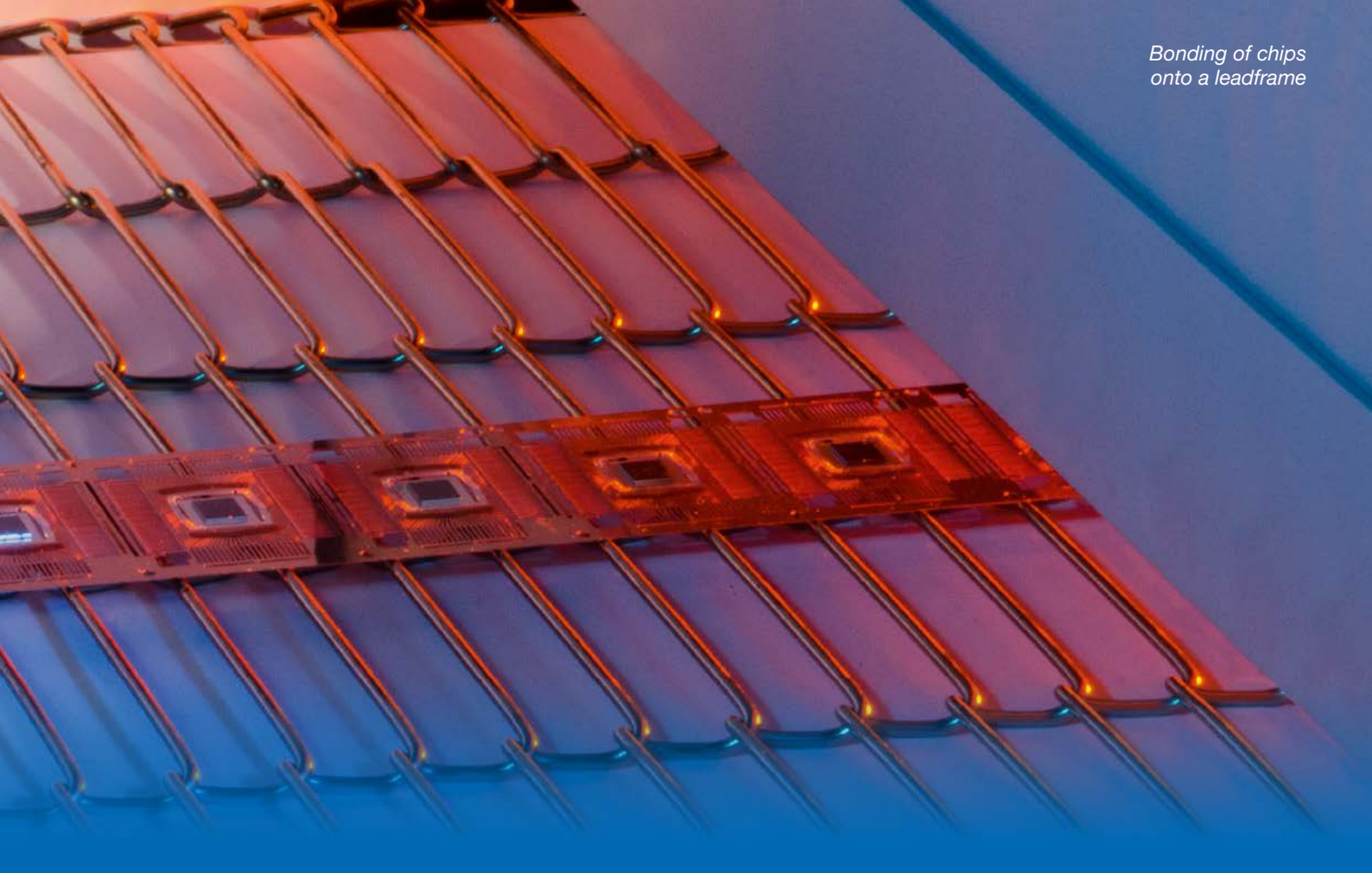


in just
6 s

Motor bonding



in just
2 min



Special advantages of DELO's heat-curing adhesives:

Advantages of heat curing	Your benefit	
Curing at low temperatures	Joining of temperature-sensitive components, greater freedom in component material selection	Page 4
Maximum reliability	Reliable functioning over the entire lifetime of the component	Page 5
High strength	High reliability of use and long lifetime	Page 6
Innovative processes	Optimized production flow, strong market position	Page 7
High flexibility	Unique selling proposition for the end product, high reliability of use	Page 8
Wide temperature range of use	Reliable functioning over the entire lifetime of the component	Page 9
Fast fixation within seconds	Short cycle times, high output, low investment and unit costs	Page 10
Excellent adhesion	High strength and long-term resistance, reliable functioning	Page 11
Miniaturization	Joining of tiny components that cannot be fixed mechanically	Page 4, 8
Product types with second curing mechanism available	Flexibility for a wide range of technological design possibilities	Page 4, 11

Adhesive colored magenta for illustration purposes



Heat curing = Curing at low temperatures

Bonding in compact camera modules

Optical components, such as lenses and image sensors, are precisely aligned using DELO DUALBOND. The adhesive remains liquid during alignment. As soon as the component has reached the position for optimal image quality, the adhesive is quickly fixed within seconds by exposure to light using DELOLUX LED curing lamps specifically adapted to this process. Subsequent final curing by heat proceeds at just +60 °C.

Technical properties of DELO DUALBOND

- Fast fixation by UV light ($\ll 1\text{ s}$ @ $1,000\text{ mW/cm}^2$)
- Curing at low temperatures:
Final curing possible at +60 °C
- Excellent adhesion to plastics, such as PBT, FR4, etc.
- Low outgassing, low shrinkage
- Good temperature stability
- Good resistance to climatic changes, humidity and in drop test
- Halogen-free according to IEC 61249-2-21

Advantages of heat curing	Your benefit
Optimized production flow	Curing at low temperatures (at just +60 °C) makes it possible to bond temperature-sensitive materials
Increased production capacity	Reliable fixation in $\ll 1\text{ s}$ (depending on the component) for short cycle times
Process reliability	Stable, low shrinkage results in high yield rate and long lifetime
High efficiency	Low energy consumption

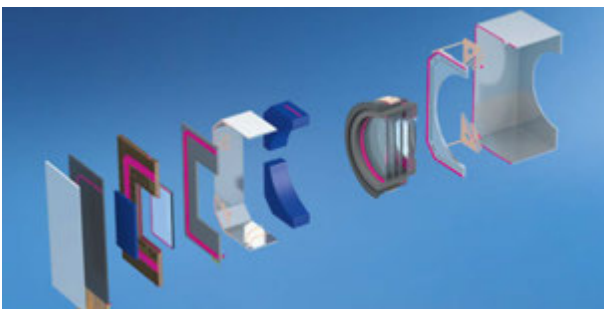


Illustration of the many bonding tasks of compact camera modules



Curing at low temperature – further examples:

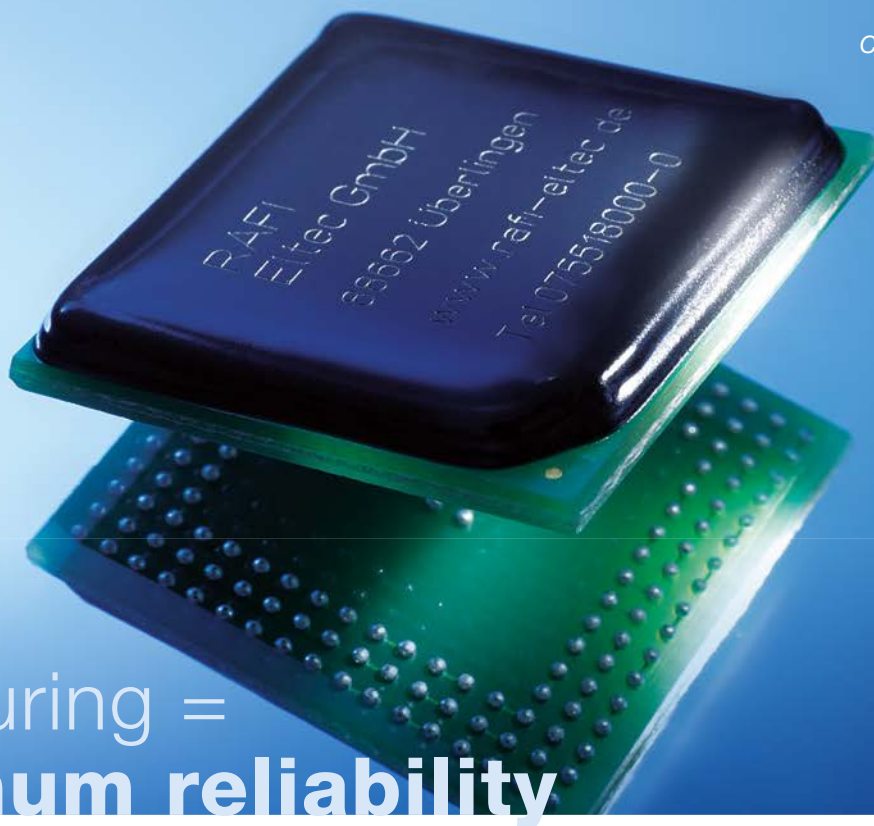
- MEMS die attach
- Chip attach
- Cap bonding



Thanks to DELO DUALBOND, it is now also possible to bond temperature-sensitive components and cure shadowed areas in a fast and highly reliable process. These adhesives are perfectly suited for the active alignment process by providing fast light curing with secondary temperature curing at only +80 °C. We often recommend that customers use DELO DUALBOND adhesives because we know that they work without fail!

Andre By, Chief Technology Officer,
Automation Engineering Incorporated





Heat curing = Maximum reliability

Chip-on-board encapsulation

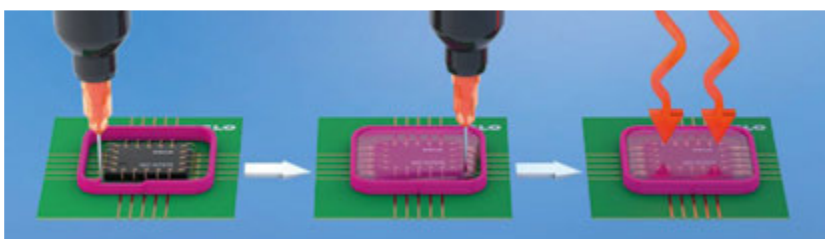
Electronic components, such as chips and sensors, must work under extreme environmental conditions in various application areas. Sensors that control the oil level or oil pressure, for example, must be highly resistant to both aggressive media and elevated temperatures. Especially for these requirements, encapsulants with anhydride-curing epoxy resin bases with outstanding media and temperature resistance have been developed.

Technical properties of DELO MONOPOX GE*

- Used as Dam & Fill or glob top
- Very low coefficient of expansion (11 – 25 ppm/K)
- Temperature of use from –65 °C to +250 °C
- Excellent media resistance to, i.e. diesel, oils, greases
- Good humidity resistance
- Variable curing parameters: Fast curing or low curing temperatures possible
- Halogen-free products available acc. to IEC 61249-2-21
- Products for fast light-fixation available

* GE = General Encapsulant

Advantages of heat curing	Your benefit
Maximum reliability	Reduction of thermo-mechanical tensions through low CTE; excellent media and temperature resistance; temperature of use of HT products up to +250 °C; reliability qualification according to JEDEC MSL 1
Optimized processing	Flow-resistant dam material for defined casting pattern; excellent flow properties of the fill material without substrate heating
Increased production capacity	Curing at +150 °C in 20 min; dam stacking without intermediate curing steps; curing of dam and fill in one step



*Dam stacking without intermediate curing:
Stable dam before and during curing, curing of dam and fill in one step*

“ DELO's highly reliable encapsulants allow curing of both Dam and Fill in just one step. Expensive intermediate steps are omitted and production capacity is increased. This is a definite benefit to us.

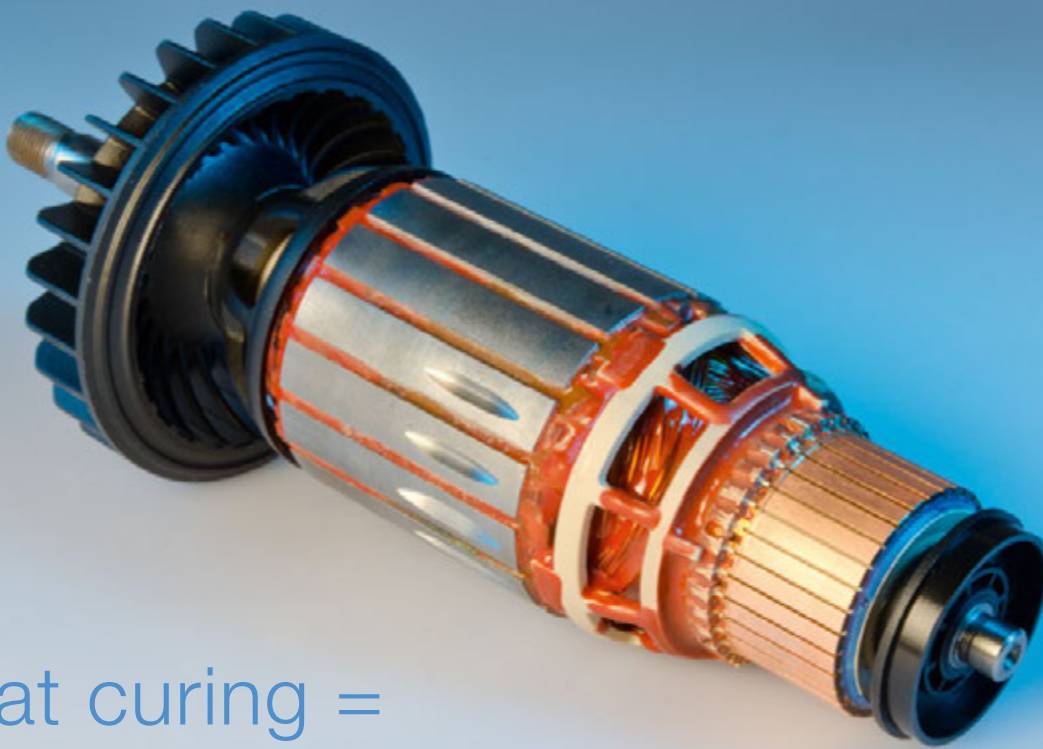
*Michael Walsh MPhys,
Technical Lead / R & D,
Xaar Technology Ltd*

”



Maximum reliability – further examples:

- MEMS die attach for oil pressure sensors
- Large-area encapsulation of PCBs



Heat curing = High strength

Bonding in electric motors

Increasing demands on electric motors in a broad variety of application areas are also boosting the design-related requirements on the bonded connections of individual motor components. The key principle for the development of the latest generation of electric motors is a compact and efficient design. DELO has developed a powerful product range especially to address these bonding challenges.

Technical properties of DELO MONOPOX

- High strength
- High impact resistance
- Low shrinkage
- Gap-filling
- High media and temperature resistance (up to +220 °C)

Advantages of heat curing	Your benefit
Increased reliability of use and longer lifetime	High strength for reliable functioning even after years of use
Maximum reliability	High functionality even when subject to aggressive media and elevated temperatures
Optimized processing	Efficient dispensing thanks to gap-filling properties; short cycle times by induction curing

Electric motor in compact angle grinder
© Metabowerke GmbH



High strength – further examples:

- Bonding of magnesium suction pipe modules
- Fixing of GRP angles for rollercoasters



We use DELO adhesive in our compact angle grinder where the requirements in terms of adhesion and temperature resistance are very high. We chose DELO MONOPOX because it offers the most suitable properties for these complex conditions compared with other adhesives.

*Michael Schmohl,
Head of R&D Motors, Metabowerke GmbH*





Dispensing of the conductive
DELO DUALBOND IC using
DELO-DOT PN3, light fixation
using DELOLUX, curing at low
temperature in tunnel oven

Heat curing = Innovative processes

Conductive bonding of microelectronic components

Microelectronics production is placing an ever-growing importance on components being attached to a substrate with the highest reliability. When the component is placed onto the printed circuit board by a machine, it must not shift or float during later movement of the assembly or final curing. For this purpose, DELO supplies specially designed adhesives that can be fixed by light and subsequently cured by heat.

Technical properties of DELO DUALBOND IC*

- Very fast light fixation strength in 0.2 s
- Curing at low temperatures from +80 °C
- Excellent adhesion to plastics, gold, silver, and silicon
- Low shrinkage
- Low outgassing

* IC = Isotropic Conductive

Advantages of heat curing	Your benefit
Optimized processing	Fast fixation by light within 0.2 s prevents the components from shifting or floating on the PCB, and enables short cycle times
Reliable functioning	Miniaturization of the components results in improved optical properties of the IR sensor components
Maximum reliability	Reliably passes consumer test requirements



Innovative processes – further examples:

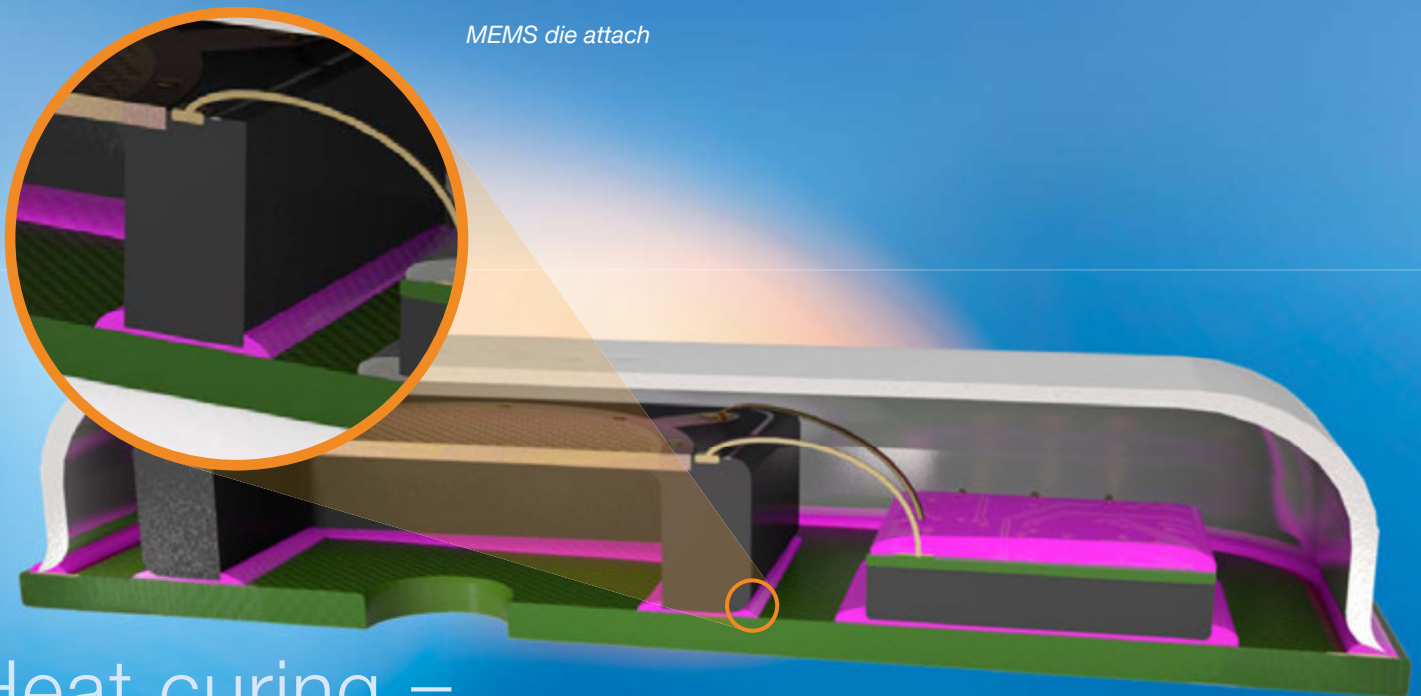
- Chip attach
- Bonding of IR housing
- Lens bonding



DELO DUALBOND enables reliable placing, precise positioning and fast, high-strength adhesive curing. DELO fulfills these key criteria for the increasing requirements of chip bonding!

Dr. Hugo Pristaux, VP Flip Chip, Besi Switzerland AG





Heat curing = High flexibility

MEMS packaging

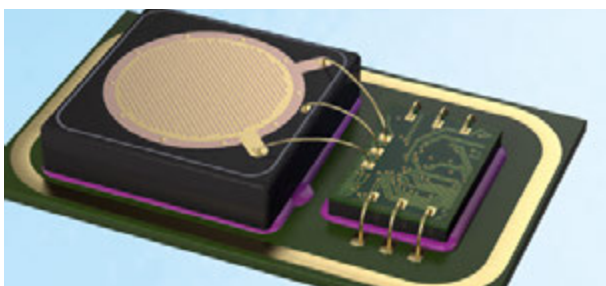
Microelectromechanical systems (MEMS) are found in many everyday products. In particular, mobile phones and automotive assemblies contain numerous MEMS elements, such as pressure sensors or accelerometers. Adhesives for MEMS packaging must overcome unique challenges. Particularly when bonding the MEMS chip to the substrate, high flexibility and high strength of the adhesive is required. It is essential that tensions on the MEMS structures, such as those arising from temperature changes for example, are relieved and associated changes in signal characteristics prevented.

Technical properties of DELO MONOPOX DA*

- High flexibility
- High die shear strength
- No embrittlement after thermal stress
- Easy to process
- Precise dispensing
- Curing at low temperatures (+80 °C) possible

* DA = Die Attach

Advantages of heat curing	Your benefit
Best function	Reduction of thermo-mechanical tensions through highest flexibility and curing at low temperatures
Increased production capacity	Fast curing (i. e. 15 min at +130 °C)
Maximum reliability	No embrittlement after thermal stress; highest die shear strength



Microelectromechanical system



High flexibility – further examples:

- Bonding in electric motors
- Die attach
- Cap bonding

Magnetic rings are bonded in the 8HP 8-speed transmission of the ZF Friedrichshafen AG (see figure below)



© ZF Friedrichshafen AG

Heat curing = Wide temperature range of use

Bonding magnet rings for automatic transmissions

Saving CO₂ emissions and lowering fuel consumption; these demands on the automotive industry are ever growing. By saving material and fuel, modern transmissions can contribute to a more environmentally friendly way of driving. For the 8HP 8-speed transmission made by ZF Friedrichshafen AG, magnetic rings are used. DELO MONOPOX bonds a plastic-infused magnetic ring to an aluminum retaining ring to form a transducer ring system.

Technical properties of DELO MONOPOX

- Excellent adhesion to metals, ferrites, magnets and many technical plastics
- Very high strength, even at elevated temperatures
- Resistance to media, humidity and vibrations/shocks
- Wide temperature range of use from –55 °C to +200 °C
- High run resistance even during heat curing

Advantages of heat curing	Your benefit
Simple solution	Bonding is the perfect joining method; due to their brittleness, it is not possible to directly connect the magnetic rings to the transmission components. Therefore, they are bonded to a retaining ring
Optimized production flow	Easy, reliable assembly of the magnetic ring in the transmission in a fully automated production process
Maximum reliability	Reliably passes all automotive tests; permanent use of the magnetic rings at temperatures between –40 °C and +180 °C and at speeds up to 10,000 revolutions per minute



Transducer ring system of MS-Schramberg for the 8HP 8-speed transmission of ZF Friedrichshafen AG (see figure above)



Wide temperature range of use – further examples:

- Bonding of suction pipe modules
- Bonding of cylinder cover
- Bonding of tool blades



For us, heat curing is the key to a permanent and reliable connection. Bonding technology is the ideal method for joining the magnetic ring to the retaining ring. Therefore, bonding with DELO is not an alternative, but our first choice.

Dietmar Schwegler, Head of Product Development & Sales, MS-Schramberg



Heat curing = Fast fixation within seconds

Flip-chip bonding

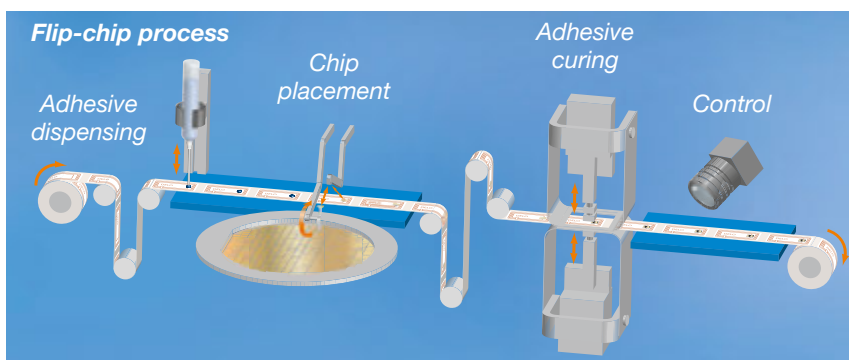
Flip-chips are equipped with electrical connectors directly at the bottom so that they have very small footprints and offer cost benefits in production and later processing. With DELO MONOPOX AC adhesives, flip-chips (such as those on RFID labels) are reliably electrically contacted and mechanically connected in seconds.

Technical properties of DELO MONOPOX AC*

- Fast thermode curing in seconds
- Permanent electrical reliability
- Universal adhesion to PET, Al, Cu, Si, Au, paper
- Suitable for needle dispensing (250 µm) and jetting of small adhesive quantities (less than 0.03 mg)

* **AC** = Anisotropic Conductive

Advantages of heat curing	Your benefit
High production capacity	Increased production output thanks to curing within seconds results in low investment and unit costs
Reliability of use	Optimal solution for products with a long lifetime and broad range of use; function is ensured
High process reliability	Maximum yield rates (> 99.9 %) thanks to optimized particle mixtures; excellent reproducibility even of extremely small dispensing quantities by jetting
More flexible production	Multi-purpose adhesive for various substrates and chips enables short changeover times and fast process adaptation



Fast fixation within seconds – further examples:

- Smart card die attach
- LED die attach
- Heat pulse process

“When bonding flip-chips, short cycle times of less than 10 seconds are decisive for clearly reducing the unit costs and increasing the production volume. DELO's comprehensive support enabled us to successfully implement our project.”

*Dr.-Ing. Frank Kriebel,
Director Advanced-Development
SMARTRAC Technology GmbH*

Figure: Würth Elektronik GmbH & Co. KG

Heat curing = Excellent adhesion

Printed circuit board – SMD assembly, PCB embedding

1) DELO MONOPOX SMD assembly adhesives are multi-purpose for a broad variety of substrates. Thanks to curing at low temperatures (approx. +80 °C), these adhesives can also be used for temperature-sensitive substrates.

2) When embedding PCBs with DELO DUALBOND mCD, the components are light-fixed in less than 1 second immediately upon placement onto the copper plate. As a result, the necessary placement accuracy is also maintained during handling down the line. During the in-line process, the adhesive is later heat-cured at low temperatures.

Technical properties of DELO MONOPOX

- Universal adhesion
- Highly reliable fixation of MELFs (Metal Electrode Leadless Faces)
- Very good wet strength
- Low extractable ion content: Na⁺, K⁺ below 10 ppm

Technical properties of DELO DUALBOND mCD*

- Halogen-free according to IEC
 - Preliminary fixation by UV light (320 – 400 nm) in 1 – 5 s; heat curing at +80 °C to +130 °C
 - CTE adjustable by filler content (more than 60 ppm)
- * mCD = modified polycarbamin acid derivatives

Advantages of heat curing	Your benefit
High efficiency	Curing during wave soldering, reflow or laminating processes saves additional curing steps
Reliable processing	Fast curing and low curing temperatures possible; easy dispensing
Innovation	Fast fixation by light in less than 1 s possible with DELO DUALBOND
Reliable functioning	High strength and long-term resistance



Excellent adhesion – further examples:

- Sensor casting
- MEMS



The DELO DUALBOND adhesives enable us to fix our components directly after placing them onto the copper plates. This prevents shifting of these components during further processing steps of the PCBs. Heat curing proceeds in the line in an oven at +130 °C to +150 °C.

Jürgen Wolf,
Assistant Manager Research & Development,
Würth Elektronik GmbH & Co. KG





DELO's heat-curing adhesives

Chemical basis	Aminic epoxy	mCD	VLT	Anhydridic epoxy	Acrylate	Cationic epoxy
Properties	oven curing at +90 to +180 °C broad product diversity good temperature and media resistance high bond strength	oven curing at +80 to +150 °C very fast curing fast light fixation silicone-like behavior possible	oven curing at +60 to +150 °C curing at very low temperatures wide viscosity and Young's modulus range	oven curing at +125 to +180 °C very good temperature and media resistance low CTE	oven curing at +80 to +130 °C very fast curing very low viscosity possible	oven curing at +90 to +180 °C good temperature and media resistance adjustable flow behavior low CTE
Light fixation	✓	✓	✓	✓	✓	✓
Microelectronic bonding						
Active/passive alignment		✓	✓			✓
Die attach	✓	✓		✓		✓
Component fixation	✓	✓	✓	✓	✓	✓
Isotropic electrically conductive	✓	✓		✓	✓	✓
Anisotropic electrically conductive	✓		✓			✓
Thermally conductive (electr. insulating)			✓		✓	✓
Structural joining						
Thermally conductive (electr. insulating)	✓					
High temperature resistance	✓					
General encapsulation						
Coating					✓	✓
Dam & fill / glob top				✓		✓
Potting	✓	✓		✓	✓	✓



Adhesive dispensing

In order to better utilize the advantages of heat-curing in production, including resistance, maximum reliability and fast processes, DELO has developed complementary

dispensing technology, such as the DELO-DOT PN3 jet valve and DELO FLEXCAP.

DELO-DOT PN3 microdispensing valve – Precise, compact and light-weight

The pneumatic DELO-DOT PN3 microdispensing valve is precise, fast and compact. It has an operating frequency of up to 330 Hz (drops per second). This unique system is made to be robust due to its modular design. This design allows the dispensing valve to be easily

disassembled into its single parts. The fluid system is strictly separated from the actuator. This avoids time-consuming cleaning, and the valve can be put into operation again quickly. The actuator has an extremely long lifetime of more than 1 billion cycles.

DELO FLEXCAP with integrated fill level sensor in the pressure tank

A flexible, hermetically tight foil replaces the conventional cartridge piston. As a result, adhesives can be stored, transported and dispensed without bubbles. The cartridge system which is free of trapped air enables the highest dispensing reliability, precision and maximum emptying. DELO FLEXCAP is available in 10 ml and 30 ml container. The fill level sensor of the pressure tank for DELO FLEXCAP provides benefits for fully automated production. Integrated sensors transmit a signal that indicates when the cartridge is nearly empty and again when it is completely empty. As a result, the user can prepare a new cartridge in time to minimize downtime.

Advantages at a glance:

- Process reliability thanks to bubble-free dispensing
- Reproducible processes with a high yield rate
- Easy to integrate into every production system
- Cost savings through reduced waste, minimized downtime, and maximum emptying of the cartridges
- The air-tight cartridge enables easy and cost-efficient transport



All DELO products are developed and produced in Germany, ensuring the highest quality of design and manufacture.



Idea

- Define the adhesive requirements together with the customer
- Determination of process specifications

Design

- Analysis of the adhesive characteristics in relation to the technical and quality requirements
- Tests in DELO's lab
- Adhesive samples for customers

Prototype

- Functional tests on the prototype
- Customer conducts test under operating conditions
- Fast on-site support

We pave the way to your success

We support our customers from the earliest product development phase, help them integrate our products in their manufacturing processes, and provide support during ongoing production whenever required.

In addition, DELO has a large network of partners. We collaborate with them extensively and work for your success.

Your contacts for process design



Besi



Mühlbauer
High Tech International

ruhlatomat
solutions for your needs.

MACK
GROUP

Your contacts for adhesive dispensing

DELO

axiss
Achs- und Dosiersysteme GmbH

bdtronic

DATRON
Innovative Produktionstechnologien



MUSASHI
ENGINEERING INC.

Nordson
ASYMTEK



VIEWEG





Introduction

- Joint determination of process specifications based on the prototype phase results
- On-site process and start-up consulting

Production

- Ongoing intensive customer support during production
- Process finetuning where necessary
- Support of quality assurance

Ongoing support

- Global support
- Adapt to process changes
- Assist the customer in improving process efficiency
- Application-specific training

Adhesive heat curing

Ovens

The adhesive is heated and cured by warm ambient temperatures in the oven. For a steady curing progress, **air convection ovens** should be preferred.

Tunnel ovens enable cost-efficient in-line thermal processes.

Application examples:

- Bonding in compact camera modules (page 4)
- Chip-on-board encapsulation (page 5)
- Bonding of microelectronic components (page 7)
- MEMS packaging (page 8)
- SMD assembly, PCB embedding (page 11)

Heated stamps/thermodes, presses, heating elements

The heat required for adhesive curing is transmitted to the component to be bonded through direct, punctiform contact. For this purpose, heated plates, pliers, grippers or (multiple) stamps are used. The heat is conducted to the adhesive and triggers fast curing in seconds. The thinner the component and the adhesive layer, the better the heat transfer and the faster the curing process. This type of curing is especially suitable for in-line processes.

Application examples:

- Flip-chip bonding (page 10)
- Bonding of friction linings

Induction

Electrically conductive components are inductively heated up to +180 °C in seconds. Therefore, the adhesive is quickly cured (sometimes in less than 1 min). Induction systems consist of a voltage generator and a coil surrounding the component.

Via a pyrometer, a thermal control system can be installed. The precision of the pyrometer measurement is influenced by the surface properties (for example, color, degree of reflection, roughness).

Application examples:

- Bonding magnetic rings for transmissions (page 9)
- Bonding slot magnets
- Bonding in electric motors (page 6)

Infrared radiators

IR radiators are used in curing ovens. However, they can also be externally integrated into the bonding process.

Very large areas are cured by IR panels – small, selective areas are cured by spot radiators without heating the whole component.

Application examples:

- Chip-on-board encapsulation (page 5)
- SMD assembly, PCB embedding (page 11)

Your contacts for adhesive curing






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 - **Taiwan** · Taipei
 - **Thailand** · Bangkok
 - **USA** · Sudbury, MA

..... www.DELO-adhesives.com

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07/19

ADHESIVES

DISPENSING

CURING

CONSULTING

DELO